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Aerospace Medical Service Journeyman

Volume 1. Patient Care Skills I

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Material in this volume is reviewed annually for technical accuracy, adequacy, and currency. For SKT purposes the examinee should check the *Weighted Airman Promotion System Catalog* to determine the correct references to study.

The B4N051, Aerospace Medical Service Journeyman, course contains three volumes. The volumes in this course should be fun for you to read as these aspects of patient care are often the ones that 4N0s enjoy the most!

This first volume addresses patient care skills that are commonly performed in the outpatient clinic setting. The second volume addresses patient care skills that are more commonly performed in an inpatient setting and are generally more advanced skills that you will need to learn as a 4N0X1.

The third volume is dedicated to medication administration and pharmacology. It is a challenging but necessary set of skills and knowledge you need to be familiar with as you become a 5-level. You will continue to build your knowledge base the longer you are in the medical field and as you gain experience as a medical technician.

The following information is covered in this first volume:

Unit 1 begins with a look at infectious agents and the infectious process. Theory and technical knowledge on body substance isolation, principles of isolation, sterility of supplies and equipment and communicable disease reporting are covered here.

Unit 2 is dedicated human growth and development and factors that influence health. The information you learn in this unit can be applied in all aspects of patient care and treatment, regardless of where you work.

Unit 3 introduces you to many skills that you will need to be knowledgeable of and be able to perform in outpatient clinics. The skills you learn here can also be applied to inpatient or deployed medicine. You will learn how to start and maintain intravenous infusions (IVs); perform electrocardiograms and a host of other tests and procedures.

Unit 4 continues to build on your clinical skills and covers procedures that you will likely complete, such as suturing; or assist with, such as basic physicals to more diagnostic examinations.

Unit 5 is dedicated to emergency response and procedures. You will be introduced to information on ambulance response and emergency patient assessment in this unit.

The information in this unit is designed to assist you in determining the correct patient care procedures involved with commonly encountered examinations and treatments in the clinical setting.

A glossary of abbreviations and acronyms used in this course is included at the end of this volume.

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This volume is valued at 27 hours and 9 points.

NOTE:

In this volume, the subject matter is divided into self-contained units. A unit menu begins each unit, identifying the lesson headings and numbers. After reading the unit menu page and unit introduction, study the section, answer the self-test questions, and compare your answers with those given at the end of the unit. Then complete unit review exercises.

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Unit 1. Infection Control

AS A 4N0X1, you must be extremely aware in both the medical facility and field environment of the potentially life-threatening hazards of communicable diseases. As a medical professional, you cannot deny care to a patient who you suspect has a communicable disease, even if you feel the patient poses a risk to your safety. To deny care in this situation is considered abandonment. Alternatively, a thorough understanding of the infectious process will allow you to practice prevention while providing patient care.

In this unit you will learn the characteristics of each link and how they interact with each other to complete the infectious process. We will begin with a look at the infectious process, including a discussion of the types of causative agents and characteristics of the infection chain. We will then look at some of the more common communicable diseases known to us and briefly discuss the reporting process. The next section will discuss the practices used to prevent, isolate, and contain these diseases within our facilities.

1–1. Communicable Disease Management

Although there are literally millions of microorganisms capable of causing disease, relatively few people actually develop illnesses from them. This section begins with an explanation of some infectious agents and then goes into detail on the process that allows these agents to grow and flourish into communicable diseases. The information you learn here will help you know what actions you can take to protect yourself and your patients and prevent the spread of disease.

001. General patient care skills

Patient care starts each time 4N0s, nurses, and other medical professionals greet patients in a clinic or hospital. Phase I introduced you to a wide variety of inpatient and outpatient tasks; in phase II you practiced these skills while rotating through Family Practice, Emergency Room, and medical-surgical wards, and at the end, gained confidence while working alongside 4N0 trainers, preceptors, and nurses. The following table on patient care skills displays some examples of general patient care skills that 4N0s perform in USAF-wide duty sections:

Patient Care Skills	
Workcenter	**General Skills Type**
Dermatology	Set-up minor surgery
General Surgery	Set-up/maintain sterile field
Family Health Clinic	Perform height and weight measurements
Pediatrics	

Patient Care Skills	
Workcenter	**General Skills Type**
Emergency Room	Record temperature
Urgent Care	Assess pain scale
Labor & Delivery	Perform and label venipuncture
OB/GYN	Assess APGAR score
Allergy Clinic	Obtain body measurements
Gastroenterology	Perform immunizations
Internal Medicine	Collect and label emesis, urine, stool samples
Intensive Care Unit	Assess respiratory rate
	Perform intake and output measurements

A more detailed listing is in your section's Master Training Plan (MTP) and Career Field Education & Training Plan (CFETP). In addition to general patient care skills, 4N0s record patient vital signs and/or assist with the treatment of various illness(es). These types of assessments require strict adherence with infection control protocols as medical technicians are frequently involved in caring for patients and/or handling equipment. The following table on equipment lists some general equipment types used when care is provided. Again, check duty section MTP and CFETP for a more detailed list.

Equipment
Hospital bed
EKG machine
Cardiac monitor/defibrillator
Wheelchair
Stretcher
Electronic thermometer
Doppler stethoscope
Pulse oximeter
Electric sphygmomanometer
Feeding pump
IV pump

Infection control

The Joint Commission (TJC) requires every hospital to have an active, effective, hospital-wide infection-control program to receive accreditation. Not only is infection control important for accreditation, it is absolutely necessary to make sure that the risk of infection—for both patients and staff members—is eliminated. We now look at some of the infection control measures and programs found in Air Force medical facilities, particularly those related to surgery. Infection control encompasses a variety of activities inside and outside the surgical suite. This subject is so broad that a complete, detailed discussion is impractical for this text. So, we limit our discussion of infection control to the major topics of concern for surgical personnel.

General principles

The Centers for Disease Control and Prevention (CDC) is a US public health service agency that provides valuable information to hospitals and outlines how infection control programs should be developed and operated. The CDC also assists hospital infection control personnel in solving infection problems, analyzing infection survey data, and investigating the outbreak of serious infections or disease. One of the CDC's most important functions is conducting research and publishing guidelines on a variety of infection control topics. We use many of these published guidelines for developing infection control programs, policies, and procedures.

In addition to the CDC, numerous other government agencies and private organizations provide information, guidance, and consultation services to hospital infection control personnel. These agencies include local, state, and federal public health services, the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the agency mentioned previously, TJC. Information regarding surgery-specific infection control practices is also found in publications provided by the American College of Surgeons (ACS) and the Association of periOperative Registered Nurses (AORN).

TJC establishes the criteria by which hospitals are evaluated to determine whether they should be accredited. Infection control programs are a major area of consideration. To attain certification, TJC requires that each facility have a coordinated process to reduce the risks of nosocomial infections in patients and healthcare workers, and this process must be managed by one or more qualified individuals. In most hospitals, the infection control process is managed by an infection control committee.

The Infection Control Committee

The Infection Control Committee (ICC) is a multidisciplinary committee charged with managing the Infection Control Program (ICP) to meet the standards of TJC and AFI 44–108, *Infection Prevention and Control Program*. The executive committee of the medical staff oversees the ICC, and only it can override the recommendations or actions of the ICC (a very rare occurrence). ICC members are responsible for informing personnel of the committee's decisions and actions as well as their own individual responsibilities. Each ICC member must also promote awareness of and compliance with existing infection control directives.

Functions of the ICC

Air Force medical facility ICCs implement national standards, such as those of TJC and OSHA, and Air Force directives, such as AFI 44–108. The committee must clearly define nosocomial infections and establish a system of reporting and investigating infections among patients, personnel, and visitors. It also keeps records of infections and its recommendations for remedial measures. The committee distinguishes, to the best of its ability, between nosocomial infections and other types of infections. The ICC interacts with other committees as needed.

Infection control officer

An infection control officer (whose credentials reflect knowledge, special interest, and/or experience in infection control) is appointed in writing by the facility commander. Usually, the infection control officer is a registered nurse with training and background in epidemiology (study of diseases), microbiology, statistics, and research methods.

Departments, patient care units, and support areas

Each department, patient care area, and support facility develops and maintains written area-specific operating instructions (OI) that explain policies and procedures for infection control. Each area is responsible for reviewing the documents annually and revising as necessary. The ICC reviews and approves these OIs at least every two years. Two exceptions to this rule are the bloodborne pathogen exposure control plan (required by OSHA) and patient isolation plans, which are reviewed annually.

002. Understanding infectious agents

Microorganisms are minute living structures, generally categorized as plants, animals, or viruses. Some organisms are called *parasites* because they rely on a living *host* organism to sustain their existence. Microorganisms found in soil, water, and debris and live off dead or decaying organic matter are called *saprophytes*. Some saprophytes, such as *Clostridium tetani* (the "bug" that causes tetanus or lockjaw), cannot live in healthy living tissue. Instead, they require dead (necrotic) tissue like that found in an old, untreated wound to survive. After reading this section, you should have a clear understanding of the basis of infectious agents.

Microorganism classification

Microorganisms are classified in many ways, but for our purposes, we will concentrate on whether they are pathogenic or nonpathogenic and whether they are resident or transient.

Pathogenic microorganisms

When microorganisms grow in or on the tissue of another life form and cause damage or disease, they are called *pathogenic*. Pathogenic microorganisms can enter the human body through a break in the skin or through a body orifice or tract that links internal body structures to the outside environment. They produce disease either because growth of the microorganism destroys surrounding tissue or because they produce toxins (poisons) which, in turn, cause disease. Pathogenic microorganisms include bacteria, viruses, fungi, molds, yeasts, rickettsiae, and protozoa.

Nonpathogenic microorganisms

Not all microorganisms are pathogenic (disease-producing). There are millions of microorganisms on your skin, in your mouth and nose, in the air you breathe, in the water you drink, and on just about everything you come in contact with. Most of these *nonpathogenic* microorganisms are harmless, and many play vital roles in maintaining normal human body function and the delicate balances in nature as a whole. However, some organisms are nonpathogenic in their normal environment but become pathogenic when introduced into another environment. For example, the bacteria *Escherichia coli* (*E. coli*) are normally found throughout the intestines but can cause a severe illness or infection when introduced into tissue outside the intestines.

Resident microorganisms

Resident microorganisms, or normal flora, live in the deep cracks and folds of the skin or in body orifices, such as the oral cavity or intestinal tract. As previously stated, many resident microorganisms are beneficial because they help maintain chemical balances within the body.

Transient microorganisms

Transient microorganisms have a very short life span and reside on the external surfaces of an object or live organism. The bacteria that grow and multiply on your skin and the microorganisms that can be found on the floor and walls of patient rooms, surgical suites, and so forth are examples of transient microorganisms.

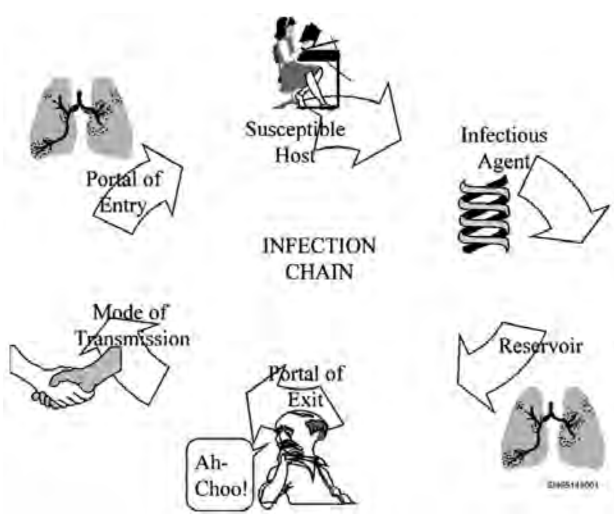


Figure 1–1. Infection chain.

The Infection chain

The key to control the spread of infection lies in the nature of the infectious process. As shown in figure 1–1, the infectious process, or “chain,” is made up of six links. The links include an infectious agent (also called causative agents), a reservoir, a portal of exit, a mode of transfer, a portal of entry, and a susceptible host. These links must form a continuous cycle to allow infection to develop and spread. For an infectious disease to occur, each link in the chain must be connected. Any break in the chain (or cycle) at any point will prevent the manifestation or spread of the disease.

Infectious agents

The first link in the infectious process chain is concerned with infectious or causative agents. These minute organisms invade and inhabit tissues in various parts of the body and cause disease by producing toxic substances or by destroying parts of the cells they have invaded. They are commonly referred to as "*microorganisms*" because most of them are so small they cannot be seen with the naked eye. This label is not entirely correct, however, because not all microorganisms are infectious or small. Microorganisms exist in almost every aspect of our environment. They reside both inside our bodies and on our skin and hair; however, most forms cannot survive in a human or animal environment and normally do not pose a threat to our health. Additionally, not all causative agents are microorganisms, although the greater majority of them are. For example, adult helminths (worms/a true parasite) are large enough to be seen without a microscope; yet, some forms can invade body tissues and cause disease. Do not confuse the term *parasite* (living off a host) with a *true parasite* (helminths). There are several terms used to describe some of the characteristics of microorganisms and the interesting relationships they have developed with their human hosts. Some of these are covered in the following paragraphs.

Normal flora

Shortly after birth, a number of different microorganisms inhabit various parts of our bodies. These microorganisms differ from person to person. We contract normal flora from exposure to various sources within our environment. They're usually found in a specific body area and are referred to as "normal" flora for that area. Normal flora exists in a state of equilibrium with the host. The microorganisms are potentially pathogenic, but as long as nothing disturbs the balance, they are not harmful. In some cases, normal flora can be beneficial. Let's use the example of *E. coli* bacteria again, which are normal flora for the intestinal tract. *E. coli* are involved in the production of vitamin K, which plays an important role in the clotting process. If disease or antibiotics disturb the normal flora and body balance, or if the normal flora is exposed to another part of the body, the microorganisms will cause disease. In fact, many of the infections found in hospitalized patients are caused by the activity of normal flora.

Commensalism

When pathogens invade a host and attempt to cause disease, the host usually responds by trying to either destroy or eliminate the microorganism. In some cases, after repeated exposures, the host will develop a tolerance for the pathogen. Such a relationship is called *commensalism.* As long as nothing disturbs the balance, the pathogenic organism will be able to live inside the host without producing an infectious reaction. As with normal flora, however, if the balance is disturbed, commensal organisms can cause infection and disease.

Carrier state

In general, most microorganisms are nonpathogenic, a few are weakly pathogenic, and some are strongly pathogenic. Once introduced into the human body, strongly pathogenic microorganisms cause disease in almost every case. A few individuals are able to withstand the effects of the pathogen. The pathogen inhabits their bodies but does not produce any symptoms of infection. Although they are not affected by the pathogen, they are still able to pass the pathogen onto other, more susceptible individuals. These individuals are called *carriers*. One famous example of a carrier was Mary Mallon (also known as Typhoid Mary). Typhoid Mary was a cook in New York City in the early 1900s. She was diagnosed as a carrier of typhoid fever in 1907, but she continued to practice her profession until 1915. It is estimated she was responsible for at least 10 outbreaks of typhoid fever, with at least three associated deaths.

Infectious state

Infection is the pathogenic relationship with which you are most concerned. An infection occurs when one of the infectious agents invades the body through one of the entry portals (discussed in lesson 002). The agent finds an area that meets its needs and begins to grow and reproduce. The infectious agent acts as a parasite by using parts of the surrounding body tissues as nutrients. Some forms also release toxic substances into the tissues. The host reacts to this invasion by activating specific and nonspecific defense mechanisms. The activity of these mechanisms produces certain symptoms (e.g., fever, inflammation, and so forth) in the host. If the infection progresses into an actual disease, the host develops symptoms that are characteristic for that particular disease.

A pathogen will not develop into an infection unless it can find an environment favorable for its growth and can withstand the host defense mechanisms. In addition to these requirements, there must be an adequate dose of the microorganism present, and they must possess some degree of virulence. These factors are interdependent and highly individualized with each type of microorganism.

The dose refers to the number of microorganisms that have invaded the host. An infection usually will not occur if only a single or a few microorganisms invade a host. Most microorganisms are not virulent enough to overcome host defenses in such small doses. On the other hand, a large dose will overcome even a strong host defense. Of course, the size of dose required to cause an infection is also related to the type of organism involved and the condition of the host.

Virulence

Virulence is a measure of the pathogenicity or ability of the organism to invade host tissues, withstand defenses, and cause an infection. The ability to move through tissue is sometimes referred to as "invasiveness." Virulence is based on the aggressiveness and toxicity of the microorganism. Aggressiveness is the rate of growth and multiplication of an organism. An organism that is highly aggressive grows or spreads very quickly. This, in turn, is affected by the condition of the host and the location that the organism is attempting to invade. If the host defenses are compromised, or if the organism finds an area highly favorable, it will become very aggressive. For example, when normal skin flora gets into a cut, they usually become aggressive and cause an infection.

Toxicity is the second aspect of virulence. When some pathogens invade body tissues, they release poisonous substances called *toxins*. These toxins reduce host resistance, destroy tissues, and cause disease. A pathogen does not need to be aggressive to be virulent. If it produces toxins, it can still cause serious disease. Each toxin has a specific chemical structure, and it affects a specific part, or specific parts, of the body. Thus, it is possible to determine the microorganism involved, according to the part of the body that is affected and the symptoms produced.

The level of virulence also is affected by the condition of the host defenses, the environment (favorable or unfavorable) where the organism establishes itself, and the transfer of the organism from one host to another. For example, under normal circumstances, the microorganisms that make up the normal flora on our skin are harmless. When you get a cut, these microorganisms can penetrate into deeper tissues, where they find little resistance, and frequently become highly virulent. If these same microorganisms are passed to another individual who happens to have a break in his or her skin, they could again become highly virulent and cause a serious infection.

Types of infectious agents

As an aerospace medical service journeyman, you should be aware of the characteristics of the common types of infectious agents. These include bacteria, fungi, protozoa, viruses, and helminths. The following information will increase your awareness of these agents.

Bacteria

Bacteria are primitive, single-celled, plant-like organisms that reproduce rapidly. Some forms are pathogenic, but others are essential for life. Bacteria reproduce asexually by binary fission (cells divide to form daughter cells, then daughter cells divide, and so forth). Under favorable conditions, reproduction is extremely rapid. On the average, bacterial cells divide every 30–120 minutes. At that rate, one cell can develop into several million within a day or so. Fortunately, other factors retard bacterial growth; otherwise, we would be up to our necks in bacterial cells!

Bacteria exist either as single cells or in large groups called *colonies*. In either case, each cell is capable of living and reproducing independently.

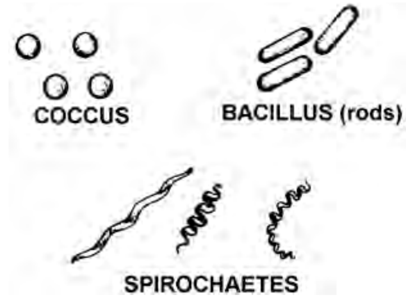


Figure 1–2. Bacterial shapes.

There are over 1,700 different types of pathogenic bacteria. They are classified according to their physical characteristics. Physical characteristics of bacteria include size, shape, and attachments. There are three basic bacterial shapes (see fig. 1–2): spherical (cocci), rod-shaped (bacilli and coccobacilli), and spiral-shaped (vibrios, spirilla, and spirochetes). Bacterial attachments include protective capsules and hair-like outgrowths called *flagella*, which help propel the cell. When a laboratory technician attempts to identify bacteria, they first look at the shape, then determine if the bacteria will stain. If the bacteria will hold a Gram stain, it is referred to as *Gram positive*; if the staining fails, it is called *Gram negative*.

Bacterial cells have the ability to adapt to survive in some extremely unfavorable conditions. Some cells react by becoming dormant until they are exposed to a more favorable environment. Other cells adapt by forming capsules and spores. A capsule is a slimy layer formed on the cell's outer layer. It protects the cell from being destroyed. A spore is a thick-walled structure formed within the cell that contains the essential cellular structures in a dehydrated, condensed form. This spore can withstand extreme environmental conditions, and it can last for an indefinite period. Bacterial cells that form spores become dormant until conditions are favorable, and they can resume their cellular activities. Spores are an excellent means of identification because only bacilli can form spores; and those species that do so, form them in a specific place within the cell.

The physiological requirements of bacteria include oxygen and nutrition. Most bacteria are called *aerobic* because they require oxygen to survive. Those that survive without oxygen are called *anaerobic*. The nutritional source is an important factor both in classifying the bacteria and in determining its relationship with us. Bacteria that obtain their nutrition from living sources are called *parasites*. These include all forms that inhabit our bodies. A pathogen is a bacterium that produces damage (disease) in the body.

Some of the more common bacterial infections you may see as an aerospace medical service journeyman are staphylococcal and streptococcal infections, among others. *Staphylococcal infections* are Gram-positive cocci responsible for a variety of diseases, including impetigo, boils (furuncles), infected lacerations, pneumonia, meningitis, and septicemia. *Streptococcal infections* are caused by group A streptococci and include strep throat, pneumonia, and otitis media. Varieties of other bacterial infections include tuberculosis, salmonella, tetanus, typhoid fever, and botulism.

Pyogenic bacteria

We call bacteria that cause wound infections *pyogens*. These bacteria cause wound inflammation that leads to pus-forming (*suppurative*) infections. If the bacterial growth is not stopped at the wound or entry site, the infection can spread to the bloodstream and then to other parts of the body. Pyogenic bacteria include most coccal (sphere-shaped) bacteria, and the enteric, or coliform, bacteria.

Staphylococci

This group of bacteria is responsible for a variety of infections, commonly called "staph" infections—the most common type of postoperative wound infections. Many staphylococcal wound infections start as relatively simple skin and mucous membrane inflammation (localized abscesses and pustules), but spread via the vascular system, causing serious infections of the lungs (pneumonia), urinary tract, nerve tissue (meningitis), and bones (osteomyelitis). They are nonspore-forming, facultative anaerobes (they grow with or without oxygen), and are commonly found on the surface of the skin and mucous membranes of the nose and throat.

Sometimes hospital personnel are staphylococci carriers. As previously mentioned, these bacteria are carried on the skin and continually "shed" into the surrounding environment. This shedding of staphylococcal bacteria not only contaminates clothing worn by the carrier but also leads to dispersal in the environment, thereby increasing the risk of wound contamination. The main purpose for wearing surgical scrub suits, hats, hoods, masks, and shoe covers is to minimize the dispersal of bacteria through carrier shedding.

Streptococci

These microorganisms cause such diseases as septic sore throat ("strep" throat), scarlet fever, impetigo, bacterial endocarditis, rheumatic fever, neonatal meningitis, and pulmonary infections, such as lobar pneumonia. These infections often appear as watery, bloodstained abscesses. "Strep" infections are often more harmful to the human body than staphylococci because the streptococcal bacteria usually cause widespread tissue damage without localized infection. Like staphylococci, most streptococci are nonspore-forming, facultative anaerobes.

There are three types of streptococci of particular concern to hospital personnel because of their ability to cause severe infections and diseases—the *Streptococcus pyogenes* group, *Streptococcus pneumoniae* (diplococci or pneumococci), and the *Streptococcus viridans* group.

Streptococci are spread via direct contact or inhalation of air containing bacterially contaminated moisture droplets and dust. Since many strains of streptococci are carried in the upper respiratory tract, they are easily transmitted when the infected person sneezes, coughs, talks, or laughs. Spread of streptococcal bacteria is prevented by using strict aseptic technique, proper handling and frequent changing of surgical masks, good room ventilation, and by excluding personnel with upper respiratory infections from direct patient contact.

Neisseria gonorrhoeae

Neisseria gonorrhoeae (Gonococcal) microorganisms cause the sexually transmitted disease gonorrhea by invading the mucous membranes of the genitourinary tract. Gonococci also cause conjunctivitis of the eyes when transferred from the perineum. Long-term gonococcal infection spreads to the reproductive system and causes sterility. When gonococci enter the circulatory system, severe septicemia may result. *Neisseria gonorrhoeae* may also infect the eyes of newborn infants during passage through the birth canal; if untreated, it can result in permanent blindness. Gonorrhea is usually transmitted by direct sexual contact but may be transmitted by contact with bedding, clothing, and other contaminated items. Control of this disease is accomplished through stringent sanitation methods and drug therapy for infected persons.

Neisseria meningitidis (Meningococci)

Neisseria meningitidis (Meningococci) are normally found in the nasopharynx but may cause meningitis in people who are susceptible to the disease. It may be fatal, particularly when the patient is a child. It is transmitted primarily through droplet inhalation or from direct contact with the source. Meningitis can cause an epidemic when many people are crowded together in confined spaces.

Enteric (coliform) bacilli

Enteric bacilli are nonspore-forming, facultative anaerobes normally found in the intestinal tracts of humans and animals. Normally, enteric bacilli are harmless—as long as they remain in their normal habitat. When introduced into other areas of the body, they can cause severe suppurative infections. For example, when an inflamed appendix ruptures, fecal material containing enteric bacilli is introduced into the abdominal cavity; these bacilli can cause severe peritonitis. Enteric bacilli that migrate from the perineal region are a common cause of urinary tract infections. Three of the more common types of enteric bacilli are *E. coli*, *Proteus mirabilis*, and *Proteus vulgaris (P. vularis)*. *Escherichia coli* are, by far, the most common enteric bacillus found in the intestinal tract. *Proteus mirabilis* and *P. vulgaris* are primarily found free-living in water, soil, and sewage but are also frequently found in fecal specimens from healthy individuals.

Another enteric bacillus is *Pseudomonas aeruginosa*. This aerobic bacterium is commonly found in soil, water, sewage, and air. Occasionally, it is also found on the skin or in the intestinal tract. It was once thought to be nonpathogenic but is now considered a pathogen—when it is introduced into an area with no normal defenses. Pseudomonas is often present in mixed bacteriological infections and also attacks the tissues of debilitated persons (particularly burn victims).

Anaerobic bacteria

The anaerobic (grow without oxygen) bacteria most commonly encountered are the *clostridia*. *Clostridia* are spore-forming bacilli, the most difficult type of bacteria to destroy. Fortunately, most spore-forming bacteria are nonpathogenic, but some strains of *Clostridia* produce potent toxins and are pathogenic. *Clostridia* are always present in soil and in the intestinal tracts of humans and animals; they help decompose organic matter. When introduced into a surgical wound, however, severe infections develop. Two types of *Clostridia* that cause severe wound infections are *Clostridium tetani* and *Clostridium perfringens (welchii)*.

Clostridium tetani

When introduced into a wound, *Clostridium tetani* causes the disease known as tetanus or "lockjaw." This disease follows the introduction of tetanus spores (from soil or feces) into puncture wounds, burns, surgical sutures, or traumatic injuries. If anaerobic conditions exist in the wound, *Clostridium tetani* spores return to their vegetative state and begin secreting a powerful toxin. This toxin attacks the tissue of the spinal cord and peripheral motor nerve endings. The damaged nerve tissue causes muscle spasms near the infection site and in the muscles of the neck and jaw; hence, the name "lockjaw." As the disease spreads, the spasms become more widespread and severe, resulting in convulsions and eventual death. *Surgical tetanus* can occur postoperatively as the result of improperly sterilized instruments or dressing materials. Tetanus is controlled by injection of antitoxin and active immunization programs. As a healthcare worker, you are required to be immunized against *Clostridium tetani*.

Clostridium perfringens (welchii)

This bacteria causes a severe infection of muscle tissue, commonly referred to as *gas gangrene* (properly known as *clostridial myonecrosis*). Gas gangrene may be a complication of severe traumatic injuries. Lacerated wounds exposed to soil and accompanied by a compound bone fracture are particularly susceptible. In this type of injury, the blood supply to the muscle tissue near the injury may be damaged or destroyed, which causes tissue necrosis (tissue death). This dead and dying tissue, rich in bacterial nutrients, provides an ideal anaerobic environment for *clostridial* spores, transferred from the soil, to grow and multiply. As the bacteria multiply, they secrete powerful toxins and enzymes that destroy the surrounding tissue. They also produce gas as the result of metabolizing tissue carbohydrates. The absorption of the gas results in further tissue death, providing continuous nutrition for *Clostridium perfringens* to thrive on. Infections caused by *clostridia* are usually mixed infections involving the presence of other types of anaerobic bacteria, not just *Clostridium perfringens* alone.

Mycobacterium tuberculosis

This bacterium is an aerobic, nonspore-forming bacillus (rod-shaped bacteria). It has a wax-like protective coating surrounding the cell, which makes tubercle bacilli nearly as hard to destroy as the spore-forming bacteria. *Mycobacterium tuberculosis* is responsible for causing the disease tuberculosis (TB), which can infect virtually every tissue in the body. The bacterium is spread through the lymphatic and vascular systems and causes dense nodules or tubercles to form in the tissue it infects. Even though most deaths caused by TB stem from infection of the lungs, the tubercle bacillus can cause infections in bone, joints, lymph nodes, spleen, liver, kidneys, and the gastrointestinal tract. This microorganism is transmitted primarily by inhalation of contaminated dust or droplets discharged by the infected person through sneezing, coughing, or kissing. Effective infection control for TB includes rigid housekeeping, immediate sterilization or disinfection of contaminated items, and strict isolation of individuals with active forms of the disease.

Rudimentary forms of bacteria

Although not possessing all the typical properties of a bacterial cell, the *Mycoplasma*, *Rickettsiae*, and *Chlamydia* are bacteria. Because they are relatively small and difficult to isolate, they once were referred to as "viruses."

Mycoplasma

Mycoplasma structures are sometimes considered to be a form of bacteria. Unlike other forms of bacteria, they are surrounded by a multilayered cell membrane rather than a cell wall. Because this membrane is flexible, the shape of mycoplasma varies. Mycoplasma structures are the smallest that can reproduce and survive outside a host cell. They average 0.1– 0.2 microns in diameter. The exact mechanisms for growth, reproduction, and nutrition of mycoplasma are not clearly understood. Fragmentation appears to be the primary method of reproduction, and some forms appear to require cholesterol for growth. The primary means of identification is the reaction of the mycoplasma's culture to different antisera (antibody preparations). What is important is that several families of mycoplasma are pathogenic, producing diseases such as pleuropneumonia, pelvic inflammatory disease, etc.

Rickettsiae

At one time, *Rickettsiae* were thought to be a separate type of organism. They are much smaller than standard forms of bacteria (averaging 0.5 microns by 1.7 microns), and with the exception of one type, they can only live and reproduce inside a living host cell. For this reason, they are called *obligate intracellular parasites*. Studies with the electron microscope have shown *Rickettsiae* do have characteristics similar to those of other bacteria. For example, they have a rigid cell wall, are Gram-negative (do not react to the Gram stain), and are shaped as either a cocci or a bacilli.

There are approximately 50 different kinds of Rickettsiae that act as parasites in the intestinal tract and salivary glands of insects, such as ticks, bedbugs, and lice. When these insects bite humans, some of the *Rickettsiae* are transferred to the human cells where they grow, multiply, and produce infections. Rocky Mountain–spotted fever and scrub typhus are two forms of infection produced by *Rickettsiae*.

Chlamydiae

Chlamydiae are another group of obligate intracellular parasites now thought to be a form of bacteria. They are smaller than *Rickettsiae* and much less understood. Their chief characteristic appears to be a complex form of reproduction. Initially, they are absorbed into a host cell as a small, dense structure called the *elementary body*. This structure then gradually develops into a larger structure called the *initial body*. The initial body also grows and divides by binary fission. The resulting initial bodies reorganize to form elementary bodies again. These reorganized elementary bodies are the infectious stage of the Chlamydia disease. The developmental cycle is over when the host cell ruptures, and the infectious elementary bodies are released to infect other host cells.

In their largest form (initial bodies), Chlamydiae are only about one micron in diameter. Due to the small size, it is somewhat difficult to see any identifying characteristics. The chief means of identification appears to be the reaction to various antigen-antibody complexes. Although it is not very well known, Chlamydiae does cause some very well-known diseases. Chief among these is *Chlamydia trachomatis*, which is considered one of the most common sexually transmitted disease in the United States today.

Fungi

The two structural categories of fungi are yeast and mold. They range in size from single-celled microscopic organisms to structures like mushrooms and puffballs, which can be seen easily. Fungi do not produce oxygen nor do they require sunlight for energy (they do not possess chlorophyll). Their main source of nutrition is dead and decaying matter. They have a rigid cell wall structure, and most forms grow as branching filaments (like the branches on a tree), such as those shown in figure 1–3. Fungi are best adapted to a warm, dark, and moist environment, but like bacteria, they can survive in fairly extreme environments. They are inactive, except when in the spore stage.

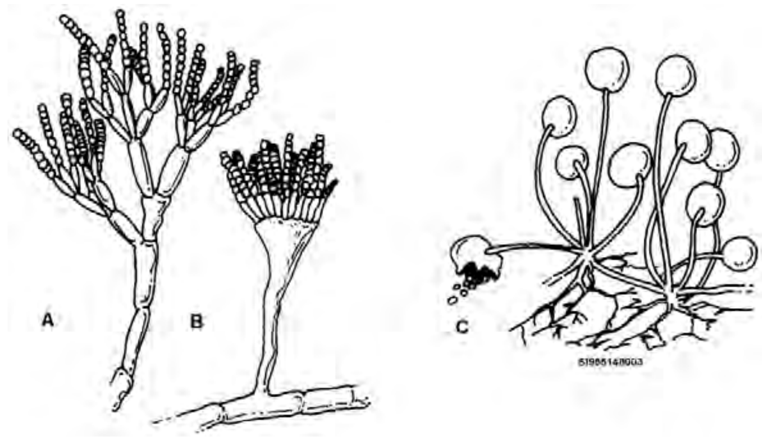


Figure 1–3. Fungi branching filaments.

Like bacteria, fungi are capable of both pathogenic and nonpathogenic activities; however, most are nonpathogenic. Some types of fungi are edible (mushrooms); others are involved in the fermentation of breads and alcoholic beverages and the production of antibiotics, such as penicillin. Fungi cause a number of superficial and systemic infections including athlete's foot, ringworm, histoplasmosis (a respiratory infection), oral thrush, and vaginal candidiasis.

Protozoa

Protozoa, shown in figure 1–4, are single-celled structures that resemble animal cells because they are surrounded by cell membranes rather than cell walls. Protozoan cells usually are larger than the microscopic forms of fungi and average from five microns to two millimeters in diameter. Because their cell walls are flexible, they assume a variety of shapes. Protozoan cells also consist of cytoplasm, one or more nuclei, and various other structures found in animal cells. Some cells also have attachments, such as flagella, to help with mobility.

Protozoa are usually found in a fluid environment that can be anything from a drop to an ocean of water. The protozoa you are concerned with are those forms that live as obligate parasites in the blood or tissue fluids of animals or humans and are pathogenic for humans. There are some types of protozoa that have developed commensalism (a relationship) with their host and do not pose a threat to humans.

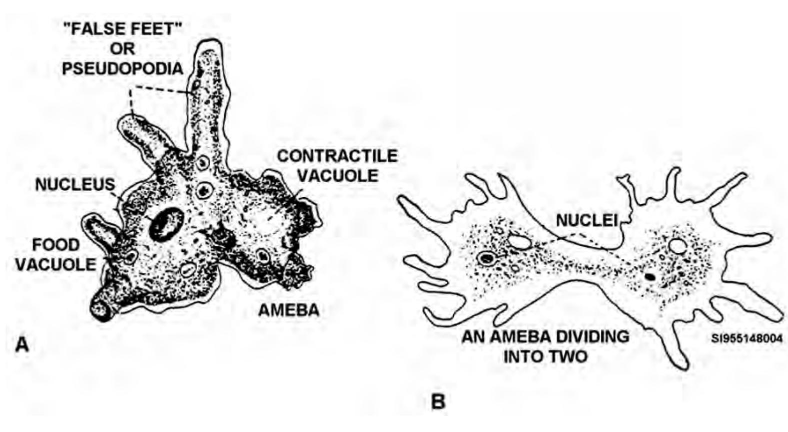


Figure 1–4. One form of protozoa (amoeba).

Protozoa cannot form a spore as bacteria and fungi do. Instead, they react to unfavorable environmental conditions by assuming a rounded shape and secreting a protective cyst-like covering. This encystment allows protozoa to withstand environmental changes and survive during the transfer from one host to another. When protozoa are placed in a fluid environment, they resume their normal activities and shape.

Protozoa are classified by shape, type of motility, type of reproduction, and method of obtaining nutrients. Pathogenic forms are scattered throughout the different classes and groups. To help you understand better, this section will briefly cover the descriptions of the pathogenic forms. These include the *Amoeba*, *Balantidium coli*, *Mastigophora*, and the *Sporozoa*.

Amoebae

The *Amoebae* are characterized by their ability to shoot out projections called *pseudopods* or *false feet*, which are used to propel the *Amoebae* and ingest food particles. *Amoebae* reproduce by asexual fission and are capable of forming cysts. They primarily infect the intestinal tract and cause infections, such as amoebic dysentery.

Balantidium coli

The *Balantidium coli* are characterized by numerous short projections called *cilia*, which help propel them through their fluid environment. They also have two nuclei and reproduce asexually by transverse fission. Some forms also have a sexual cycle. Balantidium coli also infect the intestinal tract and cause balantidiasis, which produces a bloody diarrhea similar to that caused by the *Amoebae*.

Mastigophora

The *Mastigophora* (also called *flagellates*) are characterized by several long, hair-like projections attached to each cell, called *flagella*. They reproduce asexually by longitudinal fission; however, some forms also reproduce sexually. Mastigophora can cause infections in the intestinal tract, vagina, and/or bloodstream, and are responsible for such diseases as giardiasis, trichomonas vaginitis, and African sleeping sickness.

Sporozoa

The *Sporozoa* cannot ingest solid particles and lack any obvious means of locomotion. They are further characterized by having both a sexual and an asexual reproductive cycle that sometimes requires two hosts. Sporozoa cause such diseases as malaria and toxoplasmosis.

Viruses

Viruses are much smaller than bacteria and are actually the smallest known microorganisms. They can only be seen using electron microscopes. They come in many shapes and are so small they can pass through bacterial filters. All viruses are parasites and multiply only within living cells; however, they cannot multiply until they have invaded susceptible tissue cells.

Viruses are found in soil, on the surfaces of soiled objects (fomites), or in the air but are highly selective in their growth requirements. They lack both a cell wall and a distinct nuclear structure. Each virus consists of a strand of either deoxyribonucleic acid (DNA) or ribonucleic acid (RNA) that is surrounded by a layer of protein called a *capsid*. In some cases, they are also surrounded by a membrane. Like *Rickettsiae* and *Chlamydiae*, viruses are obligate intracellular parasites. They survive by entering a host cell and altering its reproductive structures to produce additional viral structures and proteins. These new viral structures are then released to invade other cells. The original cell either is broken down through a process called *lysis* or continues to grow and produce viral structures.

Viral cells are specific for certain parts of the body. For example, the measles virus affects skin cells, rabies affects the brain and spinal cord, and yellow fever affects the liver. Viruses cause a multitude of infectious diseases ranging from the common cold to smallpox, rabies, etc. There is even some evidence viruses are responsible for some forms of cancer. Figure 1–5 shows a variety of DNA viruses.

Many pathogenic microorganisms are present in the hospital and surgical environment. To better understand infection control activities in the operating room and central supply, you should become familiar with some of the more common "bugs" that cause infections and disease. The table below and the paragraphs which follow describe some common pathogens and the diseases or infections they are associated with.

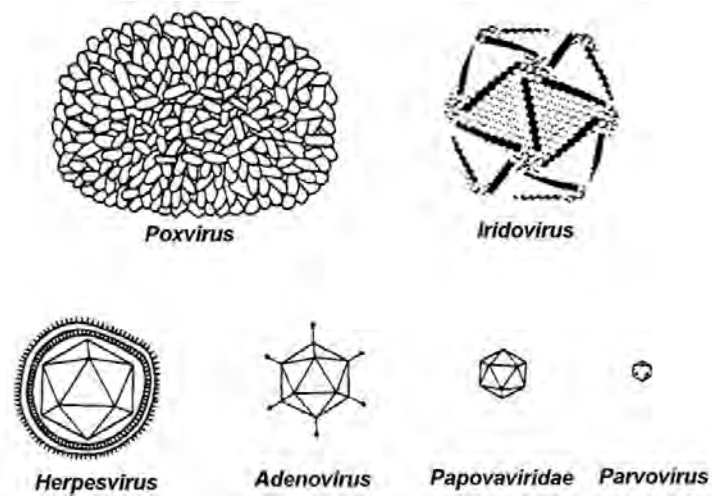


Figure 1–5. Deoxyribonucleic acid viruses.

Helminth

The last types of infectious agent that you will cover are the helminths, or worms. Helminths are not microorganisms and normally do not cause infectious diseases. These are included in the discussion of infectious agents because they are true parasites and infest human hosts, and most importantly, because they are "infectious" and can be transmitted from one individual to another.

There are many different types of helminths infesting our bodies. There is neither enough time nor space to discuss all of them in this text. Characteristically, those forms that affect humans have life cycles that include adult, egg, and larval (immature) stages. These life cycles may occur totally within the human host, or they may involve an intermediate host. Typically, the helminth enters a human host in one of the larval stages. The larva migrates to the intestine or other part (liver, lungs, blood vessels, subcutaneous tissue, or brain) of the host's body, and develops into the adult form. The adult helminth undergoes reproduction and produces eggs that are then expelled through one of the body's waste mechanisms. The eggs are ingested by an intermediate host, where they penetrate into the tissues and mature to form the larval stage again. Another human is infected when he or she eats improperly prepared, intermediate host tissues. Figure 1–6 shows the life cycle of the beef tapeworm, *Taenia saginata.*

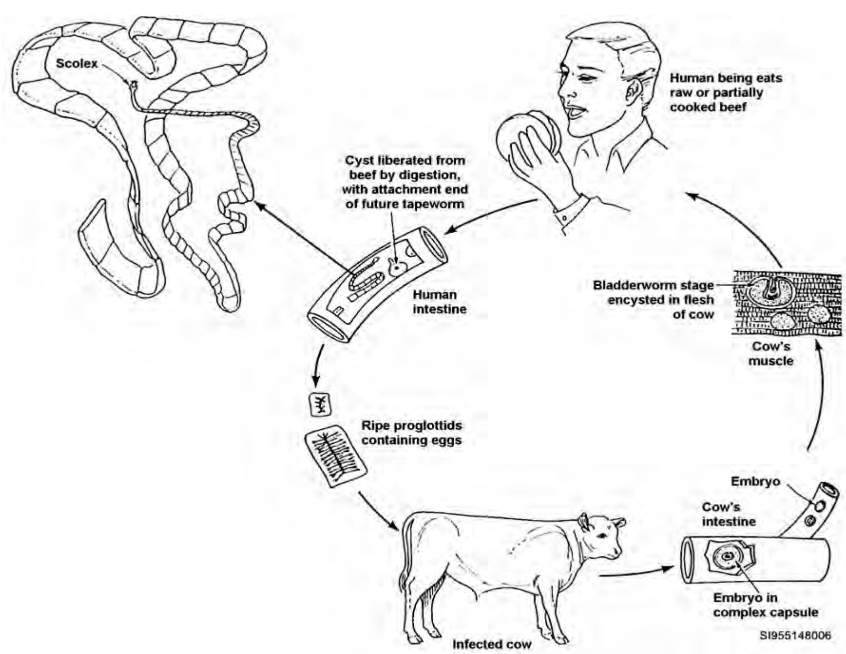


Figure 1–6. Typical helminth life cycle.

The following table lists common microorganisms, where they are commonly found, and resultant diseases:

Microorganism		Commonly Found In (On)	Infection or Disease
Staphylococci (nonspore-forming bacteria)	Staphylococcus aureus	Skin Hair Respiratory tract Urinary tract	Wound infection Boils (skin infections) Pneumonia Urinary tract infection Enterocolitis Septicemia
Streptococci (nonspore-forming bacteria)	Streptococcus pyogenes	Nose Nasopharynx	Wound infection Cellulitis Urinary tract infection
	Streptococcus pneumoniae (pneumococci)	Nose Nasopharynx Oropharynx	Lobar pneumonia Sinusitis Parotitis Conjunctivitis Peritonitis
	Streptococcus viridans	Upper respiratory tract Intestinal tract	Localized gum/mouth sores Abdominal abscess Pulmonary abscess
Neisseria (nonspore-forming bacteria)	Neisseria gonorrhoeae (gonococci)	Genitourinary tract Rectum Mouth Eye	Gonorrhea Gonorrheal vulvovaginitis Pelvic inflammatory disease Conjunctivitis
	Neisseria meningitidis (meningococci)	Nose Oropharynx	Meningitis Pneumonia
Enteric (coliform) (nonspore-forming bacteria)	Salmonella typhosa	Intestinal tract	Typhoid fever
	Shigella sonnei		Dysentery
	Salmonella (others)		Enteric fever Gastroenteritis Septicemia
	Escherichia coli	Large intestine Perineum	Peritonitis
	Proteus vulgaris	Intestinal tract	Cystitis
	Pseudomonas aeruginosa	Soil Skin Intestinal tract	Wound infection Urinary tract infection Burn infection
Clostridium (spore-forming bacteria)	Clostridium tetani	Soil Dust Feces	Tetanus (Lockjaw) Surgical tetanus
	Clostridium perfringens	Soil	Gas gangrene

Microorganism		Commonly Found In (On)	Infection or Disease
Mycobacterium tuberculosis (nonspore-forming bacteria)		Respiratory tract Urine Lymph nodes	Tuberculosis Peritonitis Meningitis Infection of almost any tissue, including: skin, bones, kidney, lymph nodes, and fallopian tubes
Viruses	Rhinoviruses and influenza viruses	Respiratory tract	Colds Flu
	Hepatitis A	Blood and urine from infected persons Sewage/contaminated water Contaminated shellfish Food handled by infected person practicing poor hygiene	Infectious hepatitis
	Hepatitis B	Blood Saliva Other body fluids Feces	Serum hepatitis
	Hepatitis C	Blood Blood products	Non-A, non-B, transfusion-associated hepatitis
	Hepatitis D	Co-exists with Hepatitis B in some patients	Superinfects liver, leads to necrotizing liver disease and death.
	Hepatitis E	Typically spread by fecally contaminated acute water.	Viral hepatitis
	Herpes virus	Lesions and body fluids of infected patients	Localized eruptions on borders of lips, in mouth, in nose (cold sores). Localized eruptions on genitalia or anal region. Conjunctivitis Meningoencephalitis
	Human immunodeficiency virus (HIV)	Blood Semen Other body fluids	Acquired immunodeficiency syndrome (AIDS)

Helminths differ in appearance in the specific stages of their life cycles and in the manner in which they are transmitted from one host to another. In any case, they cause some trauma when they invade the host tissues and may interfere with the functions of the different tissues they have invaded. They also weaken the host's defenses and make him or her more susceptible to secondary infections from other infectious agents. Occasionally, a human host ingests or otherwise absorbs the helminth in the egg stage, rather than in the larval stage. When this happens, the eggs hatch into larvae and migrate through the body of the host until they become embedded in the host's tissues as cysts. Eventually, these cysts die, producing an inflammatory reaction in the host. They may also cause problems if they become embedded in sensitive tissues, such as the brain.

Before you read about the infection chain, keep in mind that there really are no hard and fast definitions or rules for the relationship between microorganisms and their human hosts. The science of both microbiology and medicine is changing almost daily. In this text, the definitions and rules that are most commonly accepted at this time are the ones emphasized.

003. The infectious process

In this lesson, you will cover the infectious process. The chain of infection is covered in detail. If necessary, see figure 1–1 of the previous lesson to give you a visual understanding of the infectious process as you go through this lesson.

Chain of infection

The chain of infection begins when an infectious agent (causative agent) finds a location (reservoir) where it can grow and multiply. The agent multiplies, and some of the resulting offspring leave the reservoir through the portal of exit. The offspring are carried by a mode of transfer through a portal of entry into a susceptible host. The type of mode of transfer depends on the characteristic required for a particular agent to enter a susceptible host. The host is the organism (frequently a human) that harbors or allows the agent to grow and reproduce. Once in the host, the agent invades the tissues until it finds a location (reservoir) where it can grow and multiply once again. The agent causes an infectious state within the host by destroying cellular components, or by releasing toxic substances. From this summary, you can see the overall relationship of the infection chain components. Now that you have the general overview of the infectious chain, let’s take a more detailed look at each piece of the chain.

Characteristics of the infection chain

As identified previously there are several links in the infectious process; these are the infectious (or causative) agent, reservoir, portal of exit, mode of transfer, portal of entry, and susceptible host. These links must exist for an infectious agent to grow and spread. Any break in the chain, at any point, will disrupt the infectious process and prevent the spread of disease. Let’s take a closer look at each of the links and discuss how each plays a part in the overall process. Since we’ve already discussed the first link (infectious agents) in detail, we’ll begin our discussion with the next link in the chain—the reservoir.

Reservoir

As indicated at the beginning of this section, the second link in the infection chain is a location where the causative agent can grow and multiply. This location is known as the *reservoir*. Reservoirs are locations where microorganisms are found. Reservoir locations include infected wounds, contaminated food and water, animals and insects, human or animal waste, and the infected individual.

Certain precautions are used to help prevent the spread of infection to reservoirs. The most important of these is good handwashing. This is the most effective way to prevent microorganisms from spreading. Using aseptic (absence of pathologic organisms) technique while performing invasive procedures such as urinary catheters and intravenous therapy is also important in preventing the spread of infections. The bottom line is that patient areas have to be extremely clean and free from potential infectious hazards.

Portal of exit

Portals of exit are routes in which the microorganism exits the host’s body. The following are examples of normal portals of exit:

- The respiratory tract is a portal of exit when coughing or sneezing releases a pathogen. Mumps, tuberculosis, and measles can be transferred in this manner.
- The gastrointestinal tract where feces can transport a microorganism. An example would be typhoid bacillus.
- Skin and mucus membranes are portals of exit if the patient has open wounds or sores.

By identifying and treating patients who are infected, the portal of exit can be interrupted. Using standard precautions, transmission based isolation, and body substance isolation (BSI) when handling and disposing of urine, feces, secretions and exudates is critical in preventing the transfer of pathogens.

Mode of transmission

There are three primary modes of transmission, contact, droplet, and airborne. The most common mode of transmission, contact can be divided into two subgroups: direct contact and indirect contact. *Direct contact* involves contact with body secretions from wounds, sores, or boils, etc. You have *indirect contact* when you touch objects such as forks, spoons, coffee cups, and medical equipment that are contaminated with an infectious agent. *Droplet transmission* occurs when infectious agents are transmitted through the air short distances (less than three feet) by a person coughing, sneezing, or talking. *Airborne transmission* occurs when very small particles of infectious agents are dispersed in the air over longer distances (greater than three feet).

Two additional forms of transmission are *Vectorborne* and *Infection spreading*. Vectorborne transmission occurs with mosquitoes, fleas, ticks and any other insects that carry infectious disease and can transmit infection by stinging or biting. *Infection spreading* occurs when an infection spreads from one part of the body to another.

Effective hand washing can be instrumental in disrupting most modes of transfer. Proper disinfection and sterilization of hospital equipment, aseptic technique used while performing tests and procedures, and using standard precautions are all ways to prevent mode of transfer contamination. Patient education can be very effective as well. Teach them to cover their nose and mouth when they cough or sneeze. Instruct the patient to properly dispose of any soiled tissues. Have them wash their hands after coughing, sneezing, wiping the nose or mouth and after coming in contact with contaminated items or potentially contaminated items. They should also be told to try to avoid contact with individuals who may have an infection. Insect spraying programs and proper air filtering in the medical facility are also valuable methods of reducing transfer of pathogens. Additionally, using a hand sanitizer can be helpful after washing hands or to reduce the spread of germs if there is no place to wash hands.

Portal of entry

The mouth, nose, skin, trachea, and mucus membranes are all portals of entry where pathogens may enter the body. Eating or drinking something contaminated is an example of how this can occur. Contracting a virus through a cut on your hand or inhaling droplets contaminated with a pathogen are other examples of entry.

Ensuring the use of sterile and clean supplies or equipment will reduce the entry of pathogenic microorganisms. Additionally, using barriers such as masks and gloves, careful handling of food and water, proper personal hygiene, refraining from risky behavior, and careful prevention from insect bites and stings, are all methods to prevent entry of microorganisms to a susceptible host.

Susceptible host

The last link in the infection chain is a susceptible host. This is normally a person who cannot resist a microorganism invading the body, multiplying, and resulting in infection. The host is susceptible to the disease, lacking immunity or physical resistance to overcome the invasion by the pathogenic microorganism. A human host can be susceptible to pathogenic invasion by virtue of their age, state of health, or by breaks in the skin.

The stages of infection

Looking again at the infected host, you see there are four stages or periods to the infectious process. They include incubation, prodromal, illness, and convalescence.

Incubation

This period is characterized by invasion of a microorganism to the onset of symptoms. During this time the pathogen will grow and multiply. The duration of this period will vary on the type of microorganism involved. Some viral diseases may be transmitted during the incubation stage.

Prodromal

The prodromal period is the time from the onset of nonspecific symptoms to the start of specific symptoms of infection. During this period, the patient may experience lethargy, malaise, fatigue, and fever. Depending on the disease, this stage can last a few hours to a few days; microorganisms are more likely to spread within this infectious period. Many times, individuals don't realize they are truly ill until specific symptoms occur. Unfortunately, this prevents them from taking protective precautions, which allows the infection to spread.

Illness

Systemic and localized symptoms appear in the illness period. The patient may suffer from headache, malaise, and fever. Other specific signs may include rash, edema, leukocytosis, purulent wound drainage, nausea, vomiting, and diarrhea. Symptom severity and duration is based on the power of the microorganism and the individual's susceptibility to the causative agent.

Convalescence

The convalescent or *recovery* period starts when symptoms begin to subside and continues until the patient has returned to a normal, healthy state.

Body defense mechanisms

There are five major defensive systems that the body uses to prevent entry of infectious microorganisms and the spread of infection—the skin, mucous membranes, tears, lymphatic system, and antibody formation.

The skin

Skin is the body's protective armor and its best natural barrier to infection. As long as this barrier remains intact and unbroken, it repels invasion of pathogens. If the skin is penetrated or removed in any way, then microorganisms have free access to the deep tissues that provide an ideal breeding ground for infectious agents. This is important for you to remember because it not only applies to patients who may be ill or have wounds but also applies to you as a medical team member. We have stressed the importance of handling sharp instruments, needles, and blades with great care. This is not only to prevent being severely cut or stabbed but also to prevent accidental infection by highly virulent microorganisms. A needle used on a patient with type B hepatitis or HIV is a potentially deadly item!

During minor surgical procedures, we help enhance the protective nature of the patient's skin by performing preoperative skin preparation with antibacterial agents that leave a germ-killing residue. We also exercise great care in doing preoperative shave preps (when necessary) to avoid nicking or cutting the skin. Before injections or introduction of intravenous catheters, the patient's skin is antiseptically cleaned to avoid introducing infectious agents into deep tissues or the vascular system.

To protect *your* skin as well as the patient, always wear protective gloves when handling any contaminated or soiled items. If at all possible, avoid "scrubbing" if you have cuts or other breaks in the skin on your hands or arms. If harsh germicidal chemicals and soaps are drying and cracking the skin on your hands, use a skin moisturizer (after duty) to keep the skin supple and moist. Remember, healthy skin is the best defense you and your patients have against infection.

Mucous membranes

Any tract or orifice of the body that communicates with the external environment is a potential entry point for infectious microorganisms. That's why nature provided us with moist, highly vascular mucous membranes to line most of these entry points. The nose, throat, respiratory and genitourinary tracts are all lined with protective mucous membranes that trap microorganisms. Since the membranes are well supplied with blood, any invading pathogen can be quickly destroyed by a massive influx of white blood cells that engulf and digest microscopic invaders. Some mucous membranes, such as those in the nose, have hairs projecting out of them that help filter and trap foreign matter. Other mucous membranes, like those lining the trachea, have tiny hair-like projections called *cilia* that also filter and trap foreign bodies, keeping them away from more susceptible inner body tissues. Last, mucous membranes can harbor certain microorganisms (*normal flora*) that aid in defending against infection by other microorganisms. One example of this is a type of bacteria normally found in the vagina that help keep the vaginal mucosa acidic. This acidic environment helps prevent the growth of harmful microorganisms and yeasts.

Tears

Tears are the eyes' protective fluid bath. They wash away dirt, debris, and microorganisms that could potentially cause inflammation or infection.

Lymphatic system

The lymphatic system is closely associated with the circulatory system. It consists of a system of vein-like, one-way vessels that return excess tissue fluid to the blood stream. The lymphatic system also contains specialized glands and nodes that play a key role in fighting infection by producing some types of large *leukocytes* (white blood cells) that are called *lymphocytes*. Lymph nodes in this system also act as mechanical filters that trap invading organisms and prevent them from entering the blood stream. During an infection, *lymphocytes* and *leukocytes* attack, engulf, and digest the pathogenic microorganisms in the tissues. The lymphatic vessels also transport pathogens to regional lymph nodes and glands where they are trapped and destroyed by *lymphocytes* contained in the lymphatic tissue before they can enter the bloodstream.

The tonsils, adenoids, spleen, and thymus gland are parts of the lymphatic system. When your tonsils (if you still have them), or the glands in your jaw swell and are inflamed, it is a sign these glands are waging war against invading pathogens. The battle is concentrated at those sites. One of the reasons ear, nose, and throat (ENT) surgeons do not routinely remove the tonsils and adenoids of young children anymore (it was once a routine practice), is because these glands play a key role in protecting the body against disease.

In addition to the *lymphocytes* produced in the lymphatic system and transported to infection sites by the circulatory system, the body contains other large pathogen-ingesting cells called *macrophages* or *histiocytes*. These cells are found in the walls of blood vessels and in loose connective tissue. Many of these *macrophages* remain fixed in the tissue and attack any invading foreign organism that comes near them. Some *macrophages* remain immobile until activated by an inflammation; then they begin to wander, destroying foreign organisms they encounter.

Antibody formation

A part of every normal person's defensive arsenal is the immune system that creates substances called *antibodies*. These antibodies are substances created in the body to attack specific foreign substances generally classified as *antigens*. *Antigens* stimulate the manufacture of antibodies and can include such harmful agents as bacteria, foreign tissue cells, toxins, or foreign proteins.Immunity provided by antibody production can be naturally acquired by contracting a certain disease, or it can be artificially induced by inoculating a person with a vaccine or toxoid (antigen) related to the disease.

Body responses to infection

Now that you know more about the body's natural defense mechanisms, it is time to find out what actually happens when an infection starts and begins to spread.

When pathogenic microorganisms enter deep body tissues, the body responds with a defensive reaction commonly known as an *inflammatory response* or *inflammation*. This reaction can also be triggered when any foreign, physical, chemical, or biological agent enters the body.

The first reaction that occurs after microorganisms invade the injured tissues is an increase in the flow of blood to the area. The increased blood flow dilates the blood vessels in the area and carries large numbers of *leukocytes* to the damaged tissues. As a result, the tissues near the injury turn red and feel warm. The *leukocytes* carried by the blood engulf and digest invading pathogens.

After this initial attack, the blood flow to the area slows and swelling (*edema*) occurs due to the buildup of fluid in the injured tissues. The swelling causes pressure on surrounding nerves and creates the sensation of pain. As more *leukocytes* are brought to the injured area, pus begins to form. Pus is actually an accumulation of live and dead microorganisms, dead leukocytes, and tissue fluid that combine to form a thick, white-colored substance. The process of pus formation is called *suppuration* and pus-forming infections are referred to as being *suppurative*.

Up to this point, the infection is *localized* near the injury or pathogen entry site. If it remains localized, it may form a boil or abscess. If the infection is too great to be controlled at the entry site, then the lymphatic system transports the infectious agents to regional lymph nodes where the battle intensifies. Infections that spread to the lymph nodes are called *regional infections* and are characterized by painful, swollen glands.

Sometimes, the infection wins the battle in the lymph nodes and spreads to the circulatory system. Once in the blood stream, the pathogens rapidly spread throughout the body tissues resulting in what is known as a *systemic infection*. If this systemic infection persists, the resulting condition is called *septicemia*.

You should now have a general understanding of the infectious process, including the elements in the chain of infection and how the body defends against it. It is important to remember that all it takes is breaking one link in the chain to stop the infection from occurring. Let's look at how we can break the chain.

Breaking the chain of infection

As discussed earlier, the infectious process is a continual cycle, which requires certain conditions to exist to allow a disease to spread. To break the chain at certain points would disrupt this process and prevent the disease from spreading (fig 1–7). The following table demonstrates how the chain can be broken at these points in the infectious process:

Link	Method to Break Link	Interventions
Reservoir Infected patient	Prevent microorganism transfer	Standard precautions Hand washing Gloves Isolation techniques Transmission-based precautions
Portal of exit Sputum Blood Urine Feces	Prevent contamination	Standard precautions Hand washing Cough etiquette Not recapping needles Correct sharps handling Proper disposition of contaminants Disinfection Aseptic practice Transmission-based precautions
Mode of transfer	Prevent contamination	Standard precautions

Link	Method to Break Link	Interventions
Hands Contaminated food Contaminated equipment and supplies	Destroy vectors	Hand washing Sterilization Safe food handling Disinfection Proper disposal Surgical asepsis Isolation techniques Pest control measures Transmission-based precautions
Portal of entry Mucous membranes Break in skin Mouth	Protect mucous membranes Protect the skin Ensure only clean things put in mouth	Standard precautions Hand washing Skin care Antiseptic hand wash before invasive procedures Cover breaks in skin Keep items out of mouth Thorough skin cleaning before invasive procedures Transmission-based precautions
Susceptible host Susceptible patient	Proper nutrition Proper hygiene Adequate rest Reduced stress	Standard precautions Hand washing Asses potential risk for infection Enhance natural body defenses Protective isolation Transmission-based precautions

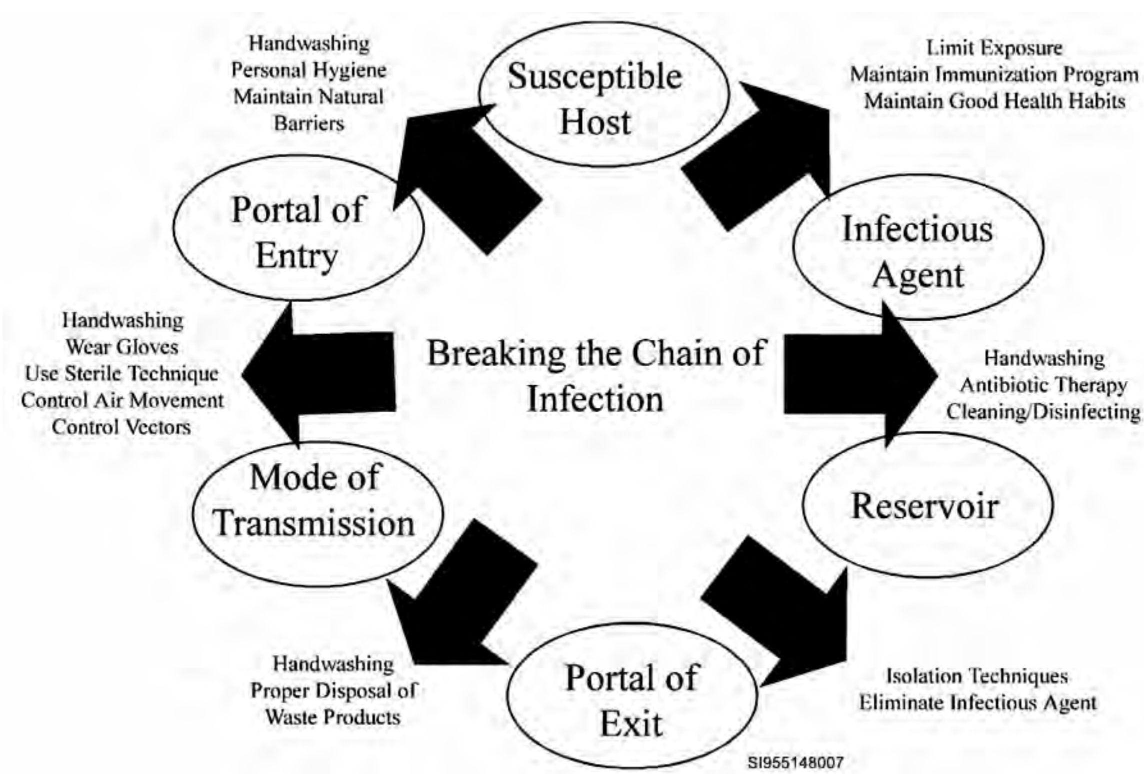


Figure 1–7. Breaking the infection chain.

Infectious agent precautions

As mentioned earlier, isolation precautions prevent the spread of disease by blocking transmission of the infectious agent. Since each infectious agent has a particular mode of transmission, the isolation precautions must be tailored to the agent. The CDC has recommended a two-tier system of precautions to be used within hospitals — standard precautions and transmission-based precautions. *Standard precautions* were developed as a primary strategy in the prevention of nosocomial infections (illness or disease originating or acquired in a medical facility). *Transmission-based precautions* were developed to prevent the spread of infectious agents by interfering with the organisms' known method of transmission.

Standard precautions

Standard precautions have been developed by the CDC to aid in breaking the infection chain. These standard precautions are designed to protect both the medical staff and the patient and are to be applied during patient contact. A partial listing of standard precautions is given in the following instructions:

1. Wash hands after touching blood, body fluids, excretions, secretions, and any contaminated items even if gloves were worn. Wash hands after every patient contact. Sometimes it may be necessary to wash hands between tasks on the same patient.
2. Wear gloves when touching body fluids, blood, secretions, excretions, and any contaminated items. Change gloves between patient contact even on the same patient.
3. Gowns or aprons are worn when splashing, splattering, smearing, or soiling from blood or body fluids is possible.
4. Masks, goggles, or face shields are worn when splattering or splashing of blood or body fluids is possible.
5. Handle used patient-care equipment soiled with body fluids, secretions, excretions, or blood in a way that ensures no contact with skin or mucous membrane, clothing, or any other patients or patient environments.
6. Each facility should have adequate policies in place for cleaning and disinfecting beds, bedrails, bedside equipment, environmental surfaces, and any frequently touched items.
7. Handle, transport, and process soiled linens in a way that ensures there is no contact with skin or mucous membrane, clothing, or any other patients or patient environments (that means do not hold dirty linen waded up in your arms or against your body). Wear appropriate personal protective equipment (PPE) and hold linen away from your body by gloved hands.
8. Use extreme care to prevent injuries when using or cleaning needles, scalpels, and any other sharp instruments or devices. Do not recap used needles, or manipulate using both hands, or use any technique that directs the needle point toward the body; rather, use the one-handed "scoop" method or a mechanical device that can hold the sheath. Place used sharps in puncture-proof containers, which are located in close proximity to where the item was used.
9. Use barrier devices such as a bag-valve-mask, pocket mask or some type of ventilatory device as an alternative to mouth-to-mouth resuscitation.
10. Patients who contaminate the environment, do not, or cannot maintain appropriate hygiene or environmental control should be placed in a private room.

Remember that standard precautions are used to reduce the risk of transmission of micro-organisms from both recognized and unrecognized sources of infection in clinics or hospitals. Simply stated, you may not know if your patient has an existing infectious process going on within their body. Therefore, it is important to your health and welfare to use precautions when dealing with any body fluid, whether it is blood, secretions, excretions, non-intact skin, or mucous membranes as it is all potentially infectious.

Transmission-based precautions

When a patient is infected with highly transmissible pathogens, transmission-based precautions are used. There are three types of transmission-based precautions: airborne, droplet, and contact precautions. For patients with highly contagious disease processes, the CDC recommends all transmission-based precautions be used in conjunction with the standard precautions. A good rule to follow is to ensure you are familiar with the disease process you are dealing with, understand the route of transmission, and ensure you follow all transmission and standard precautions to prevent the spread of infection to yourself and others.

Airborne precautions

To reduce the risk of spreading infectious agents by the "airborne" route, place the patient in a private room, which has monitored, negative air pressure. Keep the door to the room closed, and wear protective respiratory equipment (mask). Infectious agents that are spread through the air can be dispersed by air currents. Tuberculosis, varicella, and measles are diseases spread in this manner.

Droplet precautions

Patients with infectious agents that can be spread by coughing, sneezing or talking are placed in droplet precautions isolation. Wear masks when working within three feet of these patients. Bacterial infections spread by droplet transmission include diphtheria, mycoplasma pneumonia, pertussis, pneumonic plague, streptococcal pharyngitis, pneumonia, and scarlet fever. Viral infections include adenovirus, influenza, mumps, parvovirus, and rubella.

Contact precautions

Contact precautions are required when infections spread by way of direct contact or indirect contact can occur. A patient must be placed in a private room or with another patient who has the same infection. Always wear gloves when entering the patient's room, and when providing nursing care, remove the gloves when leaving and wash your hands with an antimicrobial agent. If you think your uniform may become contaminated, wear a gown for protection and remove the gown prior to leaving the patient's environment. Some of the more commonly seen diseases within this area of precaution include hepatitis A, herpes simplex, impetigo, pediculosis, scabies, and viral conjunctivitis.

General Hygiene

You may have noticed hand washing is mentioned in nearly every context that deals with breaking the chain or preventing the spread of infection. The same applies to general hygiene practices for the staff as well as the patient. Remember reading how normal bacteria in the wrong place can lead to infections? Practicing good hygiene decreases these risks by washing skin with soap, water and friction and washing facial and body hair. Good hygiene also applies to ensuring clothes are kept clean and dry and washed frequently. For some people, this may seem like a silly topic to bring up. You must realize you will be working with patients and staff from all over the world and from many different cultural backgrounds. Different cultures have very different views on hygiene practices! In some cultures, people do not use deodorant or bathe each day. On the other hand, you may also know someone who showers three times a day! It is important for you to be able to explain why regularly washing hands, wearing clean clothes, brushing teeth, showering with soap and shampooing hair are an integral part of decreasing the spread of infection and promoting health.

As a healthcare worker, it is essential you have excellent hygiene practices! Throughout a day, you may touch many sick or injured patients, handle specimens and used equipment. You must take a shower and brush your teeth at least once a day, wash your clothes and store them in a neat and clean area. Even washed clothes left in a heap in the closet or on the floor will pick up dirt and microscopic organisms that may lead to illness for you or your patients. Clothes that are contaminated at work should be changed as quickly as possible, bagged, and then washed in hot soapy water. One place many people forget to wash closely is under fingernails. It is very easy for dirt and debris to collect under your fingernails. Think about all the times you touch your face with your hands. You should use a nail scrub brush to remove particles that are not washed off with regular handwashing. This is especially important before and after assisting with any medical procedure. Last, but not least, good hygiene practices ensure you appear (and smell) professional!

Housekeeping

At first thought, what do housekeeping duties have to do with performing as a medical technician? In most cases, once a procedure is complete, the responsibility of preparing the room for the next patient lies with the technicians. Housekeeping is a locally contracted service provided to each treatment facility and specific guidelines differ from one facility to another. Ensure you know what the specifics of the housekeeping contract are before being in a situation when there are more patients than exam rooms available.

The primary purpose of the housekeeping duties is to control the spread of infection. The previous lesson reviewed the basics of asepsis. The third principle of asepsis: limiting the spread of microorganisms breaks the infection cycle, promoting an aseptic environment for our patients. Whether visiting a clinic, being admitted to an inpatient unit or undergoing major or minor surgery, preventing the spread of infection is the governing rule why housekeeping is accomplished. Most housekeeping contracts do follow some basic guidelines. Most will include:

- Empty trash daily.
- Terminally clean non-medical equipment when patients are released from care.
- Mop/clean any “slipping” hazards upon notification. There may be some limitations on biohazard materials such as blood or other body fluids.

Housekeeping is usually ***not*** responsible for:

- Emptying sharp’s containers.
- Cleaning/disinfecting medical equipment or reusable supplies.
- Cleaning up blood, feces, or dirty linens left by a patient.

These are just a few examples. You should always make sure you are aware of the Occupational Safety and Health Administration (OSHA) standards, and any other guidelines you are held to when performing housekeeping duties. Specific details for cleaning a patient unit and performing disinfection procedures will be covered in depth later in this volume.

004. Description of common communicable diseases

It is extremely critical to be familiar with the most common communicable diseases. As a 4N0, it is very likely you will be providing care for patients with some type of communicable disease. The information provided should enable you to better understand these diseases and hopefully assist in the safety of your patient as well as yourself. Although there are many different types of communicable diseases, this lesson will discuss some of the more common forms you must be aware of, along with their characteristics.

Hepatitis

Hepatitis is an inflammation of the liver caused by bacteria, viruses, protozoa, helminths, chemicals, or drugs. The *hepatitis viruses* specifically attack the liver and cause reactions ranging from slight jaundice with a full recovery to complete destruction of liver tissue resulting in death. We used to believe there were only two types of *hepatitis virus*, type A and type B. We now know there are many hepatitis viruses, including type C (formerly called non-A, non-B), type D (the delta agent), and type E (enteric). As researchers continue their investigations of viral diseases, other types may be discovered.

Hepatitis types A and E cause symptoms commonly known as infectious hepatitis. This type of hepatitis is usually transmitted by ingestion. Contaminated food, milk, and shellfish infected by sewage-polluted waters are common sources of the A virus. Contaminated water is the primary source of the E virus. Type A and type E hepatitis is found worldwide, and is particularly prevalent in countries with poor sanitation. Symptoms include fever, nausea, gastrointestinal upset, liver enlargement and tenderness, and jaundice. The disease caused by type A usually lasts from three to eight weeks (sometimes longer) and is seldom fatal. Type E hepatitis is not fully understood, but appears particularly lethal for pregnant women. A short-term vaccine is available to protect against Hepatitis A from three to six months; you may receive it if you are being deployed to a high-risk area.

Hepatitis types B, C, and D cause diseases commonly known as *serum hepatitis*; they are transmitted solely by contact with infected blood or body fluids. The symptoms are similar to those of infectious hepatitis, but the disease is more prolonged and more likely to cause permanent damage or death.Type B hepatitis primarily affects young adults in high-risk groups (such as medical personnel); adults generally recover, but the disease can be fatal in infected newborns. Type D hepatitis is found only in combination with type B; it intensifies the effects of the disease and is the type most likely to result in death. Type C accounts for as much as 90 percent of hepatitis found in post-transfusion patients.

Serum hepatitis is of special concern to medical personnel because of the probable and sometimes frequent exposure to blood and body fluids, combined with the inherent risks presented by the numerous sharp instruments used in medicine. Even 0.0001 milliliters (ml) of blood can transmit the infection, even a scratch from an infected instrument can result in the disease. This is why it is imperative for medical personnel to be immunized with the hepatitis B vaccine (the vaccine also immunizes you against type D). *The vaccine is mandatory for all military healthcare workers*. The risk of transmission is also one reason you must immediately report all needle sticks or wounds received on duty to your supervisor. You should be tested for hepatitis after any sharp instrument injury or other exposure to blood or body fluids.

Since Hepatitis A and B are better understood, let’s take a look at some additional information. Keep in mind that these diseases can be prevented with proper PPE, vaccinations, situational awareness and following public health rules, especially when you are in a foreign country.

Hepatitis A

The hepatitis A virus (HAV) is usually a mild disease lasting 1 to 2 weeks, but can be debilitating and last several months. The symptoms include fever, malaise, anorexia, nausea, and abdominal discomfort followed within a few days by jaundice. Children under the age of two with HAV usually are asymptomatic (do not exhibit symptoms). Children above this age are more likely to have symptoms. The disease is transmitted by the fecal-oral route. The incubation period is 15 to 50 days with an average of 28 days. The infected person usually sheds the virus in the feces during the last half of the incubation period. The virus usually disappears from the feces within a week after the onset of symptoms.

HAV is a common problem in child development centers because of the poor hygiene of young children and because many of the infected children are asymptomatic. This is why diapered and toilet-trained children are separated in child development centers. Also, it can be a problem for the military members who are assigned or deployed to an area of endemic disease. This virus is transmitted through contaminated food and water, including milk, sliced meats, salads, and raw or undercooked mollusks, or by direct contact.

Those at risk for hepatitis A can be educated about the importance of sanitation. For example, caregivers at child development centers are at risk of acquiring hepatitis A if they care for diapered children. If proper hand washing and diaper changing procedures are not rigidly followed, it is possible to pass the infection on to other children and caregivers. You normally will not be aware of a problem until infected caregivers or parents become symptomatic. By the time adults show symptoms you may have a full-scale epidemic on your hands.

Education is not the only preventive measure you can take to protect people exposed to HAV. Those exposed to hepatitis A can be given an injection of immunoglobulin intramuscularly (IM) to prevent hepatitis A infection or to lessen their symptoms. However, for this injection to be effective, it must be administered within two weeks of exposure.

Hepatitis B

The effects of the hepatitis B virus (HBV) can be more severe than hepatitis A. Symptoms of HBV includes anorexia, vague abdominal discomfort, nausea, and vomiting. Sometimes a rash is present and jaundice ultimately develops. Fever is usually either mild or absent. Hepatitis B virus may infrequently result in chronic infection in carriers, chronic active hepatitis, and cirrhosis of the liver. It is the primary cause of hepatocellular carcinoma, a form of liver cancer. Although HBV has been found in all body fluids, such as blood, saliva, and semen, only the blood or serum derived fluids are known to be infectious. Contaminated needles, syringes, and other intravenous equipment are important vehicles for transmitting the disease, especially among IV drug users. The infection can be spread through contamination of wounds and lacerations, or by exposure of mucous membranes to infected blood. All of these are a potential source of transmission in health care occupations. This virus is also transmitted through sexual contact.

Those exposed to HBV should be given hepatitis B immunoglobulin within one week of exposure. Since HBV is transmitted through body fluids, people such as health care providers, laboratory and blood bank workers, and dental personnel are at risk for occupational exposure. Examples of exposures might be from needle sticks or exposure to an infected patient's mucous membranes. However, there is an effective vaccine to prevent HBV infection. The vaccine is a series of three injections given over six months. The follow-up injections are given at one and six months after the initial injection. Vaccination of military members who are at high risk for occupational exposure to hepatitis B virus is now mandatory.

Airborne/respiratory diseases

One of the most significant communicable diseases occurring among the active duty population is respiratory (or airborne) disease. There is much concern over these types of diseases due to the adverse effects they can have on Air Force operations and activities. Respiratory diseases are readily transmitted by casual contact and they are difficult to control or prevent. Although vaccines have been developed for common respiratory diseases such as mumps and rubella, others still pose a threat to the health and effectiveness of our highly mobile force. While there are many respiratory or airborne diseases, only a few of the more common diseases will be covered.

Meningitis

Meningitis is simply an inflammation of the meninges covering of the brain and/or spinal cord and is caused by various organisms such as bacteria, viruses, fungi, or parasites. Though meningitis manifests in many forms, the discussion is limited to three general types—bacterial meningitis, viral meningitis, and pneumococcal meningitis.

Bacterial meningitis

This is the most serious type of meningitis and is sometimes fatal. Bacterial meningitis spreads easily from person to person by direct contact or droplet infection. Since the responsible bacteria are carried in the nasopharynx, all oral or nasal discharges are capable of transmitting the disease. Signs and symptoms include sudden onset of fever, headache, nausea, occasional vomiting, stiff neck, and very often a rash. Some patients progress to delirium or coma.

Viral meningitis

This form of meningitis, often called "aseptic meningitis," is the most common and is less severe than bacterial meningitis. Several viruses can cause the disease, but the mumps virus seems to be the most common. Other common viruses, including herpes simplex and varicella are also known to cause the disease. Viral meningitis is characterized by sudden onset of fever and headache. The mode of transmission and incubation period varies depending on the virus responsible for the infection. The illness seldom exceeds 10 days and is rarely fatal.

Pneumococcal meningitis

This type of meningitis occurs mainly in infants and the elderly. Signs and symptoms include a sudden onset of chills, fever, difficult breathing, a productive cough, and chest pain. The cough produces "rusty" or blood-tinged sputum.

Streptococcal infections

Streptococcal sore throat is the most common type of streptococcal infection caused by the *streptococcus pyogenes* (group A strep) organism. Those infected carry the organism in the oropharynx and transmit the droplets through kissing, touching, or sharing drinking or eating utensils. The incubation period of streptococcal sore throat is one to three days and characterized by the sudden onset of sore throat, fever, and headache. The normal treatment for a laboratory confirmed infection is penicillin; however, the infection usually resolves itself if untreated. The problem with untreated streptococcal sore throat is it could progress to rheumatic fever, kidney inflammation, or scarlet fever.

Rhinoviruses and influenza viruses

The diseases we call the "common cold" are caused by numerous *rhinoviruses*. The *rhinoviruses* primarily attack the respiratory system and can cause severe inflammation of the nose and throat. Young children are particularly susceptible to "colds" caused by these viruses, and pneumonia is always a possible complication.

Influenza is an acute, febrile, respiratory infection that may exhibit systemic manifestations. The average incubation period of influenza is one to three days. Symptoms include a sudden onset of chills, fever, headache, generalized aching, swollen glands and malaise. Fever may last one to seven days, with an average of three days, and most patients usually recover in a few days. Recovery is slower than with *rhinoviruses* and because of the body's weakened state bacterial pneumonia can easily develop. The elderly and people with chronic diseases are prone to complications such as pneumonia.

Because there are numerous types of *rhinoviruses* and *influenza viruses*, it is impossible to develop vaccines to inoculate against all of them. The "flu shot" you get every year is intended to inoculate you from the *influenza* strains epidemiologists believe will be most virulent during the season; *it does not protect you from all forms of influenza.* Surgical patients are particularly susceptible to viral infections because their bodies are already weakened by disease or injury. The trauma caused by surgery weakens their natural defense mechanisms and allows infection by "cold" or "flu" viruses to cause numerous complications.

Besides being highly virulent to patients with weakened immune systems, *rhinoviruses* and *influenza viruses* are highly contagious and easily transmitted from person to person. Even wearing masks does not provide complete protection as these viruses are easily spread via aerosol droplets that blow through the masks when you sneeze, cough, talk, or laugh. The viruses can contaminate sterile setups and find their way into open wounds. As a result, not only are patients infected but a mini epidemic can spread amongst medical personnel. Overall patient care suffers because there are fewer healthy staff members to provide direct patient care. Also, those infected personnel who remain on duty perform at less than peak proficiency because they simply do not feel well.

The best way to combat *rhinoviruses* and *influenza viruses* is to keep you healthy. If you do come down with a cold or the flu, report it to your supervisor. You may need to work away from direct patient care, especially if you are working with patients that are at high risk for infection.

Tuberculosis

Tuberculosis is a highly contagious infection caused by the bacterium called mycobacterium tuberculosis. It primarily affects the lungs, but it can form and cause necrosis in tissues of any organ and is transmitted by the inhalation of droplet nuclei. A single exposure to tuberculosis is not likely to result in infection. It takes repeated, prolonged exposures to develop infection, as those occurring in close quarters such as homes, dormitories, nursing homes, classrooms, or offices. Initial infection usually goes unnoticed. If a susceptible person inhales tubercle droplets and they reach the alveoli of the lungs, tuberculin sensitivity usually appears within a few weeks. Common symptoms include fatigue, weight loss, fever, chills, night sweats, loss of appetite, and a persistent cough. Most patients do not seek medical attention until they develop a persistent productive cough, cough up blood, or experience chest pains.

Sexually transmitted diseases

Sexually transmitted diseases (STD) are amongst the most common types of infectious diseases in the United States today. They are caused by a variety of infectious agents transmitted primarily through sexual contact. Although transmitted primarily through sexual activity, other methods of transmittal pose a significant threat to our safety and health while treating those infected. This category includes AIDS, chlamydia, gonorrhea, herpes, and syphilis.

Human immunodeficiency virus and acquired immunodeficiency syndrome

One of the most widely publicized, life-threatening, and incurable disease-causing viruses is the human immunodeficiency virus (HIV). It is the virus that causes acquired immunodeficiency syndrome (AIDS). This virus poses a serious occupational health risk to medical personnel.

HIV is transmitted by exposure to infected blood, blood components, or other body fluids; primarily those that contain white blood cells. The virus has been found in blood, semen, vaginal secretions, saliva, tears, breast milk, cerebro-spinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, and urine. *The virus may be spread by unprotected contact with any of these fluids, but is* **NOT** *spread by casual contact with an infected person.*

The HIV virus may remain dormant for 10 years—maybe even longer—before any symptoms of infection develop. When the HIV virus develops into AIDS, it virtually destroys the body’s immune system. This makes the body susceptible to nearly all diseases or pathogenic agents. Death is inevitable and results from complications associated with numerous diseases occurring simultaneously.

All healthcare workers who handle or are exposed to blood and body fluids run a significantly greater risk of being infected than the average person. As a result of this increased risk, the CDC recommend healthcare workers consider *all* patients as potentially infected with HIV. It also recommends healthcare workers take standard (universal) precautions with all patients. OSHA issued the standard *Occupational Exposure to Bloodborne Pathogens; Final Rule*. This standard requires employers and employees at risk of exposure to follow certain rules and wear certain attire.

AIDS is the acronym for acquired immunodeficiency syndrome first used by the CDC in 1982. It is used to describe a group of symptoms that usually result from an infection with a virus. This disease has affected many people around the world and even created a panic situation in some areas. The effects of this disease have single-handedly changed the sexual conduct of many people in our society.

The virus initially was called human T-lymphotrophic virus type III (HTLV-III) in the United States and lymphadenopathy associated virus (LAV) in France. HIV stores its genetic material in the ribonucleic acid (RNA). HIV infected cells use an enzyme called reverse transcriptase to copy the viral genetic material from RNA into DNA. This genetic information stays in the infected cell and continues to replicate more viruses that can infect other cells. HIV destroys the body’s ability to defend against invading organisms since it attacks the T_4 (T-helper or CD_4 cells), as well as, the macrophages/monocytes.

As stated above, HIV is primarily transmitted in blood, semen, or vaginal secretions through a variety of transmission modes. The most common form of contact is direct contact during sexual intercourse. Other modes of transmission include sharing contaminated needles (drug abusers) and receiving contaminated blood (hemophiliacs and other blood recipients). A number of newborn infants also have contracted the virus from infected mothers. Finally, and of particular concern to us, a few health-care workers have contracted the virus while caring for infected patients. This usually happens when the worker is exposed to the patient's secretions during a procedure.

When the AIDS virus enters the bloodstream, it begins to attack the T-lymphocytes, and one of three things happens:

1. The victim may carry the virus, but remain asymptomatic.
2. He or she may develop the characteristic signs and symptoms of the immunodeficiency syndrome.
3. The victim may develop the symptoms of a lesser condition called the AIDS-related complex (ARC).

The immunodeficiency syndrome is so named because of characteristic symptoms developed by the victims. Victims become susceptible to all sorts of opportunistic infections. An opportunistic infection is caused by a microorganism that is normally nonpathogenic or not strong enough to overcome the immune system. Some of the symptoms that develop include fever, rapid weight loss, swollen lymph glands, fatigue, diarrhea, persistent dry cough, skin blotches or bumps, and "thrush" which is a fungal infection of the mouth and throat characterized by thick white spots. All of these symptoms can also be seen in other disorders. The symptom most characteristic is the development of opportunistic infections with a very high rate of fatality (e.g., some individuals develop uncommon types of cancer). There is some evidence the virus also attacks the nervous system producing long-term damage. Signs of neurological damage include memory loss, confusion, loss of coordination, paralysis, etc.

The AIDS-related complex is less serious than the immunodeficiency syndrome. Symptoms are similar but milder than those mentioned for the actual syndrome (loss of appetite, weight loss, fever, skin rash, diarrhea, fatigue, swollen lymph glands, and a decrease in resistance to infection).

AIDS has raised a moral and ethical issue that directly affects you. It is possible for you to become infected while caring for an AIDS patient. It is extremely unlikely if you follow all the recommended precautions, but there are instances (heart attacks, surgeries, hemorrhages, and various other emergencies) where it is difficult to avoid contact with the patient's bodily fluids.

The Air Force currently uses two lab tests to confirm exposure to the HIV virus, the Enzyme-Linked Immuno-Sorbent Assay (ELISA) and Western blot test. Both tests detect HIV antibodies, but the Western blot is more specific. Neither test can detect the virus itself. These tests are highly sensitive when used for testing high-risk groups such as homosexuals and intravenous drug users, but less predictive for low-risk groups. If the ELISA test is positive on a blood sample, the sample is then tested with a Western blot test.

Human papillomavirus

Genital human papillomavirus (HPV) is now the most common sexually transmitted disease and there may be as many as 40 types of HPV. It is a virus that infects skin and mucus membranes and generally infects the genital regions in men and women to include the skin on the penis, the vulva (area outside the vagina), the cervix, lining of vagina and the rectum.

Certain types of HPV cause genital warts but otherwise may not be detectable by sight; many people do not know that they or their partner has HPV. HPV is a risk factor for cervical cancer in women. On rare occasions, a woman may pass HPV to her baby during a vaginal delivery and the child may develop warts in the throat. Recently, a new vaccine for women was introduced onto the market with recommended vaccinations for women 11 to 26 years of age. There is currently no approved preventive treatment for men other than abstinence or condoms.

Condyloma is a wart appearing on the genitalia or rectum and is also spread by sexual contact. They may be single or multiple warts that are soft, fleshy or flat and they may also occur in a cauliflower like mass. Condyloma is frequently diagnosed by a Pap smear or biopsy. The common forms of treatment are cryotherapy (freeze) or topical Podofilox 0.5%. Regardless the type of treatment, however, recurrence is common.

Chlamydia

A chlamydia infection can affect the urogenital and reproductive tract of both men and women and the conjunctiva and lungs of newborn infants. This infection is just as serious as a gonococcal infection. Chlamydia infection in men is often called non-gonococcal urethritis (NGU). Chlamydiae share properties with both bacteria and viruses. Like viruses, chlamydiae only grow intracellularly, which makes culturing difficult and expensive. Chlamydia infections are not always apparent, and many infected men and women may be asymptomatic. It can be transmitted from one person to another during sexual intercourse with either the penis or vagina becoming infected. It has also been isolated from the pharynx and rectum from both heterosexual and homosexual men and women. The organism is also transmitted from the mother's birth canal to the newborn's conjunctiva during delivery.

Gonorrhea

Gonorrhea is another common STDs. It is spread from one person to another by intimate penile, vaginal, oral, or rectal contact with an infected person. The gonococcus bacteria travel from the mucous membranes of the infected partner to the uninfected partner's mucous membranes; however, it does not always infect the uninfected partner. Organisms often die during sexual contact, making the chances of catching gonorrhea during a single exposure about 50 percent. Repeated sexual contact with an infected person greatly increases the chances of becoming infected.

In males, about three to seven days after contact, gonorrhea causes a thick, whitish-yellowish discharge of pus from the penis. This discharge consists of dead urethral cells, bacteria, and white blood cells. The meatus becomes swollen, making urination difficult and painful. Some men are asymptomatic and do not show any signs or symptoms. These men do not seek medical attention and are a major factor in the continual spread of the disease.

In about 20 percent of the men who remain untreated for longer than a month, the bacteria spread down the vas deferens, reach the epididymis on the back of one or both of the testicles, and cause gonococcal epididymitis. Epididymitis, which occurs more commonly on the left side, causes pain in the groin, a heavy sensation in the affected testicle, and the formation of a small, hard, painful swollen area at the bottom of the testicle. The overlying skin of the scrotum becomes red, hot, and painful. Even when treated, gonococcal epididymitis leaves scar tissue, which closes off the passage of sperm from the affected testicle. Complications of gonorrhea in the male are extremely rare and even when treatment is delayed, the patient will likely have a total recovery.

Gonococcal infections in females are more difficult to identify based on symptoms. The infection may cause an unusual vaginal discharge; however, this discharge is hard to distinguish from that which normally occurs during sexual excitement, ovulation, a few days before menses, or during pregnancy. Occasionally a burning sensation may occur during urination. Approximately 80 percent of cases in women are asymptomatic. Therefore, it is very important for men with symptoms to notify their female sexual partners immediately and for women to seek a medical examination for gonorrhea.

Complications can also occur in the female if the infection goes untreated. Gonorrheal pelvic inflammatory disease (PID) is the most common and most serious complication of gonorrhea infections, occurring in about 50 percent of the untreated cases of uncomplicated gonorrhea. Because uncomplicated gonorrhea does not produce noticeable symptoms in most women, the infection is often not treated. If treatment is delayed for more than 8 to 10 weeks, the bacteria may travel into the uterus. During menstruation, the bacteria can multiply rapidly in the dead cells and blood of the uterine lining, spreading quickly up the sides of the uterus and attacking the inner walls of the fallopian tubes. Infection may block the fallopian tubes, allowing pus to collect. As infection builds, the tubes become grossly enlarged. Even after the infection resolves, the fallopian tubes frequently remain blocked with scar tissue, often resulting in sterility. The infection can also travel out of the fallopian tubes and invade the pelvic cavity. When this occurs, the pelvic tissues become swollen and inflamed. A woman with gonococcal PID may experience one or more of the following symptoms:

- Lower abdominal pain.
- Pelvic tenderness.
- Elevated temperature.
- Dysuria.
- Vaginal discharge.
- Nausea.
- Vomiting.

Nongenital gonorrhea can attack organs other than the genitals. It can infect the rectum, pharynx, conjunctiva, and bloodstream. In females, infectious heavy discharge or menstrual blood may be manually transferred to the rectum and result in infection. Although it usually does not cause symptoms, rectal gonorrhea caused by anal penetration may produce rectal mucous discharge, intense rectal irritation, a feeling of incomplete evacuation after defecation, and burning pain during defecation or anal intercourse. However, these symptoms are also often associated with men who practice anal intercourse and do not have gonorrhea. Rectal contacts of persons with penile gonorrhea should receive treatment since medical examination and diagnostic cultures may not detect rectal gonorrhea.

Another form of gonorrhea is pharyngeal gonorrhea or oral gonorrhea. People with this form of gonorrhea are usually asymptomatic. However, some symptoms may develop including mild to severe sore throat, fever, and chills.

The third type of nongenital gonorrhea is gonococcal opthalmalia neonatorum, which occurs in newborn infants. The eyes are infected as the infant passes through the birth canal of the infected mother. Symptoms include intense redness, swelling, and a discharge usually occurring within three days of birth. The infection usually occurs bilaterally and if untreated may lead to corneal ulceration or orbital cellulitis. To prevent infection, all newborns in United States hospitals have silver nitrate drops placed into their eyes immediately after birth.

Herpes

Genital herpes is a viral disease that usually affects sexually active people. Newborns can also be affected during birth. Herpes is caused by herpes simplex virus (HSV). There are two types of HSV. Type one (HSV1) usually causes cold sores or fever blisters of the mouth, and type two (HSV2) usually causes genital herpes. HSV2 invades the nerve cells of the genital area. After the initial infection, the HSV2 leaves the infected genital area and travels to the nerve cells that lie next to the lower part of the spinal cord. The virus lives here for the remainder of the person's life. Periodically thereafter, reactivation of the virus within these nerve cells causes the virus to retrace its path back to the nerves of the initially infected site. It is possible for this relapse to occur years after the initial infection. Furthermore, such relapses may recur frequently or rarely. Due to the antibodies produced by the body to fight off the first invasion of the virus, the repeat episodes are generally not as painful and do not last as long as the initial infection. Herpes can be transmitted from any form of sexual contact including intercourse and oral-genital contact. Even the HSV1 has been found in the genital areas of infected patients.

Syphilis

This disease occurs in both an acute and chronic form. The acute form is characterized by primary stage lesions known as chancres; the secondary stage has characteristic skin rashes and mucous membrane eruptions, as well as long periods of latency without symptoms. The late stage of syphilis may be present as a chronic disease involving the central nervous system and the cardiovascular system. It is also possible for a pregnant woman to pass the infection to her unborn baby. Syphilis occurs in stages classified as primary, secondary, latent, late, and congenital, but is only communicable during the primary and secondary stages (and relapses during early latent stage). The following are discussions on each stage of the infection, including signs and symptoms.

Primary

The first clinical sign of syphilis is the chancre (usually a dull red, hard, insensitive lesion) that forms at the site the spirochete bacteria enters the body. The chancre is a characteristic single, painless lesion that appears on the penis, meatus, or the scrotum of infected men. In men, the chancre is usually visible; however, this is not true for women. The lesion occurs anywhere in the genital area and because it is painless, it goes unnoticed if located in the vagina or on the cervix. Some people never realize they have a lesion and progress to the secondary stage of the infection. Chancres occur around the anus of people who practice anal intercourse and on the lips or inside the mouth of those practicing oral sex. Syphilis is not confined to the chancre during the primary stage, as the spirochetes travel throughout the body.

Secondary

Usually, within 6 to 8 weeks after the primary lesion appears, the patient enters the second stage of syphilis. However, this stage could begin as soon as the primary lesion disappears or as long as several months afterwards. The clinical signs of this stage vary and may affect any organ of the body. The diagnosis is usually based on the existence of skin and mucous membrane lesions or a thinning of the scalp hair. Along with these manifestations, other clinical signs of the secondary stage consist of a mild fever, slight malaise, anorexia, headache, sore throat, myalgia, arthralgia, and aching bones. These signs may be overlooked during the diagnosis, and the symptoms usually disappear after about 4 to 12 weeks, usually without scarring.

Latent

In this stage, the patient has no clinical signs of infection. This stage is divided into two parts. First, the *early* latent stage starts when the secondary lesions disappear. This early latent stage continues for 4 years. The *late* latent stage starts at the 4-year mark after the latent stage first began. The patient may live with the late latent stage and remain asymptomatic for life or this late latent stage will last until the late stage of syphilis begins.

Late

The late stage of syphilis is considered the destructive stage of the disease. It is noninfectious and can involve any organ or tissue in the body. It has been called the great imitator since it can produce signs of almost any other disease; however, it usually involves the cardiovascular and central nervous systems (CNS). The late stage in the CNS can be diagnosed and managed, but late cardiovascular syphilis is usually identified too late for the survival of the patient. The late stage also can affect the skin and bones; however, these two forms of late stage syphilis are less common.

Congenital

The term congenital is not as accurate as prenatal in describing the transfer of the disease to the fetus. The spirochete usually crosses the placenta between the 16th and 18th week of pregnancy. Prior to this period, the cell layer of the placenta acts as a barrier to the spirochetes. This layer breaks down after the 18th week, allowing the bacteria to infect the fetus.

Congenital syphilis is divided into two basic stages, early and late congenital syphilis. There is no primary stage since the bacteria are transferred directly into the bloodstream of the fetus. The early congenital stage produces signs and symptoms before the child is two years old. If the symptoms appear within the first few weeks of life, a poor prognosis usually results. The signs include cutaneous lesions, mucous membrane lesions, poor development of the long bones, anemia, and an enlarged liver or spleen. Almost 50 percent of the patients have CNS problems related to the disease.

The late stage is defined as congenital symptoms persisting beyond two years of age. This stage is not infectious and can be similar to latent syphilis in adults; however, there are symptoms that might appear. These symptoms include dulling of the cornea, maldevelopment of the first molar teeth, eighth nerve deafness, neurosyphilis, and bone development problems such as saddle nose configuration or a poorly developed hard palate. Other signs include cracks or fissures around the mouth, cardiovascular lesions, and painless swelling of the joints. These signs may develop before puberty or as late as middle age.

Communicable disease reporting

You have learned about many diseases in this volume. At this point, you may be asking yourself, what good is this information and how will this help me in my job? One of the foundations of your job is prevention. As an aerospace medical service journeyman, you must know the specifics about a disease before you can educate people on preventing the disease. Additionally, you must know the procedures for reporting diseases and the agencies responsible for disseminating this information. The following will help you become familiar with the reporting process, the organizations to which you will report, and other actions necessary to prevent the spread of communicable diseases.

Disease reporting

As part of an active communicable disease surveillance system, many diseases must be reported immediately. In some cases, even a suspected diagnosis should be reported as soon as possible to avoid delays in epidemiologic follow-up, while waiting for laboratory confirmation. Examples of diseases requiring rapid case reporting are those which are universally required by International Health Regulations such as: cholera, yellow fever, plague, measles, and meningitis. Report any increase of communicable disease incidence in your local community to the Public Health (PH) office to identify the disease and alert them of any increase at your military treatment facility (MTF). PH reports the disease rates in the local area to the medical staff. This helps the health care providers look at the local picture of disease problems. You also have a part in making the “big picture” for the Air Force by reporting disease incidences to higher headquarters.

Action by health care providers

Upon identification of a suspected or confirmed diagnosis of any communicable disease condition, the health care provider will report the case to PH immediately. The health care provider or technician will notify the MTF PH office by phone or locally derived form. It is best to make the notification while the patient is still in your clinic in case there are any questions that need to be answered immediately or the PH office is available to see your patient at that time. Some MTFs may have a locally devised form for notification of communicable diseases, so ensure you check your facility.

United States Air Force reportable diseases

The PH office is responsible for identifying and preparing a list of diseases that must be reported under federal, state, and local laws. AFI 48–105, *Surveillance, Prevention, and Control of Diseases and Conditions of Public Health or Military Significance* lists the communicable diseases that the USAF MTFs must report to higher headquarters. It also discusses other diseases that require reporting such as sexually transmitted diseases.

Reporting procedures

PH is responsible for making communicable disease reports to civilian agencies. Anytime these reports may adversely impact security or security regulations, the civilian authorities are bypassed and the report is sent to the next higher Air Force headquarters for action.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

001. General patient care skills

1. What are some of the general patient skills 4N0s perform?

2. What kind of information and assistance does the CDC provide military hospitals?

3. Usually, what are the qualifications of an infection control officer?

002. Understanding infectious agents

1. What are two ways that a causative agent may cause disease?

2. Where do normal flora originate?

3. What type of relationship develops when a host is exposed repeatedly to a pathogen but is *never* successful in eliminating it?

4. How do carriers differ from individuals who actually develop an infectious disease?

5. What type of pathogen uses parts of the host’s tissues as nutrients?

6. What is the average rate of reproduction for bacterial cells?

7. What physical characteristics of bacteria are used to determine their classification?

8. What are the three basic bacterial shapes?

9. What type of organism causes Rocky Mountain spotted fever?

10. List three useful functions of fungi.

11. What unique quality does the cell wall of the protozoa possess, and what does it allow the cell to do?

12. What enables the amoebae to propel itself and ingest food particles?

13. What is the smallest known microorganism?

14. In what stage do helminthes normally enter the human host?

003. The infectious process

1. List the components of the chain of infection.

2. What are the normal exit portals for infectious agents?

3. Describe indirect contact.

4. Describe droplet transmission.

5. What are the stages of an infectious disease?

6. How much can the prodromal period vary for different diseases?

7. What is the body’s best natural barrier to infection?

8. How do mucous membranes defend against infection?

9. How do tears defend against infection?

10. What role does the lymphatic system play in the body's disease defense system?

11. What are antibodies?

12. What is a regional infection?

13. What are the two recommended tiers of isolation precautions developed by the CDC?

14. Why were standard precautions developed?

15. When is it important to use masks, goggles, or face shields?

16. What are the three types of transmission-based precautions?

17. Describe how to reduce the risk of spreading infectious agents by the "airborne" route.

18. If droplet precautions are in effect, when should you wear a mask?

19. Describe the primary purpose of having housekeeping duties?

004. Description of common communicable diseases

1. Define hepatitis.
2. What is meningitis, and what is the most serious type?
3. What is the most common type of meningitis?
4. Briefly describe the AIDS disease and the virus known to cause it.
5. What is the most common/serious complication of gonorrheal infections in women?
6. List the five stages of syphilis.
7. How does a physician notify the PH office of a reportable disease?
8. What directive discusses how reportable disease lists must be updated?
9. Who ensures civilian agencies are notified of reportable diseases?

1–2. Aseptic Practices

In the previous section, you read about the infectious process and the different organisms that cause infection. That information should help you understand why infection control is necessary. The next logical step is to discuss how infection control measures are implemented. First, you will learn about the principles of asepsis, and then you cover an in-depth review of medical aseptic and surgical aseptic techniques.

005. Principles of asepsis

At this point in your training, you should understand the importance of infection control. While at work you probably don't consciously think about the fact that every time you wash your hands you are stopping the spread of infection, but you are! You may remember your instructor saying, "Wash your hands, wash your hands!" Whatever reminds you to wash your hands is not important; doing it is most important. Before you learn about the two methods of reducing or eliminating microorganisms (medical and surgical asepsis), let's review exactly what the term "asepsis" means.

Asepsis is defined as the state of being free of pathogenic microorganisms. Simply stated, it means freedom from infection. If you remember these three points, you should be able to understand the principles of asepsis.

1. Asepsis is the absence of all microorganisms.
2. Asepsis can only be achieved on inanimate objects, not on people.
3. Limiting the spread of microorganisms breaks the infection chain and results in the eventual destruction of the microorganism.

Aseptic techniques

Based on these three points, you can break down asepsis into two levels or different types— medical asepsis and surgical asepsis. Let's take a closer look at these types of aseptic techniques.

Medical asepsis

This term refers to practices designed to reduce the number and prevent the spread of microorganisms. Another term often used is *clean technique*. Common sense aseptic practices, such as maintaining good personal hygiene and handwashing, are so simple many people, including medical personnel, frequently overlook them. In fact, handwashing is considered by many medical authorities to be the single most effective means of preventing the spread of infection. Hands are one of the most useful tools medical personnel have. Unfortunately, they are also one of the most frequent sources of contamination in the hospital or clinic. Much of that contamination is linked to poor handwashing techniques. To help decrease this possibility, you must take care to wash your hands before and after giving care to any patient.

Standard precautions also aid in reducing the number of organisms by interrupting the chain of infection at the transmission link. Standard precautions have been developed by the CDC to facilitate breaking the chain of infection. These precautions protect both the patient and yourself by using barriers as necessary for all patients. The barriers of standard precautions start with hand washing along with all elements personal protective equipment (PPE) or BSI. PPE or BSI includes gloves, gowns, masks, protective eyewear, and both shoe and hair coverings.

Pathogens can be killed or inactivated by disinfecting reusable equipment. The disinfection of equipment is completed after all visibly soiled items have been cleansed using proper local protocol. All items must be rinsed thoroughly after cleaning before disinfection because soap may react with the disinfectant, preventing its killing properties from working. Disinfectants are solutions containing chemical compounds such as phenol, alcohol, or chlorine that kill or inactivate the microorganisms present. Disinfectants have *bactericidal* or *bacteriostatic* properties. A bactericidal solution destroys bacteria; a bacteriostatic solution prevents the growth or reproduction of some bacteria.

Since disinfectants do not kill or prevent all pathogens, you must use surgical asepsis to kill all current pathogens and inhibit the growth of new microorganisms from growing.

Surgical asepsis

Surgical asepsis refers to practices designed to eliminate all microorganisms. When all microorganisms have been destroyed, an object is called *sterile*. Another term for surgical asepsis is *sterile technique*. Surgical aseptic techniques ensure every object, whether directly or indirectly coming in contact with skin tissues or wounds, or entering a body cavity, is completely free of all microorganisms.

Under these conditions, all articles must be sterile, and the following rules apply:

1. An article is either sterile or not sterile. There is no in-between. If any doubt exists about the sterility of an item, consider it not sterile.
2. Cover sterile items with a sterile covering until they are ready for use.
3. Touch only the outside of a wrapper or cover when you open a sterile package or container.

4. Handle a sterile article only with a sterile instrument or while wearing sterile gloves.
5. When you remove an article from a sterile container, do not return it to that container.

There are a number of terms related to aseptic techniques. *Contamination* is the exposure of a sterile item (surgical asepsis) to a microorganism or the exposure of a "clean" item (medical asepsis) to an infectious agent. *Cleaning* is the physical removal of organic material or soil from objects and is usually done using water with or without detergents. Cleaning can be applied to either surgical or medical asepsis. *Sterilization* is designed to destroy or remove all forms of microbiological life and applies to surgical asepsis only. *Disinfecting* describes measures somewhere between cleaning and sterilization. These measures are designed to destroy pathogenic organisms, but usually do not affect spores. However, if disinfectant procedures are carried out for a sufficient length of time, spores will eventually be destroyed as well. Because disinfecting contributes to elimination of pathogens and can result in eventual sterility, it is classified with surgical asepsis. Disinfectants are substances used to disinfect and are usually used on inanimate objects. Antiseptics are substances that inhibit the growth and development of microorganisms on living tissue, but do not necessarily kill them; therefore, they can only be associated with medical asepsis. Actions to perform cleaning, sterilizing and disinfecting will be discussed in more detail later in this volume.

Medical and Surgical Aseptic Techniques	
Medical	**Surgical**
Indicated: In presence of communicable disease. *Emphasis*: On cleanliness. *Purpose*: To confine disease or infection to the patient; to protect other patients and workers from additional disease; to maintain cleanliness.	*Indicated*: In presence of open wound, or when entering body tissue or cavities. *Emphasis*: On sterility. *Purpose*: To protect patients with open wounds from possible disease of workers or other patients; to maintain sterility.
Isolation	
Patients with a communicable disease are separated from the rest of the hospital by room, ward, or unit. A zone about the area is established as contaminated. Once an article touches a contaminated surface, it is contaminated. Nothing goes out of the zone without being sterilized, disinfected, or wrapped in a clean cover.	Patients are operated on in a separate department away from the rest of the hospital. A zone about the site of operation or wound is established as a sterile field. Once a sterile object touches something nonsterile, it loses its sterility. Only sterile articles are brought into the sterile field.
Masks	
Masks protect workers from inhaling disease organisms from patients. Masks also protect the patient from workers who have an illness such as a cold.	Masks protect an open wound and patient from disease organisms exhaled by workers. They also protect workers from inhaling disease organisms of a patient.
Hand Washing	
A worker's hands and forearms are washed to protect other patients, other workers, and self from any disease. Plenty of soap, water, and friction are used, rubbing well between fingers and around nails. Hands and arms are dried with paper towels.	A worker's hands and forearms are scrubbed to prevent infecting the patient. Plenty of soap, water, and friction are used, rubbing well between fingers and around nails. A brush may be used. Hands are held under tap to allow water to drain off elbows. Hands are dried with a sterile towel.
Gowns	
Clean gowns are worn to protect the worker from a patient's disease. The inside of the gown is kept clean; the outside is in contact with the patient and is therefore contaminated. The gown is worn when caring for one patient or a group of patients with the same disease.	In surgery, sterile gowns are worn to protect the patient from infection possibly carried by the worker. The outside of the gown is in contact with the sterile field; therefore, it must be kept sterile. Each gown is worn for only one operation.
Caps	
Caps are worn to protect workers from disease-laden or airborne organisms.	Caps are worn to protect the patient from possible infection carried by workers.

Medical and Surgical Aseptic Techniques	
Medical	**Surgical**
Gloves	
Gloves can be sterile or nonsterile. They are worn to protect workers when handling articles carrying infectious material.	Gloves are sterile and worn to protect a wound from organisms since hands cannot be sterilized. Gloves are in contact with a sterile field; therefore, they must be kept sterile.
Linen	
Requires special handling to protect ward and laundry workers. Placed inside a clean bag or container tagged "contaminated" and taken to the laundry facility.	Surgery has its own linen supply. After laundering, it is packed, sterilized, and kept sterile until it is used.

These types of aseptic techniques follow closely related concepts, but there are some distinct differences as well. By carefully studying the table, Medical and Surgical Aseptic Techniques, the similarities and differences in these concepts will become very apparent to you.

006. Isolation techniques

Now that you have learned about the importance of aseptic techniques, isolation techniques will be the next area covered. An isolation technique is a medical aseptic practice, which inhibits the spread and transfer of pathogenic organisms by limiting the contacts of the patient and creating some kind of physical barrier between the patient and others.

Isolation precautions

Isolation precautions are designed to prevent the spread of microorganisms among patients, personnel, and visitors. As shown in figure 1–8, isolation precautions break the chain of infection by placing transmission barriers between susceptible individuals and sources of contamination. In most cases, the patient is the source of contamination and the barriers are used to protect everyone else. Such patients are isolated because they have an extremely contagious (easily spread) disease. Other patients are isolated because they are highly susceptible to infection. These patients have a lowered level of resistance because of an injury (i.e., burn), genetic defect, disease or medication treatments. For these patients, isolation means the barriers are protecting them from the outside world. This is referred to as "reverse isolation."

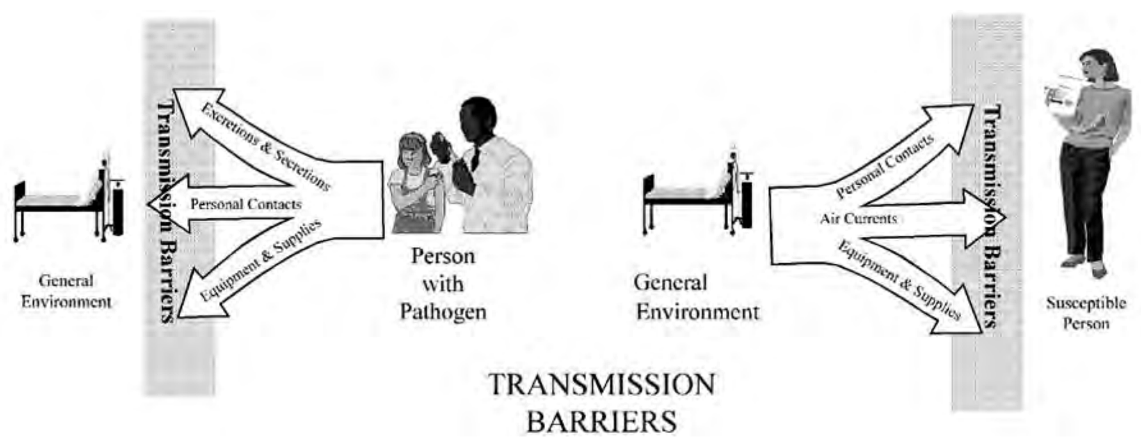


Figure 1–8. Transmission barriers.

Isolation has no effect unless all precautions are followed scrupulously by patients, visitors, and personnel. These precautions are frequently time consuming, inconvenient, and expensive. Also, the concept of "clean" versus "dirty" is difficult for some people to understand, since there is usually no visible evidence of contamination. Some people refuse to believe they can be contaminated, so they ignore the precautions. Others do not understand what they are supposed to do and become contaminated without knowing it. This is typical of visitors who do not stop at the nurses' station, listen to the nurse or follow posted instructions before visiting a patient. Also, individuals who are illiterate or do not read English can become infected due to their inability to understand the caution signs posted on isolation room doors.

Patients and visitors are not the only people who have trouble following isolation precautions. Often, medical personnel contaminate themselves because they get in a hurry and try to take shortcuts. Either they do not understand how to follow the precautions, or they think the precautions really do not apply to them.

Isolation fundamentals

The fundamentals of isolation are the techniques and physical barriers that block disease transmission. The way the different techniques are used remains constant, but the need for the different techniques varies with each type of infection.

Techniques

The techniques used include cohorting, bagging, cleaning, patient transportation, specimen transportation, handling contaminated items, and handling postmortem bodies. Let's take a closer look at each of these now.

Roommates for isolation patients (cohorting)

It is not always possible to place contaminated patients in separate rooms. Often, there are not enough rooms available to support individual cases, nor is it always necessary. The best solution is to place one infected patient in a room with another patient who has the same disorder. Also remember that the patients will normally need to be of the same gender. The term for placing patients together in the same living space is called *cohorting*. In rare circumstances, you may also place infected and noninfected patients together. However, both patients must be cooperative, understand the infectious process, and be taught how to use the isolation techniques. There should also be limited opportunity for the patients to share personal items or contaminate each other with secretions and excretions. This obviously would not work well for young, ambulatory pediatric patients.

Bagging procedures

Used articles may need to be enclosed in a bag before they are removed from an isolation unit. Since these articles are probably contaminated, they are bagged or placed in a container to prevent contamination of the general environment and other people. If there is *no* possibility an item is contaminated, it may be removed without bagging. A single bag is adequate if the bag is sturdy and the article can be placed in the bag without contaminating the outside of the bag. If there is any doubt, the article should be double bagged. In any case, the bag should be sealed, labeled appropriately, and disposed of promptly.

Figure 1–9.
Double bagging technique.

You learned the double-bagging technique in tech school, but let's refresh your memory. This procedure requires two technicians—one inside the isolation unit and one outside. The technician in the unit places contaminated items in a bag and seals it tightly. The techinican inside the room then takes the bag to the door where another technician is standing outside the room. The technician outside should be holding another impervious bag open with their hands under a cuff made by rolling back the top of the bag (fig. 1–9). The technician inside the isolation room then places the bag containing contaminated items into the other bag, being careful not to touch the outside. The technician on the outside of the room seals and labels the bag and disposes of it promptly.

Cleaning

Unfortunately, you cannot always rely on the availability of housekeeping personnel to clean and maintain the isolation units. If they are not there, guess who gets to do it? Right! You do! Cleaning may be either routine or terminal. *Routine cleaning* is done every day. It is usually performed the same as in other areas of the hospital (wiping up spills, damp mopping floors, vacuuming carpets, etc.). If the patient's disease is such that he or she requires a private room, cleaning equipment should be conducted using an approved disinfectant before going to another room (discard water; launder and dry mop heads and cloths; disinfect buckets; etc.). If the cleaning cloths and mop heads are grossly contaminated, bag and label them appropriately before sending them to be laundered.

Terminal cleaning

This type of cleaning is directed primarily toward objects the patient has actually been in contact with (e.g., the patient is unlikely to come in contact with the ceiling so you do not have to worry much about cleaning it). Prepare fresh disinfectant or detergent solution for terminal cleaning. The solution you use is selected by your local infection control committee according to Environmental Protection Agency (EPA) standards. Use the same protective precautions (gowns, mask, gloves, etc.) used when the patient was in the room. Clean (as necessary), bag, and label any reusable items (bedpans, instruments, etc.), and send them to central supply (CS) for disinfection and processing. Discard disposable items. If these items are contaminated, bag, label, and dispose of them according to your infection control committee's guidelines. Clean any equipment that was not sent to CS or discarded with the appropriate disinfectant-detergent solution. This would include all horizontal surfaces of furniture, mattress covers, and floors. Wash walls, blinds, and curtains only if they are visibly contaminated. (**NOTE:** Do not worry about using disinfectant fogging or airing the room; the former is ineffective and the latter is unnecessary.) Once all the surfaces have dried, you can resupply and use the room.

Transporting contaminated patients, specimens, or other items

Before transporting infectious patients, give them protective barriers (gown, mask, and gloves) to wear. Call the department before transporting the patient, so they can take the necessary precautions to protect themselves from contamination. If you are transporting specimens or other articles, place them in a well-constructed container with a tightly fitting lid (if applicable). Then place the container in a sturdy plastic bag (impervious to water) and label it appropriately. (Some specimens will not need to be bagged. Follow local guidelines.)

Postmortem handling of bodies

Generally speaking, use the same precautions you would use if the patient were alive (masks are probably not necessary), and show the same respect. Follow your infection control committee's guidelines for labeling and wrapping the body.

Physical barriers

The physical barriers of isolation fundamentals include the unit itself, masks, gowns, gloves, equipment, linen, trays, and the patient's personal belongings. Let's look at each one.

Patient unit

The most effective type of isolation unit is a private room. Here, the patient is physically separated from other patients, and personnel are more apt to remember to wash their hands, etc., before going on to the other patients. A private room is not a requirement, but should be used for patients who are affected by highly infectious or virulent disorders. It should also be used for patients who have poor hygiene habits and will likely contaminate the environment, or who share contaminated items (e.g., pediatric or confused patients). In addition, patients who have clinically significant microorganisms (resistant bacteria) or infectious blood disorders will be placed in a private room.

Private rooms (fig. 1–10) should be equipped with hand washing, toilet, and bathing facilities. An anteroom (waiting room) is useful for storage and creating a space barrier to prevent airborne transmission, but is not essential. The room should also have a trash container lined with an impervious bag and a linen hamper. In some instances (e.g., patients with infectious airborne pathogens), a room with negative pressure ventilation is recommended. This ventilation creates a pressure difference between the room and the outside so that air is drawn into the room rather than expelled when the door is opened. This system should provide at least six air changes per hour and should be discharged outdoors.

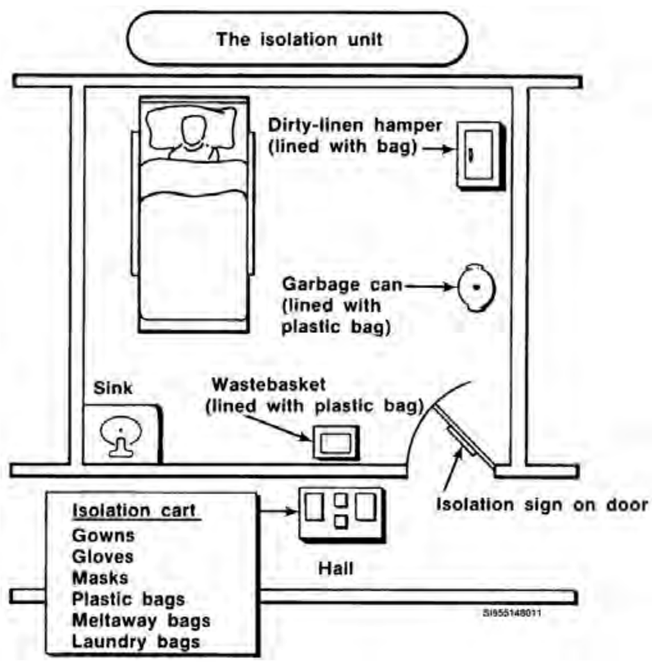


Figure 1–10. Private isolation room.

As an alternative to an anteroom, you can place an isolation cart just outside the door to the isolation unit. This cart should have all the supplies (barriers) that are needed for isolation precautions. You should restock the cart as needed and keep it *outside* the room. As a final note, there should be a sign on the door specifying the type of isolation and precautions to take.

Masks

Masks are used to prevent transmission of airborne infectious agents. They protect the wearer from inhaling large particle aerosols (droplets) that are transmitted by close contact (with infected patients), and generally travel only short distances (3 feet). They also protect against small particle aerosols (droplet nuclei) that remain suspended in air and travel longer distances. Masks might also prevent transmission of some infections that are spread by direct contact with mucous membranes, because masks may discourage personnel from touching the mucous membranes of their eyes, nose, and mouth. The high-efficiency disposable masks are more effective than cotton gauze or paper tissue masks. Place the mask on before entering the room and remove it before exiting. If the infection is transmitted by large-particle aerosols, you need a mask only if you are working close to the patient. If the infection is transmitted over longer distances, you should wear a mask when you enter the room for any reason. See figure 1–11.

Figure 1–11. Applying a mask.

Gowns

Gowns are used to prevent contamination of your uniform when caring for patients and to protect your skin from blood and body fluid exposures. You will most likely need a gown if you are going to have extensive contact with the patient, or if the patient's disorder could cause an outbreak in the hospital. When gowns are worn to prevent the spread of infection they are worn only once and discarded before leaving the unit. See figure 1–12.

Figure 1–12. Applying a gown.

Gloves

Gloves are worn: (1) to provide a protective barrier and prevent gross contamination of the hands when touching blood, body fluids, secretions, excretions, mucous membranes, and non intact skin; (2) to reduce the likelihood that microorganisms present on the hands will be transmitted to patients during invasive or other patient care procedures that involve touching a patient's mucous membranes and non intact skin; and (3) to reduce the likelihood that hands contaminated with microorganisms from a patient or fomites can transmit these organisms to another patient.

When working with a patient in isolation, the gloves you wear may be either sterile or nonsterile, depending on the type of isolation or the procedure being done. If you are doing a sterile procedure or working with an immunosuppressed patient, for example, you should wear sterile gloves. For routine care, you can wear nonsterile gloves. Gloves, however, do *not* eliminate the need for handwashing! You will still accumulate microorganisms beneath the gloves, and there is always a possibility that the gloves could be torn or punctured.

Eye protection and face shields

Wearing goggles or face shields in certain circumstances is mandated by the Occupational Safety and Health Administration (OSHA) to prevent the transmission of bloodborne pathogens. The purpose of wearing such protective equipment is to protect your eyes and the mucous membranes of your mouth when the possibility of splattering or splashing of blood or body fluids is possible. See figure 1–13.

Equipment

If disposable equipment becomes contaminated, it should be bagged, labeled, and disposed of according to local policy. When nondisposable equipment becomes contaminated, it should be cleaned, bagged, and sent to CS for disinfection and processing. No special precautions are needed for sphygmomanometers and stethoscopes, unless they become contaminated. If so, they are dealt with in the same manner as other contaminated equipment. All equipment should be wiped down with an approved disinfectant. Thermometers should be sterilized before being reused. Take special care with needles, syringes, scalpel blades, and other items that may be contaminated with the patient's blood. Place such items in an appropriate biohazard storage device. This device should be maintained in the isolation unit. When it is full or when the patient leaves, the device should be bagged, labeled, and disposed of according to infection control and EPA guidelines.

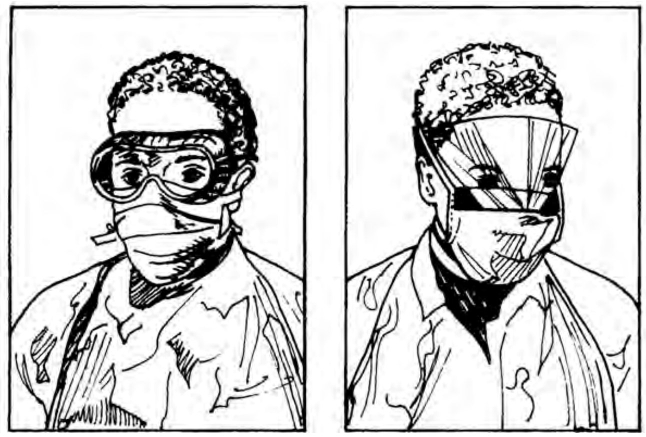


Figure 1–13. Eye and mucous membrane protection.

Food trays

There are no special precautions needed for dishes, glasses, cups, or eating utensils. Your facility will use either disposable or reusable dishes for patients in isolation. The CDC has determined the use of hot water and detergents in hospital dishwashers is sufficient to decontaminate the reusable tray items.

Linen

You should handle linen carefully, and as little as possible, to avoid contamination. Do *not* shake linen out to unfold it or drop it on the floor when you are changing the bed. Most linen used in isolation rooms are contaminated with pathogenic microorganisms, but the risk of transmission is insignificant if it is handled, transported, and laundered in a manner that avoids transfer of microorganisms. All handling of linen, whether or not it is isolation linen, is determined by local policy.

Patients' belongings

Patients often bring several personal items with them when they come into the hospital. There is nothing wrong with this in most instances, because these items improve a patient's morale. However, isolation patients must be advised any item in the room that becomes contaminated must be disinfected or destroyed. This can create problems, particularly when personally significant items cannot withstand the disinfection process. To avoid having to destroy such items, explain the isolation policy to the patient, family and friends and ask them to send home any valuable items that could become contaminated.

Waste products

Waste products were mentioned earlier when you learned about terminal cleaning. However, you should not wait for the patient to leave to take care of contaminated dressings, urine, feces, and other waste products. Urine and feces should be flushed, and bedpans and other containers should be cleaned and disinfected immediately after they are used. All waste products (contaminated dressings, disposable dishes, etc.) should be bagged, labeled, and disposed of according to local policy and EPA standards. This should be done at least daily or more often to prevent accumulation.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

005. Principles of asepsis

1. What does the term "asepsis" mean?

2. What is another term used for medical asepsis?

3. What is another term use for surgical asepsis?

4. What procedure is designed to destroy pathogens but usually does not affect spores?

5. What is the difference between disinfectants and antiseptics?

006. Isolation techniques

1. What is the purpose of isolation precautions?

2. What are three reasons nonmedical individuals contaminate themselves when attempting to deal with isolation?

3. Why do medical staff members violate isolation principles?

4. Under what conditions can a roommate be placed with an isolation patient?

5. Why are contaminated articles bagged before they are taken out of the isolation unit?

6. Define routine and terminal cleaning.

7. What additional precautions should be taken with cleaning equipment if the patient's condition requires a private room?

8. How is the solution that is used for terminal cleaning selected?

9. What should infectious patients wear when they are being transported through the hospital?

10. Why is a private room the *most* effective type of isolation unit?

11. How do masks protect the wearer?

12. When should you put on and take off a mask?

13. For what reasons are gloves worn?

14. What should you do with disposable equipment when it becomes contaminated?

15. What should you do with an isolation patient's food tray?

1–3. Principles of sterilization

Effective sterilization and disinfection of patient care items are the "master links" in the chain of infection control activities performed in a medical facility. It makes no sense to provide care or operate on a patient to correct a problem if the environment and items you use to do so are crawling with pathogens that will result in an infection—which, in turn, will cause greater problems. As a medical technician, you need to be familiar with the principles and methods of sterilization and disinfection to ensure your patients (and co-workers) remain free from infection.

007. Disinfection and sterilization procedures

Before you attempt to disinfect or sterilize any object, you should know:

- What each term means.
- Which items we disinfect.
- Which items we sterilize.
- Why we sterilize or disinfect these items.

You should also be familiar with the processes or methods we routinely use to achieve these conditions.

Sterilization

The absolute definition of sterilization is:

> *A process that destroys all living microorganisms, including bacterial spores and viruses.*

This state of total destruction is technically impossible to scientifically measure; it is impractical to test each and every item after sterilization because the testing would render it nonsterile for patient use. The more technically correct definition is:

> *A process that provides the highest level of assurance that an item can be expected to be free of viable microorganisms.*

However, the goal is to completely destroy all microbial life that may be on equipment or supplies used for specific procedures. So for practical purposes, the absolute definition is acceptable. When an item is “considered sterile,” it is an absolute term—an item is either sterile or not sterile—there is no such condition as “partially sterile” or “almost sterile.”

For an item to be considered sterile, the process used must be capable of achieving this (theoretical) total destruction. The items exposed to a sterilization process are considered sterile if all mechanical parameters are met and all external and internal sterilization cycle indicators are acceptable. We will discuss these parameters and indicators in greater detail later in this unit.

Deep tissues, body cavities, and intravascular areas are considered sterile. This is because they usually only contain resident bacteria that are common to that patient and as such will not normally cause an infection. Surgical procedures involving these areas are considered *invasive procedures*. Because these areas are sterile, any surgical instrument or supply that comes in contact with these areas should also be sterile.

Sterilization is the elimination of all microorganisms from an object. Sterilization procedures include cleaning, disinfecting, wrapping, and sterilizing. As stated before, you should use the most current guidelines from the Centers for Disease Control (CDC), the Environmental Protection Agency (EPA) and locally developed guidance and policy in your daily duties. Although, sterilization procedures are primarily the responsibility of the central sterile supply (CSS) personnel (normally 4N1X1s), you may staff the CSS in some hospitals and clinics, or you may perform some steps of the sterilization process in others.

Disinfection

Disinfection is the destruction of microorganisms by pasteurization (exposure to boiling water), exposure to chemical germicides, or ultraviolet irradiation. In terms of antimicrobial action, disinfection falls somewhere between cleaning and full sterilization. Although it kills most microorganisms, disinfection does not affect spores; thus, it cannot be considered true sterilization.

There are three levels of disinfection—*high*, *intermediate*, and *low*. *High-level* disinfection destroys bacteria, viruses, and fungi, but does not affect bacterial spores. This level is satisfactory for semi critical items when sterilization is not feasible. *Intermediate-level* disinfection destroys fungi, almost all active bacteria, and some viruses, but does not affect spores or resistant forms of bacteria and viruses. It can be used for non critical items (laundry, stethoscopes, etc.), or for general cleaning purposes. *Low-level* disinfection destroys fungi, some forms of active bacteria, and a few viruses, but does not affect spores or other forms of bacteria and viruses. Low-level disinfection is useful for general cleaning purposes. The level of disinfection achieved depends on the length of exposure, temperature, type and concentration of chemical disinfectant, and resistance of the microorganism.

Pasteurization

Pasteurization is an intermediate- to high-level nontoxic disinfection process that can be used for items such as inhalation therapy tubing. Usually, it is done by placing small items in boiling water for a specified period. Pasteurization is effective against fungi and some forms of bacteria, but has no effect on spores and is of limited use against viruses.

Chemical disinfection

Sterilization is the method of choice for all surgical supplies, equipment, and instruments because it destroys all pathogens—and all other living organisms as well. In an ideal world, everything in the medical facility would be sterile; if all organisms were destroyed, infection would be impossible. In reality, many items or surfaces can not be sterilized. In some cases, it is simply not practical and, in other cases, sterilization damages or destroys the item. To render items and surfaces that cannot be sterilized as biologically safe as possible, medical personnel use a process known as disinfection.

Like most areas of infection control, certain principles apply to disinfection. These principles are generally outlined as guidelines and are based on numerous factors that influence the disinfection process.

There is a wide variety of chemical disinfectants under an even wider variety of brand names. These disinfectants include alcohol, chlorine compounds, iodophors (iodine), glutaraldehyde 2 percent (Cidex), phenols (LpH, Vesphene), quaternary ammonium compounds (Zephiran), and others. The EPA classifies these solutions as *sporicides*, *general disinfectants*, *hospital disinfectants*, *sanitizers*, and *others*. They are classified according to the types of microorganisms they destroy. Disinfectants that are classified as "sporicides" are considered sterilants if the contact times are long enough to destroy all forms of microbial life. They are considered high-level disinfectants if contact times are shorter. Sanitizers usually fall into the category of low-level disinfectants. Other disinfectant solutions are classified as either low- or intermediate-level disinfectants, depending on the specific microorganisms they claim to destroy.

Many of these chemical solutions are caustic. Wear gloves to protect your skin when working with these chemicals. In some cases, you also need to rinse disinfected objects in sterile water to remove toxic or irritating residues. All disinfected items should be allowed to air dry thoroughly, and then they should be stored in a manner to prevent recontamination. Your infection control committee specifies both the type and use for disinfectants.

Basic rules of chemical disinfection

Certain variables must be considered for all procedures of chemical disinfection, they include:

1. The number and types of microorganisms (particularly their resistance) determine the effectiveness of a chemical agent. As a rule, the greater the number and the more resistant the type of microbes, the less effective the disinfecting agent is.
2. Disinfectants vary in their level of effectiveness according to the makeup, or concentration of, the chemical agent and the manner in which it is used. If the concentration is diluted, the effectiveness decreases; an agent that is wiped-on and allowed to dry is not as effective as the agent would be if the item were completely immersed for an extended period. In addition:
    - The solution must be of sufficient strength to be lethal to the microorganisms for which it is intended.
    - The disinfectant must contact the entire surface of the item.
    - The exposure period must be accurately timed and consistent for bactericidal effect.
    - The disinfectant must be economical and safe for patients and personnel.

Commonly used disinfecting agents

To help you select the most appropriate disinfectant, several of the most commonly used disinfecting agents are described below. Although there are many chemical agents used as hospital disinfectants, the ones discussed below are the most common.

Alcohol

Alcohol—either ethyl or isopropyl—is useful as a disinfectant in concentrations of 70 to 95 percent. Alcohol kills vegetative bacteria, pseudomonas, and fungi after about 10 minutes of exposure. It kills tubercle bacillus and most viruses after about 15 minutes. Alcohol is classified as an intermediate-level disinfectant, and may be used to disinfect semi-critical items. Alcohol is also sometimes used as an antiseptic.

Advantages of alcohol are related to its fairly rapid action and fast evaporation times. It is relatively nontoxic, easy to use, and inexpensive. Because alcohol evaporates quickly and leaves no residue, it is commonly used to damp-dust environmental surfaces. When used in this way, it should be allowed to evaporate or "air dry" for best effectiveness.

Disadvantages of alcohol are related to its effects on people and items; it is also flammable. Alcohol is irritating to open wounds and skin lesions, and prolonged use dries the skin; wear gloves and eye protection when using it. Alcohol is corrosive to some metals and other materials. Frequent or long exposure hardens and swells some plastics. *Do not use alcohol on lensed instruments because it dissolves the cement holding the lens in place*. Alcohol is volatile; it is highly flammable and it loses its germicidal capability as it evaporates and its concentration drops below 50 percent. Alcohol is also inactivated by organic material, and it will not penetrate many oils. Its effectiveness against the HBV virus is sporadic, so it should ***not*** be used if this virus is known to be present.

Iodophors

Iodophors are solutions containing a mixture of iodine and detergent. Depending on the concentration of the solution, iodophors kill vegetative bacteria and pseudomonas after 10 to 20 minutes exposure, and are tuberculocidal and virucidal after 20 minutes at high concentrations (450 parts per million [ppm] iodine). Iodophors are classified as low- to intermediate-level disinfectants, again depending on the concentration of iodine. Iodophors are most frequently used as antiseptics.

Advantages of iodophors are related to their low toxicity and broad-spectrum effectiveness. By mixing the iodine with a detergent, the solution is rendered nontoxic, non-staining, and non-irritating *unless the individual exposed to it is allergic to iodine*. The detergent also increases the biocidal activity of the iodine. Iodophors dry more slowly than alcohol, so the exposure time; thereby the effectiveness, is also increased. Iodophors are useful for housekeeping activities, such as cleaning floors, walls, and furniture, because they clean as well as disinfect the surfaces.

One of the major drawbacks of iodophors is the iodine stains porous surfaces such as linens and certain plastics. This staining is reduced, or is temporary, by the added detergent, but is still a problem on some items. Iodophors also corrode some metals. Some iodophors are rendered ineffective by organic soil, hard water, or heat. Another disadvantage is that although frequently used as a skin antiseptic, iodophors cause chemical burns if allowed to remain in contact with the skin for prolonged periods. Some people are allergic to iodine or iodine-containing compounds and have severe allergic reactions from even slight exposure to the chemical.

Chlorine compounds

Sodium hypochlorite, more commonly known as household bleach, is an effective low-level disinfectant in concentrations from 1–5 percent. It is mainly used as a sanitizing agent for spot cleaning floors and furniture. Chlorine in high concentrations can be bactericidal, fungicidal, tuberculocidal, and virucidal to many viruses, including HIV and HBV. One chlorine compound (*sodium dichloroisocyanurate*) has a lowered pH to increase its microbial effectiveness. Chlorine compounds act rapidly, leave no residue, are easy to use, and are inexpensive.

Disadvantages are numerous. Chlorine compounds usually have an objectionable odor, are very toxic to skin, eyes, respiratory tract and mucous membranes, and are corrosive to many metals and plastics. They are not used for disinfection of surgical instruments. Chlorine compounds are seldom used in the OR or central supply.

Phenolics

Phenolics are derived from phenol (phenolic or carbolic acid), which is obtained from coal tar. Pure phenol is extremely caustic to tissue and is rarely used. However, many of the housekeeping detergent-germicides used today are phenol-containing compounds. In proper concentrations, phenolics are low-level disinfectants, and are capable of killing vegetative bacteria, fungi, tubercle bacilli, and some viruses, but *not* spores.

Advantages are many. Phenolics are easy to use, economical, stable, non corrosive to environmental surfaces, and remain active after mild heating or prolonged drying. Dry surfaces previously treated with a phenolic compound, which are moistened, again, will once again become bactericidal due to the residue left by the agent. Because of this residual germicidal action, phenolic detergent-germicides are widely used in the OR and central sterile supply (CSS) to clean and disinfect environmental surfaces. They are the agents of choice when dealing with fecal contamination (*E. coli*).

Disadvantages are primarily related to toxicity. Phenolic compounds are toxic and are not used on porous materials, rubber, and some plastics. They are also highly corrosive and should not be used on instruments. Skin and mucous membrane contact with phenolic compounds is irritating, so always wear protective gloves and face protection when handling these agents. The capability of phenolics to reactivate after drying, coupled with their skin/membrane irritation properties, make phenolics *unsuitable for disinfecting instruments that will contact skin or mucous membranes*, such as anesthesia equipment. Phenolics may also have an unpleasant odor.

Formaldehydes

This agent is used in concentrated solutions of 37 percent if mixed in water (aqueous formalin), or 8 percent if mixed in 70 percent isopropyl alcohol (alcohol formalin). Formaldehyde mixtures can be used to attain high-level disinfection of instruments. Formaldehyde is bactericidal and fungicidal after an exposure period of 5 minutes, and is tuberculocidal and virucidal after 10 minutes (in alcohol) or 15 minutes (in water). It is sporicidal after 12 hours.

Disadvantages of formaldehyde are related to its toxicity. The solution is irritating to the skin, eyes, and mucous membranes; gloves and face protection must be worn when using it. Instruments must be thoroughly rinsed in sterile water after disinfection, and items that may absorb the solution should not be disinfected in formaldehyde. The fumes are highly toxic and prolonged inhalation must be avoided. In fact, the fumes are so toxic formaldehyde is *not suitable* for housekeeping use.

Ultraviolet irradiation

Ultraviolet lights produce rays that can destroy microorganisms. Unfortunately, the contact must be direct, and few microorganisms remain in one place long enough to be affected. Ultraviolet lights have been installed in some rooms as a method of reducing transient bacteria. Because ultraviolet irradiation is irritating to the eyes and skin, wear protective garments such as: gown, gloves, and protective glasses when using this process to prevent injury.

Now you know the basic principles of disinfection and are aware of the factors that influence the effectiveness of chemical disinfection, it is time we look at how they are used. The specific procedure for disinfecting instruments is usually listed on the bottle containing the agent. The instructions provided by the instrument manufacturer must also be considered. Chemical agents used for disinfection are primarily liquids. Most disinfectants require immersion of the instrument. The basic steps for disinfecting articles are listed in the table below.

Steps for Disinfecting Articles	
Step	**Discussion**
1	Disassemble, if possible, the articles to be disinfected to allow disinfectant to contact all surfaces.
2	Thoroughly clean and dry all components of the articles: • Use a cleaning agent that leaves no residue, and pay particular attention to removal of blood and other organic matter from instrument surfaces. • Apply friction to remove soil; use brushes to clean the lumens of tubular instruments. • Change the cleaning solution often if several instruments are washed to prevent gross contamination of the cleaning bath.
3	After cleaning, rinse the articles thoroughly with water.
4	Allow the articles to air dry.
5	Completely submerge the articles in the disinfectant solution. • The solution must contact all surfaces of the instrument; therefore, all lumens need to be flushed with the disinfectant using a syringe (be sure to open all stopcocks and channels as well). • The instrument must be dry before immersion in the disinfectant to prevent dilution of the agent, which decreases the concentration and germicidal action. • Cover the container to prevent evaporation and airborne contamination of the solution, as well as to contain any vapors or fumes.
6	Expose the articles to the disinfectant for the prescribed period of time. • Start timing as soon as the articles are submerged and all surfaces are in contact with the disinfectant. • Refer to the disinfectant manufacturer's instructions for proper exposure periods.
7	Remove the articles when the specified time has elapsed.
8	Rinse thoroughly with sterile water for irrigation. This is necessary to remove any chemical residues that may irritate, inflame, or even burn a patient's tissues.

Always wear gloves when handling a disinfected instrument to not only prevent re-contaminating it but also to protect yourself.

Remember, these are just basic guidelines. You must always follow local policies, procedures, and any applicable manufacturer's guidelines to ensure both patient and hospital personnel safety when disinfecting patient care items.

Processing instruments and equipment

Obviously, it is neither possible nor necessary to sterilize everything (e.g., a bed). Some items are simply cleaned, others are cleaned and disinfected, and still others are actually exposed to some sort of sterilization process. The level of decontamination depends on the intended use and the potential for infection of the item.

For sterilization purposes, items used in patient care are classified as "critical," "semicritical," and "non critical." *Critical* items are instruments or objects introduced directly into the bloodstream, or into other normally sterile areas of the body. Some examples include surgical instruments, intravenous needles, catheters, biopsy needles, etc. Critical items must be sterilized prior to reuse.

Semicritical items are instruments or objects that come in contact with intact mucous membranes, but normally do not penetrate body surfaces. Examples include fiber-optic endoscopes, endotracheal tubes, cystoscopes, etc. Semicritical items should be sterilized, but they may be exposed to high-level disinfection if sterilization is not feasible.

The last category, *noncritical* items, includes those objects that either do not touch the patient or touch only intact skin. Examples include stethoscopes, blood pressure cuffs, crutches, IV poles, etc. Non critical items are either exposed to low-level disinfection or simply washed with a detergent. The following table summarizes much of what was just mentioned. Keep it handy; it will prove to be useful.

Classification of Items Used in Patient Care	Patient use	Examples
Critical	Items used for invasive procedures (introduced into the body).	Surgical instruments, IV needles, catheters, biopsy needles.
Semicritical	Items that come into contact with intact mucous membranes, but do not penetrate body surfaces.	Fiber-optic endoscopes, endotracheal tubes, cystoscopes.
Noncritical	Items that do not touch the patient, or only touch intact skin.	Stethoscopes, blood pressure cuffs, crutches, IV poles.

Cleaning

Cleaning is the physical removal of organic material (blood, feces, etc.) or soil from objects. It is the first step in preparing objects for sterilization. These organic substances frequently contain high levels of microorganisms and may either inactivate chemical germicides or protect the microorganisms from the disinfection or sterilization process. If objects are not cleaned physically, these microorganisms will continue to grow and become a source of contamination even after the object has been "sterilized."

Critical and semicritical items usually are cleaned and disinfected in a specifically designated location, which normally is the receiving/decontamination area of CSS. Your main responsibility is to remove all visible or gross contaminants from items immediately after use. You do this by wiping them with a wet sponge or cloth (preferably while in the room where the procedure was performed). You then prepare the items for transport to CSS, according to local policy. According to TJC recommendations, after gross contaminants are removed, the items are carried, in a protective barrier, to the dirty utility room, and dropped carefully into a bucket/container containing a locally approved disinfectant. Of course, you must follow standard precautions anytime you are handling potentially contaminated items.

The following information is used if you are working in the CSS and are responsible for cleaning and sterilizing equipment. There is no one specific way to clean equipment. The method used depends on local policy, type of object to be cleaned, and amount and type of organic material on the object. There are a few basic suggestions or guidelines that may help you:

1. Remember cleaning will **not** kill most microorganisms. Treat the objects you are cleaning and the equipment you use to clean those objects as contaminated.
2. Always wear gloves, eye protection, and adhere to locally required protection when you clean to protect yourself from contamination.
3. Avoid splashing. The splashed water will contaminate anything it contacts.
4. Rinse objects in cold water first. Cold water loosens organic materials (blood) and makes cleaning easier.
5. Use hot water, soap or detergent, and a scrubbing device (brush, cloth, etc.) to clean the objects. (A little elbow grease is also helpful; the dirt is not going to just lift itself off!)
6. For manual cleaning, objects should be cleaned and rinsed while submerged to prevent splashing.

7. Disassemble objects whenever possible to ensure cleanliness of all surfaces, crevices, and connection points.
8. Rinse and air-dry objects thoroughly after they are clean.

In addition to scrubbing items by hand, technicians at some facilities mechanically wash objects with special washer-sterilizers (or washer-decontaminators) and sonic energy cleaning machines. Washer-sterilizers work like dishwashers. The objects are placed in the machine and cleaned with mechanically agitated water and a detergent. These machines also sterilize objects after they are cleaned. (The temperature of the water is much hotter than that for the dishwasher!) The sonic energy equipment cleans by passing ultrasonic waves through a fluid. This produces submicroscopic bubbles that collapse and pull dirt from objects by suction. Sonic cleaning usually is done after physical and mechanical cleaning, and removes any remaining particles of organic material from the object. Once an item has been cleaned, it is either disinfected or wrapped to prepare it for sterilization. More information on the washer-sterilizer will be covered later in this unit.

Wrapping and packaging

Wrapping or packaging is part of the preparation for the actual sterilization. Items that are going to be sterilized are wrapped so that they remain sterile until they are used. Otherwise, these items would be contaminated by airborne microorganisms as soon as the door to the sterilizer was opened.

Depending on the size of the item, method of sterilization, and availability of materials, items may be packaged in paper/plastic envelopes (peel-packs), or wrapped in cloth or commercially manufactured disposable wraps. Regardless of the type used, the wrapper must be constructed to allow the sterilizing agent to enter and leave, without allowing microorganisms or dust particles to enter. It must be durable enough to withstand conditions in the sterilizer and in storage, and must provide physical protection for delicate items. The wrapper must also be flexible enough to adapt to the shape of the object and allow the package to be opened without contaminating the contents. Finally, the wrapper must be cost-effective.

Arranging packages

Items to be sterilized usually are arranged and packaged by CSS staff, but you must work closely with them when designing or preparing packs specifically for your work area. When you prepare a package to be sterilized, you must arrange the contents so the sterilizing agent can reach all the surfaces. If you are packaging metal instruments or other impervious items, separate them with porous material (sponge or cloth) to prevent metal-to-metal contact. Along the same line, open hinged instruments to allow the sterilizing agent to reach all surfaces. Arrange the contents in order of use when possible. If it’s a procedural pack, for example, it won’t help the user if the first instrument needed is beneath all the others. Limit the contents of the package to what is needed for that procedure or purpose. Remember, the package can be used only one time and on only one patient. Therefore, don’t waste time and space adding items that won’t be used for a specific procedure.

The size and density of packages have a direct relationship to the amount of time required for sterilization. As a rule, the larger the package, the longer it takes to sterilize. You are also limited to the capacity of the sterilizer. Obviously, there are some exceptions (large instruments, etc.), but the normally accepted maximum size for a package should not exceed 12 by 12 by 20 inches, and 12 pounds in weight for woven materials (16 to 17 pounds for metals).

Wrapping techniques

Once the package is arranged, it must be packaged in a paper-plastic envelope, or wrapped. As previously mentioned, the wrapper may be cloth or a commercially manufactured disposable wrap. Normally, the packages are double wrapped to create multiple layers of material between the contents and the environment. The two layers are wrapped independently so they can be opened separately. The outer layer acts as a protective barrier, and the inner layer becomes a sterile field when opened.

The wrappers you select must be large enough to wrap completely around the contents and tuck in at all the edges and corners.

The two basic ways to wrap packages are the diagonal method and the straight method. The diagonal method is used for most items or materials. The steps for this method are shown in figure 1–14 and explained in the following table.

Step	Explanation
A	Place two square wrappers on the worktable, with one corner toward you. Put the item that is to be wrapped in the center of the wrappers and at right angles to a line between the corner toward you and the corner opposite you. Fold the corner of the first wrapper that is toward you over the item being wrapped. Fold the same corner back toward you to make a tab.
B	Fold the right corner of the first wrapper over the item being wrapped, and make a similar tab.
C	Fold the left corner of the first wrapper over the item being wrapped, and make a similar tab.
D	Fold the corner of the first wrapper away from you over the item being wrapped, and make a tab on this last fold.
E	Repeat the process with the second wrapper, but do not put a tab on the last fold.
F	Secure the package with pressure-sensitive indicator tape.

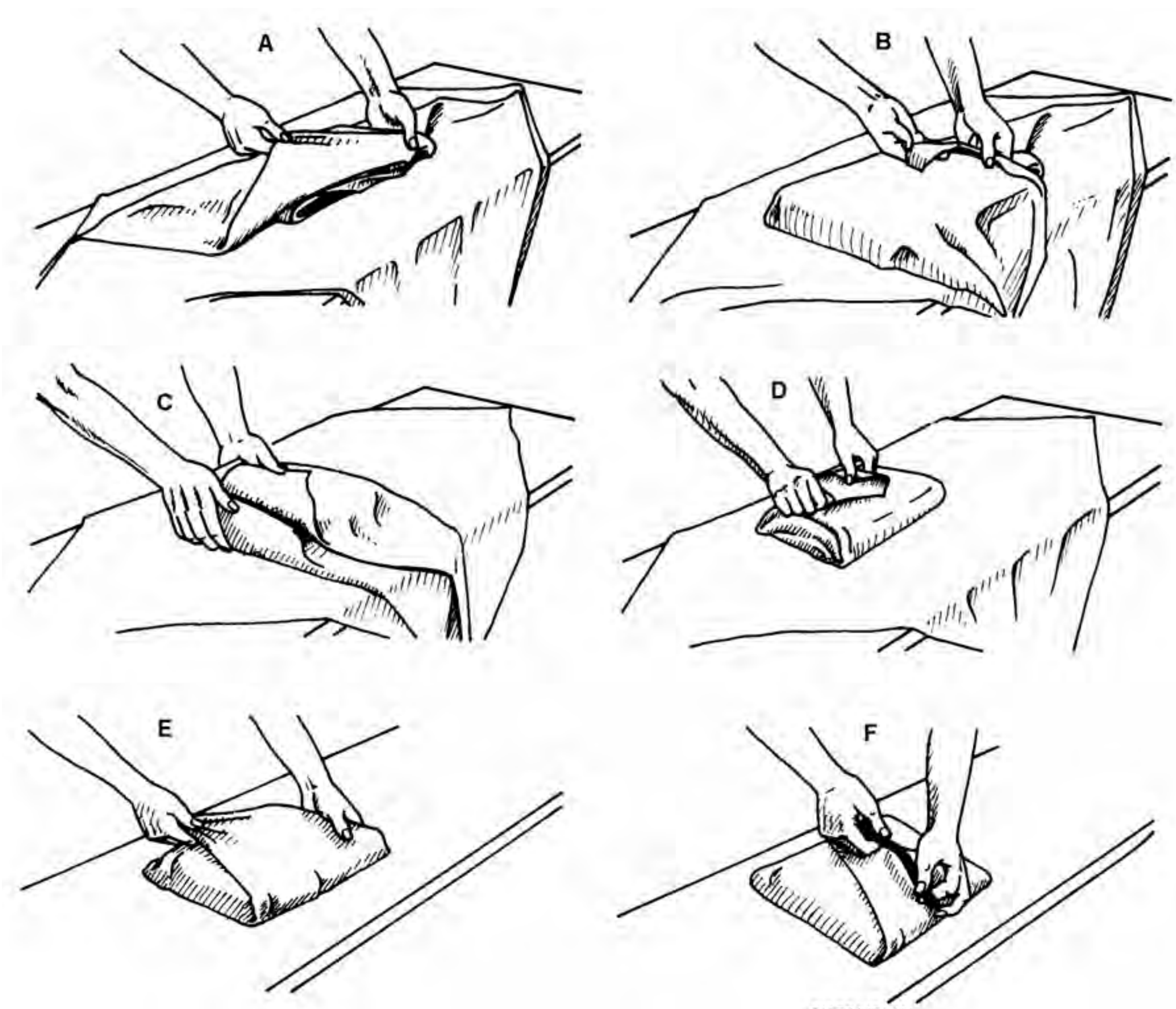


Figure 1–14. Wrapping technique (diagonal method).

Usually, the straight method is used only for larger packages, such as double basin sets. Wrapping such packages is easier if two people work together. The steps for the straight method are shown in figure 1–15 and are explained in the following table. (**NOTE:** Instead of individual wrappers, sheets are sometimes folded in half to make each double thickness wrapper. Place two sheets folded in half on the table with one single fold toward you and one single fold away from you.)

Step	Explanation
A	Place the item to be wrapped in the center of the wrapper and square with its sides. Fold the single folded side of the first wrapper over the top of the item that is being wrapped, making a cuff.
B	Fold the other side over the top of the item being wrapped, making a cuff.
C	Fold the left side over the item, and fold the ends under so that they do not extend beyond the package.
D	Fold the right side over the item being wrapped, again folding the ends under. (You can see the advantage of using two people to do these steps neatly.)
E	Repeat these steps with the second wrapper. Do not fold the last two ends under; secure the final fold with pressure-sensitive tape, as shown.

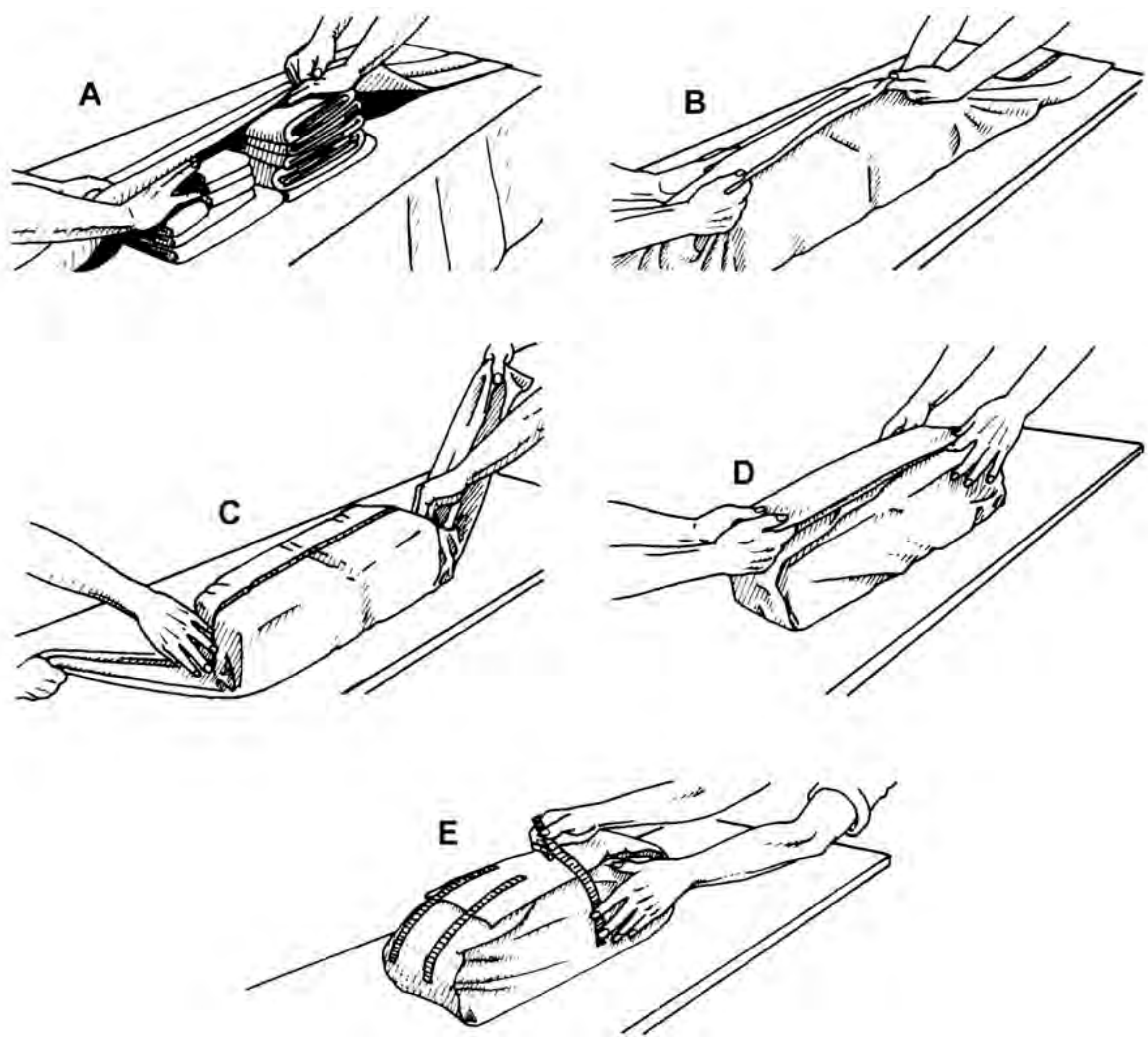


Figure 1–15. Wrapping technique (straight method).

When you finish wrapping using either method, you should have a neat, snug package with no openings or loose edges. At the same time, the wrappers should not be so tight that the sterilizing agent is unable to circulate freely. To ensure an appropriate wrap, inspect the package for protruding contents and that it is securely wrapped.

Never use clips, pins, or staples to secure packages. Such objects make holes in the wrapper through which microorganisms can enter. They also cause a tendency to wrap the package too tight. A special pressure-sensitive tape should be used to secure these packages. This tape has indicator markings that change when exposed to the sterilizing process. The tape secures the package and indicates whether the package has been sterilized. It also identifies the contents of the package. (**NOTE:** The indicator markings do *not* prove that the wrapped item is sterile; they merely indicate that it has been sterilized.)

Labeling is very important because it lists the contents of the package and provides information about its sterility. You can either use a preprinted indicator tape or write the information on the "external chemical indicator" tape. If you write the information, use an indelible-ink, felt tipped marker (like a laundry marker). Do not use a regular ballpoint pen, because the ink will run and the label will be illegible. Also, do not write on the wrapper itself. The ink can cause deterioration and may allow microorganisms to enter. The information you put on the label should include the contents of the package and the preparer's initials; it may also include a designation for the receiving unit. Use standard nomenclature and abbreviations (i.e., O.B. PACK — L&D). The label also includes a sterilization control number that usually consists of the sterilizer number, load number, and Julian date of sterilization. Depending on the local policy on shelf life, the label may also include an expiration date.

Hospitals use two methods to determine the shelf-life of locally sterilized items, the *time-related* method and the *event-related* method. The traditional or "time-related" method, assigns an expiration date to each package. This expiration date is determined by the material used to wrap the package. Wrapped items usually are considered sterile for 28–30 days. Items that are peel-packed, or wrapped then sealed in plastic dust covers, usually are considered sterile for six months. Under the time-related method, all sterilized packages must be labeled with an expiration date. After this date, the contents may not be used. The expiration date is necessary to ensure that only sterile items are issued and used. You must check your supplies for expired or outdated items on a regular basis. If something does become outdated, return it to CSS for resterilization.

A relatively new way of determining shelf life is the event-related method. This method considers items sterile until an event occurs that will render them unsterile. Under this method, all packages must have a label stating the item may be used as long as the package integrity is not compromised. Use of this method requires adhering to strict guidelines for packaging, sterilizer testing, and storage. Local policy will determine the method you use. However, whichever is selected, package integrity is always performed before use, and supplies must always be rotated.

Rotation of sterile items is simply using the most recently sterilized item last. When you receive a package from CSS, you should store it behind other, similar packages. That way, you will use the oldest package first, and packages will not be allowed to remain on the shelf too long.

Sterilizing

The last step in the sterilization process is the actual destruction of microorganisms. The basic methods of sterilization are physical sterilization, chemical sterilization, or ionizing radiation (seldom used in hospitals). Although each of these uses a different sterilizing agent, they have certain common requirements. They all require a period of exposure, which allows the agent to effectively destroy the microorganisms, and a physical arrangement, to allow the agent to reach all the surfaces. The exposure time required depends on the following factors: the type of agent used, the type of equipment or material being sterilized, the type of material used to wrap the item, the amount and type of contamination, the concentration, temperature, and the pH of the agent (chemical sterilant).

The method used depends on the type of material to be sterilized and the capabilities of the facility. Steam is most economical, but it is unsuitable for many delicate items. Gas can be used on delicate items, but it is expensive and slow. This section briefly describes the different types of sterilizers and discusses their advantages and disadvantages in more detail.

Steam sterilization is done using pressurized steam. Pressurized steam sterilizers (or autoclaves) are designed to hold items for sterilization, allowing pressurized steam to contact or penetrate these items. There are several types of steam sterilizers, including gravity (downward) displacement sterilizers, prevacuum (high-vacuum) sterilizers, and high-speed, pressure sterilizers (flash sterilizers). Washer-sterilizers are sometimes classified as steam sterilizers, although they are designed primarily for terminal (decontamination) sterilization, not for sterilizing items for storage.

Pressurized steam sterilizers work about the same as your home pressure cooker. Water is heated in a chamber, producing steam and tremendous amounts of heat. Essentially, what you are doing is cooking the microorganism. The heat alters the cellular structure and the microorganism dies. Of course, sterilizers are more sophisticated than pressure cookers. For one thing, scientists have learned that air acts as an insulator, so for full effect, the sterilizer must eliminate the air. The typical sterilizer consists of a chamber within a chamber and openings for air to escape and for steam to enter. The chambers are sealed by an airtight door, or doors. Steam is supplied from a central point, or from water heated by electric coils beneath the sterilizer. As the steam builds up, the pressure increases; as the pressure increases, the steam gets hotter. When the air has been removed and the heat reaches a preset point, the sterilizer begins timing the actual sterilization cycle. The length of the cycle varies according to the temperature reached and the type of material being sterilized. An exposure period chart should be available to provide information about the different times, temperatures, and materials. Once the sterilization cycle is over, the item must be allowed to dry and cool before it can be handled. Handling a hot or damp package allows bacteria from your hands to "strike-through" the package and contaminate its contents.

The different types of steam sterilizers vary according to the way air is removed from the chamber, the speed with which the operational temperature is reached, and the operational temperature itself. The slowest type is the downward displacement sterilizer, which uses gravity to force air out of the chamber. This sterilizer operates at a lower exposure temperature (about 250°F) and has longer exposure and drying cycles than other sterilizers.

Steam sterilizers have many advantages. They are effective, economical, nontoxic, and relatively fast. On the other hand, they use great amounts of heat and cannot be used for many delicate items made of plastic or rubber. Since these sterilizers do get hot, great care should be taken when opening the door and removing the sterilized items. Insulated gloves generally are used to prevent burns.

When sterilizing liquids, special precautions must be taken. If you try to move the solutions too soon, the lids will blow off and splash hot liquid, scalding anyone in the vicinity. Normally, liquids are sterilized at the end of the day and allowed to cool overnight. Fortunately, most liquids used today are packaged for sterile use, and local sterilization is rare.

Gravity displacement steam sterilizer

Figure 1–16 shows the basic design of a typical gravity displacement, sometimes called a downward displacement, steam sterilizer. After the door is closed and the button is pressed to start the cycle, the following events take place in the sterilizer as shown in the figure.

1. The steam enters the chamber through an inlet located in the center of the topmost back of the chamber.
2. The steam is forced upward and to both sides in the chamber by a baffle plate. Because the hot steam is heavier than the cool air, gravity causes the steam to compress the air to the bottom-front of the sterilization chamber.

3. As the air is forced downward, a drain valve opens. This allows the cooler air to escape through a screened drain outlet located in the bottom-front of the chamber.
4. As the air is displaced by the steam, the temperature in the chamber and drain increases, causing the chamber drain valve to close. Then the steam begins to build pressure in the chamber. This process is rapid when the sterilizer is empty. But when it is filled, air can get trapped in and around the packages. This causes cool air pockets to form in the load preventing the steam from contacting all portions of the contents, which, in turn, severely decreases the killing power of the steam.
5. As the pressure rises, the temperature increases. If loaded properly, the steam penetrates to the center of all packs and heats all items.
6. When the internal thermometer measures that the proper temperature is reached, the timing of the exposure period begins. The internal thermometer is usually located in the discharge line, just after the chamber drain strainer but before the control valve, because it is the coolest area of the chamber.
7. Most gravity displacement sterilizers operate at 15–17 psi and at a temperature of 250–254° F. The *minimum exposure period* to kill all organisms is 15 minutes at 250° F, but, because the steam can take some time to penetrate and heat all items, 30 minutes is the most common exposure time used. These operating parameters vary, depending on the items being sterilized, the size of the load, and manufacturer's recommendations.

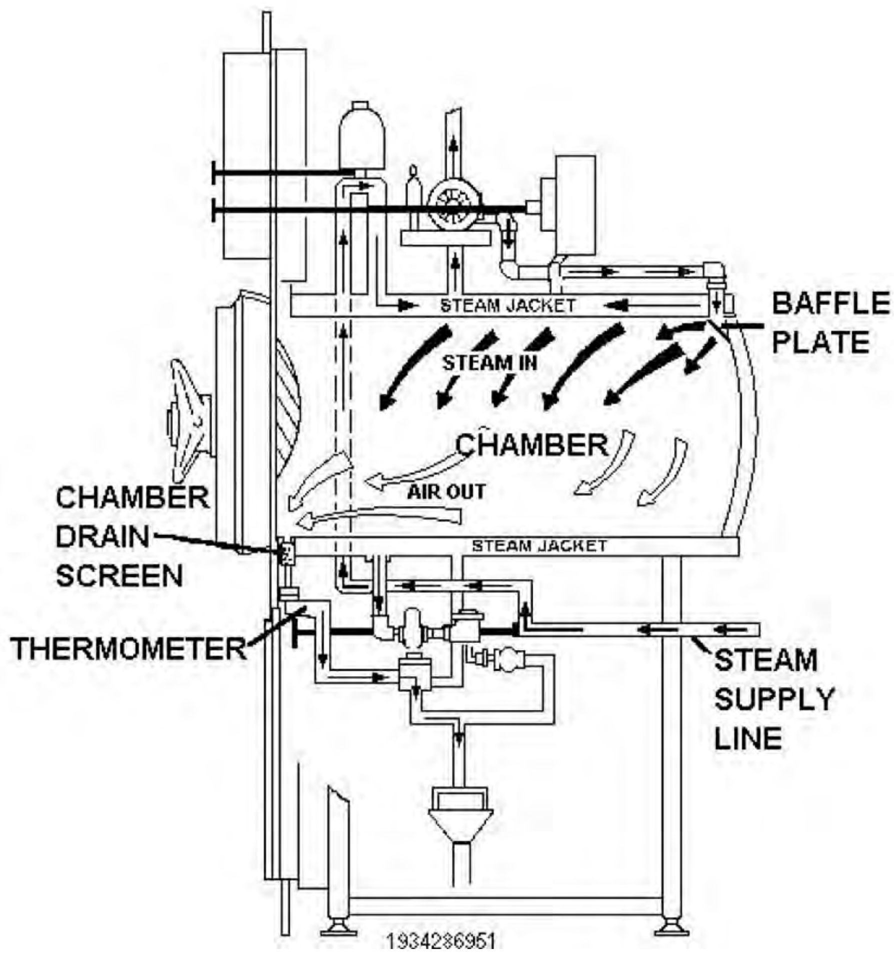


Figure 1–16. A typical gravity displacement sterilizer.

The exposure period is determined by considering three distinct phases: heat-up, thermal death (or holding), and a safety factor. A typical 30-minute cycle breaks down into three stages:

1. A 12-minute *heat-up period*. This allows the steam to penetrate the load and bring the temperature of all items in the load to the same temperature as the surrounding steam.
2. A 15-minute *thermal death period* or kill time. This is the *minimum* recommended time for a 250° F sterilizer load to ensure total destruction of all microorganisms.
3. A 3-minute *safety factor*. This is generally added to each cycle to ensure that effective sterilization is achieved.

When the preset exposure time is reached, the steam is automatically and rapidly exhausted from the chamber and a drying cycle begins. The typical dry cycle in a gravity displacement sterilizer is 15 minutes. At the end of this “dry” cycle, the chamber pressure returns to zero, an audible alarm sounds, and the operator opens the door.

Note that the total cycle time, from the time you close the sterilizer door and push the cycle “start” button until the drying period is completed, is much longer than the sterilization time you preset on the sterilizer control panel.

The entire cycle includes the time it takes to:

- Remove the air from and pressurize the chamber with steam.
- Sterilize the load.
- Exhaust the steam from the chamber.
- Dry the load.

Total cycle time averages about 60 minutes for a 30-minute *exposure period* cycle.

When the end-of-cycle signal sounds, open the door slightly, or *crack the door*. This allows residual steam to vent from the chamber. Allow a few minutes for the items in the sterilizer load to begin cooling-down in the chamber before removing them for final cooling and drying.

Prevacuum steam sterilizer

The prevacuum, high-temperature sterilizer is the most efficient steam sterilizer. This sterilizer design provides a faster and more reliable method of sterilization than that provided by the gravity displacement sterilizer. Air trapped inside the sterilizer chamber is one of the greatest dangers associated with steam-under-pressure sterilization. The prevacuum sterilizer reduces this danger and improves the speed and efficiency of the sterilizer by using a pump to literally “suck” the air out of the chamber. This creates a near-perfect vacuum before the steam is introduced into the chamber which allows for rapid air removal; thereby resulting in faster (virtually instantaneous) and more positive steam penetration of the entire load. The vacuum that removes air prior to the exposure cycle shortens the time needed to reach operational temperature and allows for a higher operational temperature (270°F) and shortens the drying cycle.

As you can see from figure 1–17, the prevacuum sterilizer looks very similar to the gravity displacement sterilizer. The steam inlet and chamber drain are usually located in the same places as in the gravity sterilizer. The difference is in the sterilization cycle.

After the door is closed and the button is pressed to start the cycle, the following events occur in a typical prevacuum sterilizer:

1. First, the chamber drain valve opens, and the vacuum pump removes nearly all the air in the chamber.
2. A steam injector preconditions the load contents and assists the vacuum pump with air removal. This generally takes about 8– 10 minutes.
3. Next, the drain valve closes, and the sterilizing steam is rapidly forced into the chamber.

4. The vacuum and preconditioning phase allow the sterilizing steam to penetrate the contents almost instantly. The rest of the sterilizing cycle is similar to that of the gravity displacement sterilizer. Following the pressure and temperature increases, the timed cycle begins when the selected temperature is reached. Steam is automatically exhausted from the chamber after the exposure period is complete.
5. After the sterilization cycle, a vacuum is again created to help moisture dissipate during the "dry" cycle.

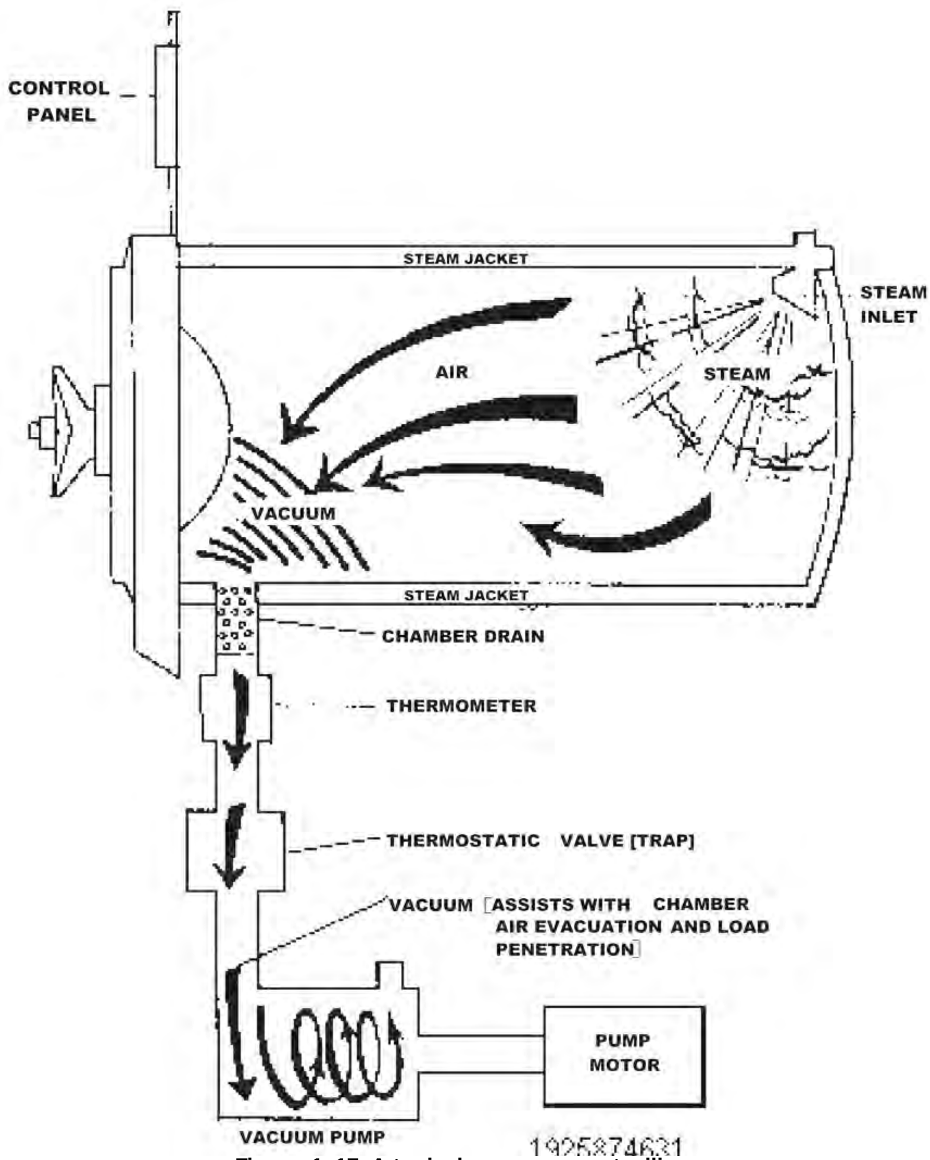


Figure 1–17. A typical prevacuum sterilizer.

The prevacuum sterilization cycle generally differs from the gravity displacement in three ways:

1. The sterilizer temperature is between 270 and 276° F.
2. The chamber pressure is set between 27 and 28 psi.
3. The exposure time period is a *minimum* of four minutes.

A typical prevacuum cycle takes between 15–30 minutes from start to finish, depending on factors such as sterilizer capacity, vacuum depth, and load contents.

Some prevacuum sterilizers use a series of vacuum *pulses* to evacuate the chamber. These pulses usually vary in depth with each pulse getting progressively stronger to ensure optimal evacuation of air during the conditioning phase and optimal evacuation of moisture during the drying phase. The total cycle time for these sterilizers is slightly longer than for single vacuum sterilizers.

High-speed pressure sterilizer (flash sterilizer)

This steam sterilizer is designed to sterilize small quantities of unwrapped surgical instruments or supplies that are needed quickly. It is generally used for instruments that have been omitted from sets or that have been accidentally contaminated during a surgical procedure. As the name (flash) implies, it is *designed for rapid sterilization.*

The flash sterilizer may operate as a gravity displacement sterilizer, a prevacuum sterilizer, or may be capable of both types of sterilization cycles. The most common flash cycle is a gravity displacement cycle with a chamber pressure of 27–28 psi, a temperature between 270 and 274° F, and a *minimum exposure period* of 3 minutes. This cycle is only acceptable for small quantities of unwrapped, non-porous, non-lumen containing items. The time must be increased for other types of items.

Note: Items intended for implantation should ***never*** be routinely flash sterilized.

The specific uses and applications of flash sterilization are controversial, so flash sterilizers should be used only in special situations:

- When the preferred method of sterilization is impractical or not available.
- In ORs specifically designed to meet all national standards for flash sterilization and decontamination.

As always, follow the specific, written, policies established by your facility for flash sterilization procedures.

Instrument washer-sterilizer

This sterilizer is designed primarily for decontaminating and terminally sterilizing *used* patient care items. Because the washer-sterilizer uses the high temperatures associated with steam sterilization, all gross contaminants and visible organic debris should be removed from the instruments before they are processed in the washer-sterilizer. If a grossly contaminated item is processed, the debris is literally "baked-on" and is nearly impossible to remove. Many surgical instruments have been seriously damaged when a technician failed to clean the instruments during (and immediately after) the surgical procedure and the instruments were washer-sterilized.

The wash-and-sterilize cycle consists of two distinct parts. The *wash cycle* washes the instruments in a detergent solution. The method used to wash the instruments—and the effectiveness of the wash—depends on the sterilizer. Most washer-sterilizer chambers fill with water and use "jets" to agitate the water to clean the instruments; a few use "spray-arms" to wash the instruments. After the contents are washed, they are usually rinsed with clean water, then the *sterilize phase* of the cycle begins. Most washer-sterilizers use a standard three- or 10-minute "flash" cycle at 270° F as the sterilize phase of the cycle. Because washer-sterilizer chambers are usually single-walled, there is not a steam jacket to provide residual heat so there in no real "dry" phase. Although washer-sterilizers can be used to flash sterilize instruments, their primary purpose is to decontaminate used instruments so that they can be handled (assembled, wrapped, etc.) without danger from contaminants to personnel.

When the sterilization phase is complete, the instruments are removed from the chamber for further processing. A washer-sterilizer cycle should be used *only for terminal sterilization. Do not* use items from the washer-sterilizer on a patient until the instruments are inspected for cleanliness and sterilized by a more "permanent" method.

In addition to the wash-sterilize cycle, most washer-sterilizers have other sterilization cycles programmed to increase their versatility. These cycles can generally be used only for unwrapped items because there is no drying phase. The cycles on most units are the:

- Three-minute “flash” cycle at 270° F for sterilizing unwrapped non-porous instruments or utensils.
- Ten-minute “flash” cycle at 270° F for sterilizing other unwrapped instruments, utensils, glass, tubing, or mixed loads of porous items.

Packaging and loading items in a steam sterilizer

Packaging of items and loading of the sterilizer has to be done in a manner to permit free access of steam to all areas and surfaces in the load. When you load a sterilizer, you should arrange packages and containers (basins, bowls, prep cups, medicine glasses, and so forth) on their sides so air is not trapped in pockets. Do not place them upright or in a manner that allows them to hold water. If the condensation “pools” in the containers, the sterilized items will not dry and contamination occurs via “strike-through.” Instrument sets or pans that must be sterilized “flat” should have perforated or mesh bottoms so they do not hold water. Also, do not place basins, bowls, or cups upside-down; this traps air, so the insides of the containers do not reach sterilizing conditions.

The primary exception to this loading rule is rigid container systems; most should be sterilized flat. Follow the container manufacturer’s and the sterilizer manufacturer’s written guidelines when using these containers. The design of the container can influence the sterilization cycle used. For example, some rigid containers do not have perforated bottoms, so they may **not** be used in a gravity-displacement sterilizer because air cannot escape downward through the container and air pockets would result. Non-perforated bottoms also would collect and allow the water in the steam to pool.

Facilitating steam penetration

The steam must be able to penetrate every fiber of permeable items, and contact all surfaces of all items in a sterilizer load. All dirt, organic material, grease, or oil has to be removed from the surfaces of all items to be sterilized because the steam cannot penetrate. Hinges and ratchets of all instruments should be opened. This is one of the reasons that exposure times vary; the exposure time must allow complete steam penetration to all parts of the load. Some materials are penetrated more easily than others, so it is important to follow the manufacturer’s recommendations for each item being sterilized. A common example of this is air-powered instruments which often must be subjected to longer exposure periods than metal instruments do. Many facilities post charts next to the sterilizers listing the specific exposure periods for each specialty item used in the facility.

Monitoring the sterilization cycle

The sterilization cycle must be monitored by close supervision of processes, constant monitoring of control devices, proper use of biological and chemical sterilization indicators, and proper documentation of each sterilization cycle. Qualified, fully trained personnel should inspect and maintain sterilizers regularly. Problems to look for include:

- Unsaturated (superheated) steam.
- Wet (over-saturated) steam.
- Incomplete air removal from the chamber.
- Automatic timer failure and other mechanical failures.

Steam sterilization is safe, relatively simple, and extremely effective—especially with modern sterilizer design and operating controls. However, you must realize that effective steam sterilization depends on the right combination of several factors, most of which you—the sterilizer operator—have direct control of. Despite all the “high-tech” improvements in sterilization equipment, effective sterilization still depends heavily on the skill, knowledge, and conscientiousness of the operator. Learn everything you can about the steam sterilizers you work with. Read the manufacturer's operating instructions and recommendations and strictly follow all local policies, procedures, and guidelines pertaining to in-hospital sterilization.

To ensure steam sterilization is accomplished in an effective and reliable manner, there are several rules to follow when loading the sterilization chamber. Figure 1–18, A through D, shows some examples of properly loaded sterilizer carts. Refer to it as you study the "Do's and Don'ts" of sterilizer loading.

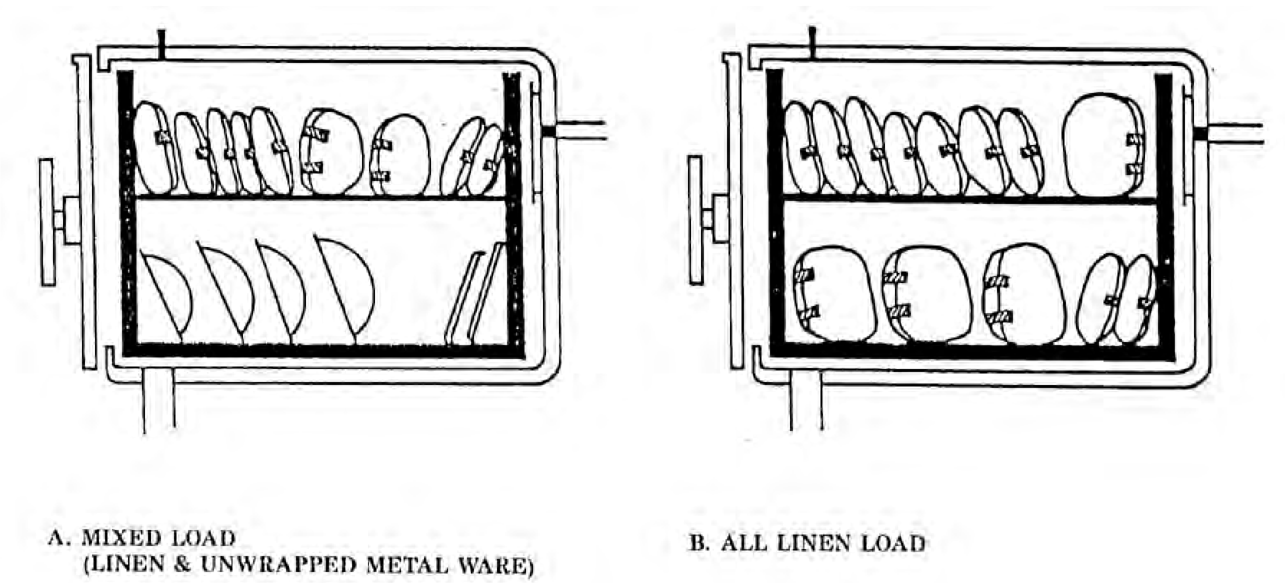


Figure 1–18, A and B. Various "mixed" sterilizer loads.

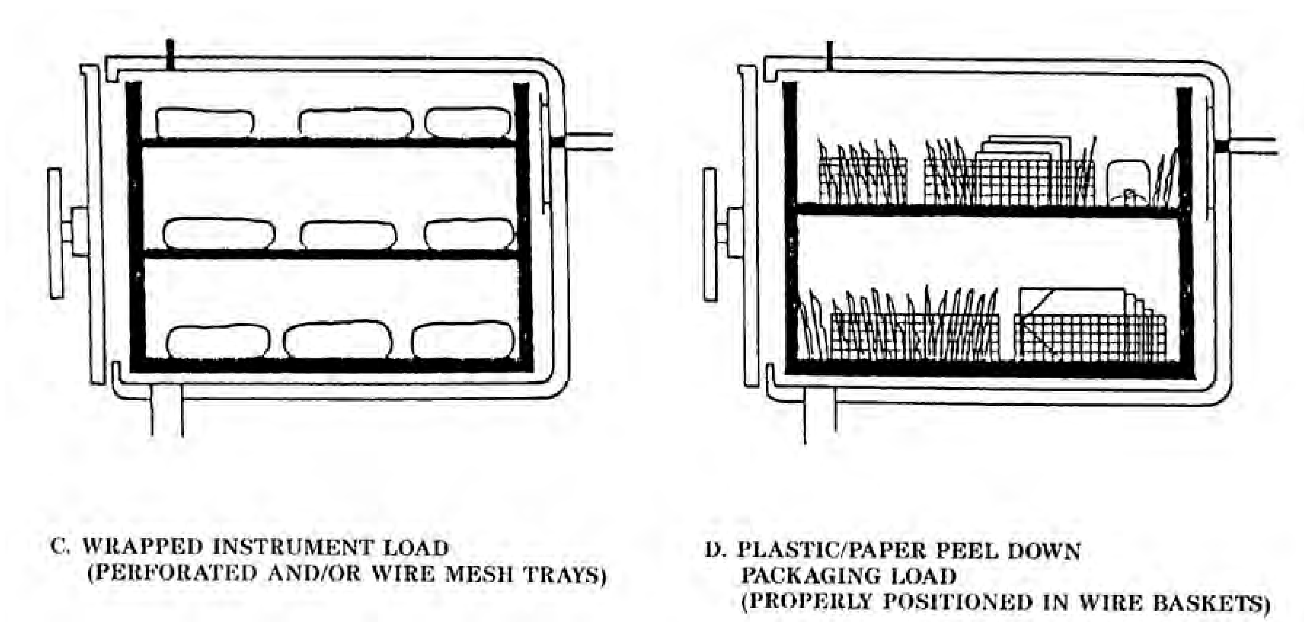


Figure 1–18, C and D. Various "mixed" sterilizer loads.

Do's and Don'ts of Sterilizer Loading	
DO	Load all packages with loose contact between individual items.
DON'T	Overcrowd or overload the chamber racks or sterilizer cart.

<table>
<tr><th colspan="2">Do's and Don'ts of Sterilizer Loading</th></tr>
<tr><td colspan="2">This ensures the passage of steam meets minimal resistance from the top to the bottom of the chamber and throughout the load. By not overloading the sterilizer, you reduce the tendency for air pockets to form in the load and shorten load drying time.</td></tr>
<tr><td>DO</td><td>• Place all packages, trays, and sets (except rigid containers) on edge with the longest side of the pack on the rack shelf.
• Place receptacles such as basins and bowls on their sides.
• Tip wrapped packages slightly forward (fig. 1–18,A).
• Place rigid containers flat on the shelf.
• Allow at least three inches between the top of the sterilizer chamber and the topmost packages of the load.</td></tr>
<tr><td>DON'T</td><td>Ever allow items in the load to touch the sterilizer chamber walls.</td></tr>
<tr><td colspan="2">This prevents air pocket formation, ensures that steam freely contacts all surfaces, and prevents condensation from being trapped in containers during load cool down.</td></tr>
<tr><td>DO</td><td>• Place hard goods on the bottom shelf; linens and soft goods on the top (fig. 4–3,A).
• Place the larger packs on the lower shelves and the smaller packs on the top shelves. (fig. 1–18,B).</td></tr>
<tr><td>DON'T</td><td>Place instrument sets with numerous metal instruments directly over linen goods or porous, absorbent items.</td></tr>
<tr><td colspan="2">This stops the linen packs and smaller items from getting wet from the water condensation in the hard goods and large packages as the load cools.</td></tr>
<tr><td>DO</td><td>• Place heavy instrument sets in mesh or perforated bottom trays, flat on the rack or cart shelf (fig. 1–18,C).
• Place rigid containers flat on the sterilizer shelf.</td></tr>
<tr><td>DON'T</td><td>• Ever place packages directly on the sterilizer chamber floor.
• "Stack" rigid containers unless the container manufacturer and sterilizer manufacturer specifically state they may be stacked.</td></tr>
<tr><td colspan="2">This allows adequate air removal and steam circulation. If heavy items are stacked together, the weight tends to compress the load and reduce the steam circulation.</td></tr>
<tr><td>DO</td><td>• Place paper and plastic peel packaged items on edge with the plastic side of one package facing the paper side of the adjacent package.
• Use wire baskets to hold the peel packaged items on the rack or cart shelves to ensure this position is maintained during the cycle and to provide easier handling (fig. 1–18,D).</td></tr>
<tr><td>DON'T</td><td>Place them together plastic-to-plastic, or lying flat on the shelf</td></tr>
<tr><td colspan="2">The steam may not penetrate between the two layers of plastic to plastic, and moisture may collect in concave surfaces of peel-packs placed flat on the shelf.</td></tr>
<tr><td>DO</td><td>Sterilize like items together in a load (whenever possible); do not mix with other type items. For example, sterilize linens in one load and hard goods (instrument sets, basins, trays) in a separate load.</td></tr>
<tr><td>DON'T</td><td>Sterilize fluids mixed with non-fluids in a sterilizer load.</td></tr>
<tr><td colspan="2">Sterilizing like items together ensures that items that require the same exposure time, temperature, pressure, drying time, etc., are subjected to the proper requirements for sterilization and safe handling. If fluids must be sterilized (a rare occurrence), they are sterilized separately using a slow exhaust cycle (instead of the usual rapid exhaust) to prevent the container lids from bursting and the fluid from being expelled into the sterilizer chamber.</td></tr>
<tr><td>DO</td><td>• Promptly check the chamber pressure gauge prior to opening the door once the sterilization cycle is finished and the audible alarm sounds.
• Remove the sterilized load as soon as possible after any locally specified "cool-down" period.</td></tr>
<tr><td>DON'T</td><td>• Put items into a heated sterilizer until its time to start the sterilization cycle.
• Leave items in a hot sterilizer for extended periods.</td></tr>
</table>

Do's and Don'ts of Sterilizer Loading
Permitting items to remain in the hot chamber causes the linen and other contents to over-dry or become superheated, and may cause permanent damage.

After the sterilizer is loaded, the items are steam sterilized by one of the methods covered previously, and the "cycle complete" alarm sounds. You must now unload the sterilizer.

Unloading the sterilizer

As soon as the alarm sounds, check the chamber pressure gauge or digital readout to ensure there is no pressure in the chamber.

- *Always check the chamber pressure **before** opening any sterilizer door.*
- As you open the sterilizer door, *stand slightly towards the hinged side, **never** directly in front of the opening side of the chamber*.

These safety precautions greatly reduce the likelihood you will ever suffer a steam burn or other injury as you open the door. All sterilizers have a pressure-lock system on the door that prevents it from being opened when steam pressure is still in the chamber. However, particularly with older sterilizers, this safety device may fail. You never know when a mechanical device will malfunction, so check the chamber pressure. And, just in case—keep the door between you and the heat!

The next step is to "crack" (open) the door slightly a few inches (about 6–8 inches) to allow the residual steam in the chamber to vent. Again, *do not* stand in front of the open door, you *can* get burned. Allow the load to cool-down for the period specified by your local policy, usually 15 to 30 minutes. This helps any remaining moisture to evaporate and makes the load slightly cooler and safer to transport to the sterile supply cooling area. It also reduces the likelihood of condensation occurring within the packs, which results if the hot items are exposed to cool room air too quickly.

After this cool-down period in the sterilizer, unload the items from the sterilizer. If the items are on a roll-out rack, unloading is greatly simplified. All you have to do is position the rack cart in front of the sterilizer, lock it in place, and roll the rack out of the chamber onto the cart until it locks into position on the cart frame. *Always wear heat-resistant, insulated gloves to cover your hands and forearms when pulling the rack onto the cart.*

The rack, chamber door, chamber walls, and load items are still extremely hot and can give you a severe contact burn. Place the rack and cart in an area free of cold drafts, and not directly under an air conditioning duct, to prevent the load from cooling too fast. If the hot load is cooled too rapidly, condensation forms in the packs resulting in strike-through contamination. Allow the load to cool to room temperature. This usually takes an hour or more, depending on contents of the load and the environment in the cool-down area. It is a good idea to advise other personnel who may need to enter the cool-down area the load is hot. Some units place simple signs in front of hot items to keep others from receiving an unpleasant surprise!

When the load reaches room temperature, you can safely store or transport the items. Always check the outside wrappers of every item in the load for signs of wetness. If water droplets or visible moisture is on the outer wrapper or securing tape, the package is considered contaminated. If a number of items are wet, the entire load is usually considered contaminated. In this case, a mechanical sterilizer malfunction should be suspected.

Unloading items directly from a sterilizer shelf is *not* recommended, but is sometimes unavoidable. Follow the same basic guidelines when unloading individual items by hand. However, there are several additional precautions to take.

- Once again, always wear protective gloves when manually unloading individual items.
- Handle the items as little as possible—transfer them from the sterilizer directly to a drying rack or table if at all possible.

- Do not place the hot items on a cold surface. Put them on a well-padded, fabric covered surface to prevent condensation.
- Check for wet packs and allow the items to cool to room temperature in an area free from drafts and air conditioning currents before storing them.

Never allow sterilized items to remain in the sterilizer chamber for long periods of time following sterilization. Over-drying leads to linen deterioration, causes tape to bake onto the wrappers, can damage package contents, and potentially could cause a fire.

Routine operator maintenance of steam sterilizers

To ensure steam sterilizers stay in top working order, and to protect the taxpayer's investment in expensive equipment, you must perform some routine operator maintenance tasks. Clean and inspect steam sterilizers on a regular basis. Establish and strictly follow daily and weekly routines.

Sterilizer Cleaning & Inspecting Routines	
Daily	**Weekly**
Perform the procedures listed below the first thing in the morning when the sterilizer is cool. • Clean the interior of the chamber, the door, and all trays, carriages, and racks with a mild detergent; rinse with clean tap water. Never use strong abrasive cleaners, wire brushes, steel wool, or similar substances to clean the sterilizer as they damage the metal surfaces and lead to rusting and corrosion. Refer to the sterilizer manufacturer's instruction manual for recommended cleaning agents and procedures. • Remove the chamber drain strainer (plug screen) and use a brush to clean lint and sediment from the openings in the screen. This permits free discharge of air at the beginning of the sterilizing cycle and proper steam exhaust at the end of the cycle. Don't forget to replace the strainer after cleaning.	In addition to the daily maintenance routines, perform the following operator maintenance steps weekly. • Remove the chamber drain strainer or screen and clean the chamber discharge line and steam trap by flushing with a solution of trisodium phosphate and hot water, or other manufacturer recommended product. Mix one ounce of trisodium phosphate to one quart of water or use a non-phosphate detergent as a flushing agent (liquid detergents designed for use in the ultrasonic cleaner can usually be used as a substitute for trisodium phosphate). Follow this by flushing the drain with one quart of hot water. • Check the sterilizer controls for burned out indicator lights, faulty gauges, loose or leaking control valves, faulty thermometers, etc. • Check the door closing mechanisms. Also, check the door gasket for cleanliness, proper fit, and signs of deterioration. • Visually inspect steam and water lines for leaks. Do not touch them! Leave repair to the professionals.

If you discover any problems, immediately report them to your supervisor and then medical equipment maintenance personnel. *Do not use the sterilizer until it is repaired and tested according to local policies.*

Medical maintenance personnel also perform extensive periodic inspections and preventive maintenance in accordance with the manufacturer's recommendations. Work with them to ensure your steam sterilizing equipment stays in top shape.

Advantages and disadvantages

Why is steam sterilization the most widely used method of sterilization? To answer this question, we need to look at some of the advantages and disadvantages of steam sterilization.

Advantages

- Steam sterilization is relatively easy and safe. It is also the most "sure-fire" method of in-house sterilization available. If an item is not damaged by heat and moisture, chances are it can be—and should be—steam sterilized.
- Steam sterilization is the fastest method. Steam penetrates many items quickly, carries considerable heat, and rapidly transfers the heat to the items being sterilized (via the process

of condensation). As a result, microbes are killed faster than during dry-heat or chemical sterilization.

- Steam sterilization is the least expensive method. Steam can be generated in either in-house boilers or out of the hospital, then be piped in to the sterilization area. Steam generators are also available that will generate steam from water when piped-in steam is not available.
- Many items used in surgery, such as metal instruments, are safely sterilized by steam. Steam leaves no residue after the process. Even fabrics such as linen can be repeatedly sterilized with minimal damage, provided they are properly re-processed before each sterilization cycle.
- Most steam sterilizers have automatic, pre-set controls that make each type of sterilization cycle virtually "fool-proof." All the operator has to do is properly load the items in the chamber, close the door, and press the button to start the cycle. The sterilizer conditions the chamber, "times" the exposure period, exhausts the steam from the chamber, and dries the load. The operator listens for a buzzer or other alarm, and then opens the door. Many steam sterilizers have "manual overrides" that allow the operator to sterilize items in emergency situations, even if electrical power is lost.

Disadvantages

- Heat and moisture damages or destroys some materials and equipment (such as laryngoscopes and bronchoscopes).
- If the items being sterilized are not prepared, packaged, and loaded properly, the steam may not penetrate and sterilize the item, or the item may not dry properly. Wet items are contaminated via "strike-through."
- Steam must penetrate or directly contact all surfaces of items being sterilized. The packaging must allow penetration of steam, but prevent penetration of microbes after the sterilization cycle.
- Steam does not easily penetrate some materials, such as oils, greases, and powders. It also does not penetrate some components of some equipment. Dirt and organic soilage also reduces the steam penetration. All items to be sterilized must be thoroughly clean and grease or oil free. Since steam does not penetrate all materials equally, the exposure period is not constant and has to be adjusted for individual items.
- The quality of the steam is difficult for the operator to monitor. If the steam is not pure, air pockets may form in, moisture may collect on, or solid particles may stain items being sterilized.

NOTE: Automatic cycles *do not* remove the need for close supervision and monitoring of each and every sterilization load; they simply reduce the likelihood of "human error" during the cycle.

These are the principles, basic conditions, and advantages versus disadvantages of steam sterilization. You now need to learn about some of the common types of steam sterilizers used in the OR and central sterile supply.

Chemical sterilization

Chemical sterilizing agents are effective, though their effectiveness varies. They can be classified as either liquid agents or gaseous agents. When using liquid agents, items must be completely immersed in the solution. This may be done by simply immersing the item in a basin containing the solution, or it may be accomplished using an automatic cycle and specialized equipment. Gaseous agents are used in specially designed sterilizers under specific conditions. For any chemical agent to be a sterilant, the agent must contact all surfaces of the items for a defined time of exposure.

Chemical sterilizing agents are considered hazardous chemicals by the Occupational Safety and Health Administration (OSHA). Ensure you wear eye protection, splash protection, and gloves when working with them. Some, such as ethylene oxide, also require respiratory protection. Always ensure you follow specific local policies and guidelines outlined by your hazardous communication program.

Peracetic and acetic acid solutions

Peracetic (technically peroxyacetic) acid solutions are also used as sterilants. These solutions are liquid sterilants which means items must be fully immersed in the solution to achieve sterilization. One method (Steris™) mixes peracetic acid with hydrogen peroxide and an anti-corrosive/buffer powder in a specially designed table-top or sterilizer. The sterilizer automatically mixes the solution to about 0.2 percent peracetic acid, heats the solution to between 122 and 131°F, immerses the contents for a specified period, then rinses the now sterile contents—all in about 30-minutes.

Operation of peracetic acid sterilizer

The peracetic acid processor is a fairly simple piece of equipment to operate. Once you prepare your instruments and devices for sterilization, place them in the processor, add sterilant, press the start button, and the processor does the rest. The processor will submerse the instruments and devices in a 122–131°F (50–55°C) peracetic acid solution for 12 minutes. Once that is completed, it will perform four consecutive rinses with sterile water. At the completion of the cycle, an audible alarm will sound and the "cycle completion" light will come on. One of the unique qualities of the peracetic acid sterilizer is that it has a self-diagnostics monitor which continually monitors all conditions of the sterilization process. In the event of a malfunction, the sterilization processor automatically aborts the cycle and prints out the reason the cycle aborted. This is a real brief synopsis of what happens. Let's take a look at the process in more detail.

First, let's look at the peracetic acid processor (fig. 1–19). Notice there is a latch near the bottom in the middle of the processor. To open the processor, simply pull up on the latch and the lid will open. Once you open the lid to the processor, notice there is an empty chamber with a fill valve connection and a drain connection. Before sterilization, choose the appropriate processing tray to place in the chamber. There are two types.

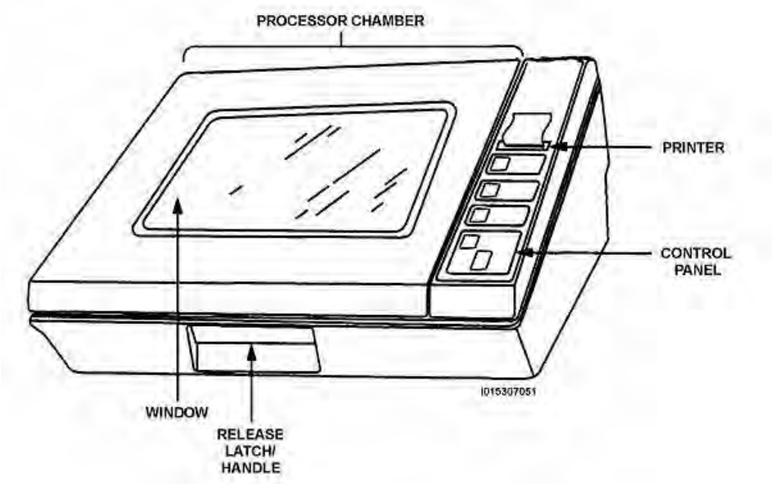


Figure 1–19. Front view of peracetic acid sterilizer/processor.

The first type of processing tray is a general processing tray (fig. 1–20). This tray is used to sterilize surgical instruments, cameras, light cords, adapters, and rigid endoscopic devices. The second type of processing tray is a flexible processing tray (fig. 1–21). This tray has a special design that allows you to place a flexible endoscope into the tray without kinking it. *Always remember how delicate flexible endoscopes are*. It also has special connectors and tubing to introduce the sterilant into the endoscope lumen to ensure complete sterilization.

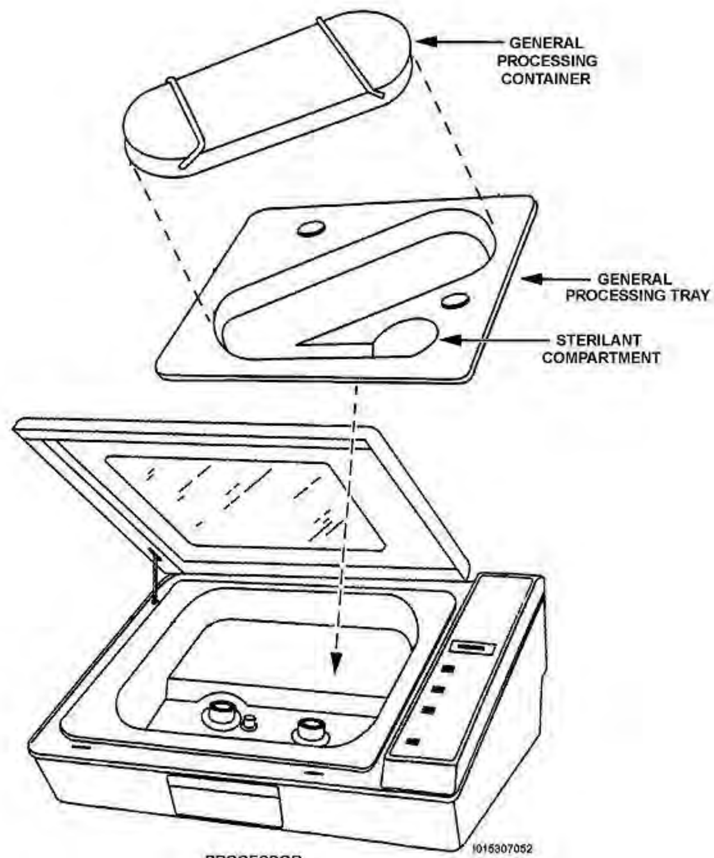


Figure 1–20. Open view of peracetic acid sterilizer/processor with general processing tray/.

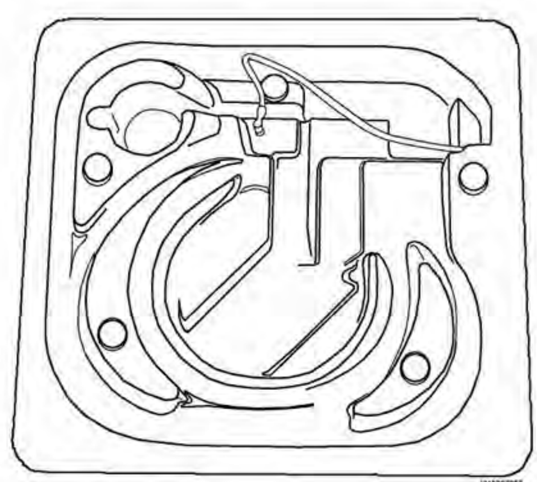


Figure 1–21. Top view of peracetic acid sterilizer/processor flexible processing tray.

Once you determine the type of processing tray you need, place it inside the processor chamber. If you are using the flexible processing tray, place your scope directly into the processing tray and connect the special tubing and connectors. (Refer to the manufacturer's recommendations when selecting and connecting different types of hoses and connectors.) If you are sterilizing instruments, cameras, light cords, adapters, or rigid endoscopic devices, place them in a general processing container with a chemical indicator and then place the container inside the processing tray. We will discuss loading instruments into the processing container later in this unit.

Once you load your instruments or devices into the processor, place the sterilant into the processor. Before you place the sterilant into the sterilizer, verify the expiration date, ensure the container is intact, and gently squeeze the bottom of the container to make sure the powder is soft. Next, place the container into the bottom right-hand side of the processing tray. Push the sterilant container down until the lid is flush with the processing tray. Once you start pushing it down, a cup cutter in the bottom of the processor will cause a slight clockwise rotation as it tears a hole in the bottom of the container and releases the buffer powder into the processor. The next step is to insert the plastic aspirator probe assembly into the center of the lid of the sterilant container until it is firmly seated on the container. *Make sure the plastic hose connected to the aspirator probe is not kinked.* This allows the sterilant to flow freely during the sterilization process. Then, close the lid and press the start button. If you meet resistance when closing the lid, stop and inspect the positioning of the container, tray, and aspirator assembly. From this moment on, the process is automated so all you need to do is wait for the process to finish.

Once you press the start button, the chamber begins to fill with water and peracetic acid sterilant. As it dilutes, it will turn to a greenish-yellow color. All devices in the processor are submerged in the heated sterilant. During the sterilization process, the peracetic acid solution is heated to a temperature between 122 and 131° F (50–55° C) for a 12-minute period. Once the sterilization cycle is completed, the sterilant is discharged through a sanitary drain. The instruments are then automatically rinsed in tap water a total of four times. The peracetic acid sterilizer has a filtering system where tap water is filtered through two external prefilters in addition to an internal micro filtration system. Even the smallest known bacterium, Pseudomonas dimenuta, is unable to pass through this filter system. After the fourth rinse, the cycle is completed. An audible alarm will sound and the “cycle completion” light will come on. The entire process takes 20–30 minutes. The actual processing time is dependent on water temperature, water pressure, and the status of the water filter. When the cycle is complete; press the “cancel” button. Once this is accomplished, the inflatable seal will deflate. Then, lift the handle and open the lid. Check the chemical indicator and the processor printout to ensure all sterilization parameters were met. The product is now sterile and ready for immediate use. Finally, remove the aspirator probe from the sterilant container, remove the empty sterilant container, and discard it in the trash.

Advantages and disadvantages

Now let’s turn our attention to some of the advantages and disadvantages of peracetic acid sterilization.

Advantages

- Peracetic acid sterilization is relatively easy and safe. It is a fairly fast method of sterilizing medical instruments and devices.
- Many heat-sensitive items used in surgery, such as scopes and cameras, are safely sterilized with peracetic acid.
- The peracetic acid sterilizer has a self-diagnostics monitor that continually monitors all conditions of the sterilization process. In the event of a malfunction, the processor automatically aborts the cycle and prints out the reason the cycle aborted.
- It uses a standard tap water supply, a regular sanitary drain, and a standard 110-volt electrical connection.
- During the sterilization process, the processing tray is also sterilized. It can be directly transferred to the sterile field using aseptic technique.
- All the operator has to do is properly load the items in the processor, place the sterilant in the appropriate location, close the door, and press the start button. The processor takes over from

there. Once you hear the audible alarm, open the sterilizer and remove the sterile processing tray.

Disadvantages

- Peracetic acid must penetrate or directly contact all surfaces of items being sterilized.
- For peracetic acid to effectively sterilize, all items must be thoroughly clean and free of grease and oil.
- Cannot be used for long-term storage. This process is designed for "just-in-time" sterilization.
- You cannot sterilize items that cannot be submersed in liquid.
- You must avoid contact with the skin because peracetic acid is corrosive and may cause skin irritation.

Loading, unloading, biological monitoring, and operator maintenance

As stated previously, to effectively sterilize using peracetic acid, the sterilant must thoroughly contact all areas of the items being sterilized. To make sure this happens during a sterilization cycle, the instrument and devices must be loaded properly.

Loading the sterilizer

To make sure sterilization is effective and reliable, follow these steps when loading instruments into the processing container:

1. The items must me properly cleaned prior to sterilization.
2. Ensure all devices are properly inspected and are in good working order.
3. Place water-resistant caps on cameras, light cables, etc., if required by the manufacturer's recommendations. Failure to place caps on these devices may result in damage and costly repairs.
4. Position devices to ensure exposure of the sterilant to all surfaces. Make sure all devices are disassembled into the smallest components. Open all valves. All small components need to be placed in a mesh bag. Open the ratchets on all graspers and clamps.
5. Load the instruments into the processing container so as to allow gravity flow of the sterilant. Devices with lumens need to be positioned so as to allow the liquid sterilant to flow upward through the lumen. This also aids in proper rinsing of the device following sterilization.
6. Correctly place a chemical indicator in the processing container for *each* sterilization load.
7. Place the lid on top of the processing container and position it in the processing tray. Make sure you align the fluid ports of the processing container with the fluid ports of the processing tray. You do this by resting the processing container on the rubber fluid port gasket. Now you are ready to close the lid and start the process.

If you are sterilizing flexible endoscopic equipment, you must carefully position the endoscope and accessories in the flexible processing tray. You must also attach appropriate adapters and hoses for proper sterilization. (Refer to the manufacturer's recommendations for positioning and proper attachments.)

Unloading the sterilizer

When the cycle is complete, an audible alarm will sound. Check the processor printout to ensure all conditions for sterilization were met. The following conditions must be reflected on the printout:

- Temperature reading should read between 122 and 131° F (50–55° C).
- The concentration must be 175 or greater.
- The exposure time must be 12 minutes.

Once you determine the conditions of sterilization were met, it is time to open the processor. The first step is to press the "cancel" button. Once you do this, the inflatable seal will deflate. Then lift the handle, open the lid and visually check the chemical indicator. The effectiveness of the chemical indicator is identified by a color change from white to purple. If the appropriate color change occurred, your product is now sterile and ready for immediate use. Finally, remove the aspirator probe from the sterilant container, remove the empty sterilant container, and discard the container in the trash.

One of the unique qualities is that this sterilization system sterilizes everything inside the processor—instruments and devices, processing container, and processing tray. The next step is to remove the processing container using aseptic technique. The entire container can be placed directly on to the sterile field.

Biological monitoring of the peracetic acid sterilizer

The peracetic acid sterilizer is unique in that it provides operators with three methods of quality assurance. First, it has a computer processor that monitors the entire sterilization process and identifies any problems. At the conclusion of a load, it prints a report that records the conditions of the sterilization process. Second, a chemical strip is placed in every load. The third and final quality assurance mechanism put into place to further monitor the effectiveness of the sterilization process is biological monitoring.

Biological monitoring ensures that sterilization conditions are met and maintained during the sterilization process. The biological indicator used to monitor the effectiveness of peracetic acid sterilization is either Bacillus subtilis or Bacillus stearothermophilus spore strips. Biological testing should be conducted and documented at least weekly. Refer to local policy for specific guidance on frequency.

To perform biological monitoring, take the following steps:

1. Put on a pair of gloves and open the envelope containing the spore strip. Using the special clip provided, grasp the spore strip and place it in the processing tray channel or in an empty processing container.
2. Add sterilant and run a standard sterilization cycle.
3. Once the cycle is complete, don new gloves. Using strict aseptic technique, transfer the spore strip into the biological vial. **Avoid contact with any unsterile surface!** Be careful not to let the indicator touch the outside of the vial because this can cause a false positive reading.
4. Once the spore strip is inserted into the vial, screw the cap on and make sure the spore strip is completely immersed.
5. Label the vial with the load number, the date, and your initials, and place it into the incubator. If you are using Bacillus subtilis spore strips, the incubator must be maintained at 37° C. If you are using Bacillus stearothermophilus, the incubator must be maintained at 56° C.
6. Annotate the appropriate information into the peracetic acid biological logbook.
7. The vial can be kept in the incubator up to seven days. Check for daily growth. Refer to local policy and/or manufacturer recommendations for completion of biological monitoring procedures.
8. In addition to placing the processed spore strip into the incubator, you also need to incubate a control. Remove a spore strip from its envelope and place it directly into the vial and incubate. Refer to local policy and/or manufacturer's recommendations for completion of biological monitoring procedures.

Routine operator maintenance of peracetic acid sterilizers

To ensure peracetic acid sterilizers stay in top working order, you must perform some routine operator maintenance tasks and checks. Clean and inspect sterilizers on a regular basis. Below is a list of the daily cleaning requirements for the peracetic acid sterilizer.

1. It is recommended that a diagnostic test be run on the peracetic acid sterilizer every 24 hours. Initiating a diagnostic test each day validates the integrity of the processor. The diagnostic test ensures all electro/mechanical systems and the sterile water filter are functioning correctly. The completion of a successful diagnostic cycle assures the user that the processor will operate appropriately. If a diagnostic cycle fails, the processor will prohibit you from initiating any cycles till the problem has been corrected and a successful diagnostic test has been completed. Refer to the manufacturer's manual on specific instructions for running a diagnostics cycle.
2. All cleaning of the processor should be done with a soft cloth dampened with 70% isopropyl alcohol. Clean the external surfaces of the processor first.
3. Open the lid and clean the processing tray by thoroughly wiping the inner surface and seal. Next, clean the processing container and accessories rack.
4. Wipe the aspirator assembly and sterilant compartment.
5. Visually inspect the aspirator assembly and make sure the probe lumen is clear, that there are no cracks or chips, and that the hose connection is secure. If there is a crack or chip, replace the aspirator assembly.
6. Check the drain screen, which is located in the bottom of the sterilant compartment. Ensure it is clean and remove any lint or debris. To remove the screen, lift the processing tray and unscrew the drogue. Remember to replace the screen after cleaning.
7. Remove the processing tray and clean the processor chamber. Then replace the processing tray and container.
8. Open the control panel and check your printer paper. Replace with a new roll, as needed.

Since the peracetic acid sterilizer utilizes several filters, you will also be required to change these filters at their recommended time. Refer to the owner's manual for specific periodic maintenance schedule and instructions.

Hydrogen peroxide plasma or vapor

Hydrogen peroxide is used as a sterilant by converting it from a liquid to either a vapor or to plasma. A hydrogen peroxide *plasma sterilizer* subjects the liquid hydrogen peroxide to radiofrequency energy to form a plasma. Air is evacuated from the chamber, the liquid hydrogen peroxide enters the chamber and is vaporized, and then radiofrequency energy converts the vapor to a plasma within the chamber. The plasma sterilizer operates at about 104° F and sterilizes in about an hour.

A hydrogen peroxide *gas plasma sterilizer* passes the liquid hydrogen peroxide through an electromagnetic field to generate its plasma. This plasma is then introduced to the chamber. The gas plasma sterilizer operates at about the same temperature as the plasma sterilizer, and sterilizes unwrapped items in about 30 minutes, and wrapped supplies in about 90 minutes.

In a hydrogen peroxide *vapor phase sterilizer*, a vacuum is created in the chamber, and then a cold vapor of hydrogen peroxide is introduced. It sterilizes between 39 and 46° F; the time varies.

Just like the peracetic acid sterilizer, the hydrogen peroxide plasma sterilizer is also a fairly simple piece of equipment to operate. During the sterilization process, the hydrogen peroxide plasma sterilizer automatically monitors and controls the sterilization process. Most hydrogen peroxide plasma sterilizers use four different methods to do this:

1. **Message screen (LCD).** The screen continually indicates the status of the unit and displays the time remaining to cycle completion.

2. **Status indicator lights**. The lights identify the current stage of the sterilization cycle and assist you in monitoring the cycle stages (vacuum, injection, diffusion, plasma, and vent).
3. **Paper printout.** At the completion of a sterilization cycle or a cycle cancellation, a paper exits the front panel. This records the cycle parameters and should be kept for your records. If problems were encountered during the sterilization cycle, they will be identified on the printout.
4. **Beeps.** At the conclusion of a cycle or if a cancellation occurs, the beeps will alert you.

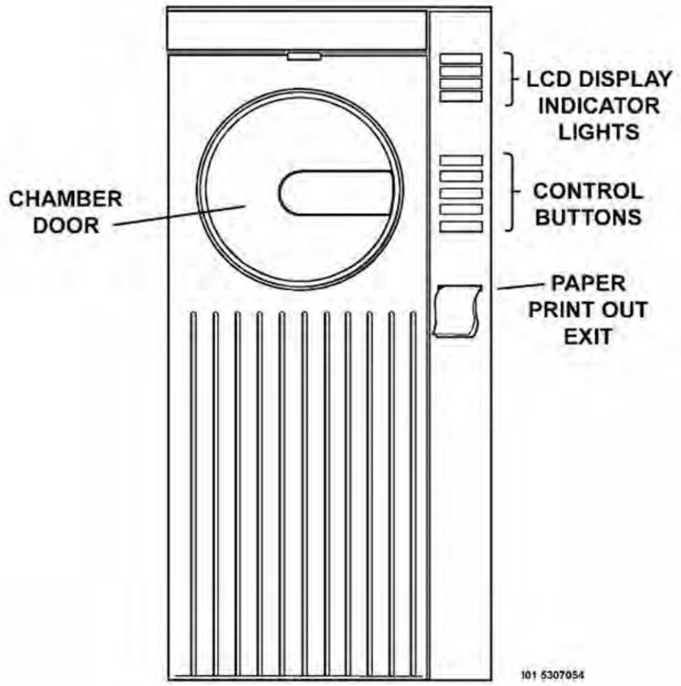


Figure 1–22. Typical front view of hydrogen peroxide plasma sterilizer.

Once you prepare your instruments and devices, properly load them into the sterilizer chamber. Next, verify the status of the hydrogen peroxide plasma cassette. Most hydrogen peroxide cassettes provide enough hydrogen peroxide for several loads. If a cassette is empty or expired, it needs to be replaced. It also needs to be replaced if you are directed by a message on the sterilizer display. Once this is done, you are ready to start the cycle. Press the start button, and the processor does the rest. Once the cycle starts, there are five different stages the sterilizer goes through: vacuum, injection, diffusion, plasma, and vent. Depending on which sterilizer you use, it may go through just the five stages or it may go through the injection, diffusion, and plasma stage twice. The load is sterilized in approximately one hour. Once the load is completed, an audible alarm will sound and a message will be displayed on the message screen. A report will also print that records the conditions of the sterilization load. Once the cycle is complete, you can open the door. After you open the door, check your chemical strips and make sure they changed from red to yellow. Remember, the chemical indicator does not guarantee sterility: it indicates the load was exposed to hydrogen peroxide. Remove the items from the chamber and they are ready for immediate use.

Advantages and disadvantages

Let’s look at some of the advantages and disadvantages of hydrogen peroxide plasma sterilization.

Advantages

- The hydrogen peroxide plasma sterilization is dry and nontoxic.
- Because hydrogen peroxide plasma is a by-product of oxygen and water vapor, it can be evacuated into the room atmosphere.
- Its low temperature allows sterilization of many heat-sensitive items such as endoscopes and fiberoptic devices.
- The sterilizer is simple to operate and connects to a standard electrical outlet.
- It is safe, effective, economical, and easy to use.
- No aeration is required and the sterilized items are ready for immediate use.

Disadvantages

- Metal trays block the radio-frequency waves.
- You cannot sterilize items with cellulose (i.e., woven textiles with cotton fibers and paper products).
- After repeated exposure, nylon becomes brittle.
- The concentrated hydrogen peroxide solution is corrosive to the skin, eyes, nose, throat, lungs, and gastrointestinal tract.
- All items must be cleaned and dried before sterilization. If the sterilizer detects moisture, it may cancel the cycle.
- The sterilizer cannot be unplugged or turned off for more than 24 hours.

Loading the hydrogen peroxide plasma sterilizer

To ensure sterilization is effective and reliable, follow these rules when loading instruments into the hydrogen peroxide plasma sterilizer:

1. Make sure the items you are preparing for sterilization can be sterilized using hydrogen peroxide plasma. (The best way to determine if they are suitable for this type of sterilization is to refer to the medical device manufacturer's manual.) Hydrogen peroxide plasma is designed for sterilization of both metal and nonmetal devices. It is also suitable for heat and moisture sensitive instruments. *Do not* sterilize items with cellulose, such as woven textiles with cotton fibers and paper products or items that absorb liquids (i.e., gauze sponges, hand towels, linens). This means you cannot include count sheets inside your sets. *If an item is labeled for "gravity steam methods," or cannot withstand a vacuum, it cannot be sterilized in this sterilizer.*
2. All items placed in a hydrogen peroxide plasma sterilizer must be cleaned, rinsed, and dried. *Absolutely all moisture must be removed.*
3. Hydrogen peroxide plasma sterilizers require the use of special trays specifically designed to allow the diffusion of hydrogen peroxide and the plasma around all the items in the sterilizer. Do not pad trays with linen. Refer to manufacturer's recommendation for appropriate padding.
4. Arrange items in an instrument tray in a manner that allows the hydrogen peroxide and plasma to surround them. Do not stack instrument trays. Place a chemical indicator in each tray and peel pack.
5. When loading items into the sterilization chamber, place the trays flat on the shelves. *Do not stack trays or basins within the trays*.
6. Position peel pouches on edge and arrange them so the transparent side of the pouch faces the opaque side of the next pouch.
7. Do not allow any items to touch the walls or doors and provide at least one inch of space between the ceiling of the electrode and the top of the load.
8. Place a biological test pack in the sterilizer at the back of the sterilization chamber on the bottom shelf.

Unloading the sterilizer

Once the load is completed, an audible alarm will sound and a message will be displayed on the message screen. It will also print out a report that records the conditions of the sterilization load. Check the printout to make sure there were no problems with the load. Once the cycle is complete, you can open the door. After you open the door, check your chemical strips and make sure they changed from red to yellow. Remember, the chemical indicator does not guarantee sterility; it indicates the load was exposed to hydrogen peroxide. The items can be immediately removed from the sterilizer and delivered to their appropriate location.

Biological monitoring of the hydrogen peroxide plasma sterilizer

Biological monitoring ensures sterilization conditions are met and maintained during the sterilization process. The biological indicator used to monitor the effectiveness of hydrogen peroxide plasma sterilization is *Bacillus subtilis* var. *niger* spore strips. Biological testing of hydrogen peroxide plasma sterilizers is accomplished through the use of commercially prepared test packs. The pack contains both a chemical and a biological indicator. Biological testing should be conducted and documented at least once per day. The correct placement of the biological indicator is at the back of the sterilization chamber, on the bottom shelf. Make sure the opening of the biological test pack is facing the back of the chamber and is not obstructed.

Once the sterilization load is completed, remove the test pack from the sterilizer. Check the chemical indicator for appropriate color change. If the appropriate color change is noted, remove the spore strip and transfer it into the vial using strict aseptic technique and incubate. *The transfer process should be completed within 15 minutes of cycle completion.* Refer to local policy and/or manufacturer's recommendations for completion of biological monitoring procedures**.**

Routine operator maintenance of hydrogen peroxide plasma sterilizers

To ensure hydrogen peroxide sterilizers stay in top working order, you must perform some routine operator maintenance tasks and checks. Clean and inspect sterilizers on a regular basis.

To clean the outside surfaces of the sterilizer, wipe them down with a mild detergent. The inside of the chamber normally does not require cleaning. Never wipe the chamber door or the chamber with anything abrasive. Refer to your manufacture's manual for specific cleaning requirements for your sterilizer.

Since the hydrogen peroxide plasma sterilizer uses hydrogen peroxide cassettes, you will need to replace the cassette collection box from time to time. The cassette collection box usually holds about 30 used cassettes. Other routine maintenance you will need to do is to replace the printer ribbon or cartridge, replace printer paper, and clean or replace the injector valve vaporizer bowl. Refer to manufacturer's recommendations on the instructions to perform these tasks.

Glutaraldehyde solutions

Glutaraldehyde is the last chemical sterilizer we will cover. Glutaraldehyde solutions have been used primarily as high-level disinfectants, but are capable of sterilizing items. It works by denaturing the cells, but acts very slowly on spore-forming bacteria. It takes a *minimum* of 10 hours direct exposure to most glutaraldehyde solutions before an item can be considered sterile. Glutaraldehyde may be packaged as two-part solutions; you must mix the two chemicals to "activate" the solution. Glutaraldehyde may also be packaged full-strength, or in concentrations that must be mixed. Glutaraldehyde is used multiple times in some facilities. After it is dispensed, the container is labeled with the type (brand name) of glutaraldehyde, and expiration date, and the name or initials of the person dispensing or mixing the solution. If it is reusable, a test strip may be used to ensure the solution is still potent. Always follow the manufacturer's instructions, particularly when mixing the solution, sterilizing an item, and determining the date of expiration.

Non-ionizing radiation

Non-ionizing radiation, commonly called microwaves, sterilization currently uses low-pressure steam combined with microwaves to generate very rapid high localized temperatures. Cycle times may be as short as 30 seconds with this type of sterilization. However, technology limitations, such as the requirement to place metal items in a partial vacuum within a glass container, have prevented its practical wide-spread use in medical facilities.

Ionizing radiation

This method of sterilization uses a combination of thermal and chemical energy to destroy microbes. Ionizing radiation involves the bombardment of items with beta and gamma rays from a radioactive source (cobalt 60). These rays destroy the microorganisms by disrupting their molecular structure. Ionizing radiation is used commercially, primarily for bulk sterilization of items. The need for shielding, trained personnel, and radioactive substances prohibits its use in the average medical facility.

The following table summarizes the methods used to limit organisms in our facilities.

Procedures	Levels	Methods Used	Results
Cleaning		Washing by hand	Used for noncritical items
		Washing in sterilizer	
		Sonic energy cleaning	
Disinfecting	High Intermediate Low	Pasteurization Chemical germicides Ultraviolet irradiation	Kills most microorganisms but NOT spores. Used for noncritical items
Sterilization		Physical Chemical Radiation	Kills ALL microorganisms and is used for critical items

Sterilization indicators

Since you can not see microorganisms, there is no way to tell if items are sterile. There are devices or indicators that tell you if the item has been sterilized and whether the sterilization process was effective. The special tape you use to seal the packages is an *external chemical indicator*, it has been chemically treated so that it will either change color or develop darkened lines when it is exposed to the sterilizing agent. Unfortunately, these indicators only show that the outside of the item has been exposed to sterilizing conditions, not whether it is sterile. However, it does serve one useful purpose—if the tape on the package you are going to use has not changed, you will know that the item is *not* sterile. Do not use it!

Internal chemical indicator

A paper strip placed inside the package is called an *internal chemical indicator*. It, too, changes color when the package has been sterilized. When you open a sterilized package, check the strip to make sure it has changed. As with the tape on the outside, the inside strip does not guarantee sterility, it only indicates the inside has been exposed to sterilizing conditions. Again, if the strip has not changed, do not use the item. While these chemical indicators tell us only that sterilizing conditions have been met, biological indicators are used to test for actual sterility.

Biological test indicators

Biological indicators are used to test the sterilizers. They are not usually used to test individual items for sterility. These biological indicators usually are commercially prepared ampules containing highly resistant spores and a growth medium. The test ampule is processed in the sterilizer per local policy (usually in each cycle), then activated and incubated as recommended by the manufacturer (12–48 hours). If the spores grow, the indicator changes color to show the sterilization cycle was not effective. Any item processed since the last effective test is recalled. This is another reason to rotate your sterile supplies. If you use the newest first, you may wind up using an un sterile item.

In addition to checking the tape, always examine your sterile packages for stains, tears, holes, loose tape, or past expiration dates. If you find any of these, or if you doubt the sterility of the package for any reason, DO NOT USE IT! It is always better to be safe than sorry! You should check these packages thoroughly when you receive them, and check them again when you are ready to use them.

In this lesson, you learned about sterilizing and ensuring the sterility of the packages sterilized in the hospital. For the most part, you will use manufacturer sterilized, prepackaged, disposable supplies. As long as the container or package is intact and there is no expiration date, such items are considered sterile until used. However, you must still examine the package carefully before using any of these items. The cardinal rule of sterility is WHEN IN DOUBT—TOSS IT OUT! (Do not throw it away; just do not use it).

008. Universal Protocol concepts

A culture of patient safety is demonstrated by an organizational commitment to provide safe, high quality patient care via a focus on collaborative teamwork, communication, and effective processes. This commitment must be shared by leadership and staff members at all levels. Organizations with a culture of patient safety acknowledge that medical errors can and will occur and strive to identify and reduce risk before it results in harm.

Framework for safer and more effective healthcare

According to AFI 44–119, *Medical Quality Operations*, patient safety proactively and retroactively identifies potential and actual risks to safety, identifies underlying causes, and makes the necessary improvements to reduce risks. It establishes processes in response to sentinel events and adverse incidents by identifying risks through a Root Cause Analysis (RCA) and implementing process improvements. Patient safety, in collaboration with other activities, including performance improvement and risk management, promotes a culture of safety in which errors are identified and reported freely without retribution. The goal is to reduce variability and vulnerability for error in processes.

Safety is rooted in the daily operations of the healthcare organization where proactive risk identification, assessment, and control are the foundation for safe and effective healthcare. This systems-based approach to advance a culture of safety, reduce vulnerability, and promote competent patient-centered care is driven by the leadership at each medical organization through the endorsement and active support of commanders, medical, and nursing leadership. These concepts are anchored in the organization's mission, vision, prioritization plan, guidance, and policies.

Regulatory compliance

All MTFs will use each patient's full name and date of birth as the two standard identifiers associated with National Patient Safety Guidelines (NPSG). Use these two patient identifiers at a *minimum* when providing care, treatment, or services. The intent of this goal is to reliably identify the individual as the person for whom the service or treatment is intended and to match the service or treatment to that individual. These same two identifiers must be directly associated with medications, blood products, specimen containers, and treatments or procedures. Standardization of this goal across the Air Force Medical Service (AFMS) is intrinsic to the delivery of safe, high quality healthcare and system-wide solutions.

Universal Protocol checklist

The Universal Protocol (UP) was established by TJC in 2003 and became effective in 2004 for all accredited hospitals as a mechanism for preventing wrong site, wrong procedure, and wrong person surgery. The UP is built on three key components: (1) preprocedure verification, (2) site marking, and (3) preprocedure time out. All MTFs will adhere to the NPSGs for UP. UP applies to all surgical and nonsurgical invasive procedures as determined by the MTF. MTFs will ensure UP compliance by developing facility-specific processes that use the UP surgical checklist (fig. 1–23) and incorporate elements of the nonoperating room procedure verification checklists into established processes. The checklist templates are located in the Patient Safety Handbook posted on the Kx.

UNIVERSAL PROTOCOL SURGICAL CHECKLIST

PROCEDURE:	SITE:	DATE:

	Y	N	N/A	
Preprocedure Verification *(with patient involvement when possible)* ___ (Surgeon's Initials) Attending Surgeon/Residents discussed procedure and patient care management ___ (Surgeon's Initials) Attending Surgeon/Residents discussed case with OR team prior to surgery				Preprocedure Verification Completed. **Signature:**
Verify the following:	Y	N	N/A	**Time:**
- Patient identification *(Name and DOB)*	☐	☐	☐	**Comments:**
- Pt/Parent/Guardian verbalizes understanding of procedure and site	☐	☐	☐	
- Consent signed/dated by provider, patient, and witness	☐	☐	☐	
- H&P completed/reviewed by licensed provider	☐	☐	☐	
- Pre-anesthesia assessment completed -- *Safety check accomplished, Antibiotics available, anticipated blood loss*	☐	☐	☐	**Site marked by:** ____________________ **Attending** ☐ **Resident** ☐ **P.A.** ☐
- Nursing assessment completed	☐	☐	☐	
- Labeled diagnostic, radiology, pathology tests results, blood products, implants, devices and/or special equipment present and operational	☐	☐	☐	
- Surgical site marked and initialed by licensed independent practitioner directly involved with procedure *(includes alternate marking method if necessary)*	☐	☐	☐	
Final Time Out *(Licensed provider, Anesthesia Provider, Circulating Nurse and Technician)* *(Verbally confirm with each team member immediately prior to invasive procedure/incision and prior to start of second procedure)*				Final Time Out Completed. **Signature:**
Verify the following:	Y	N	N/A	**Time:**
- Correct patient, procedure, and site	☐	☐	☐	
- Surgical site marked	☐	☐	☐	**Team Members:**
- Consent form accurate and correct	☐	☐	☐	
- Team members agrees on procedure/positioning correct	☐	☐	☐	
- Antibiotics started/given	☐	☐	☐	
- Appropriate pre-op beta blocker administered	☐	☐	☐	**Comments:**
- Required items available *(e.g. irrigation fluids, equipment, blood/blood products)*	☐	☐	☐	
- Relevant images and results properly labeled and displayed	☐	☐	☐	
- DVT prophylaxis as ordered	☐	☐	☐	
- Appropriate measures taken to prevent hypothermia	☐	☐	☐	
Post-Procedure Brief				Post Procedure Brief Completed. **Signature:**
Verify the following:	Y	N	N/A	**Time:**
- Name of procedure recorded	☐	☐	☐	**Comments:**
- Instrument, sponge, and needle *(if applicable)* counts correct	☐	☐	☐	
- Specimens labeled correctly	☐	☐	☐	
- Any equipment problems addressed	☐	☐	☐	
- Licensed provider, anesthesia provider, and nurse *(If applicable)* reviewed key concerns for recovery/management	☐	☐	☐	
				PATIENT IDENTIFICATION STAMP

Figure 1–23. Universal Protocol surgical checklist.

Nonoperating room

The checklist (fig. 1–24) only applies to nonoperating room procedures (i.e., when medical staff assists with procedures in a clinic). Staff must use the checklist to verify the right patient and procedure as well as attain consent, along with prepping equipment, supplies, and the surgery site. These responsibilities are not solely done by one person but must include all team members involved with the procedure (provider/surgeon/nurse/technicians).

Operating room

This checklist (fig. 1–24) is used by operating-room staff before surgery begins; it's one last check to ensure verification of all resources used before, during, and after surgery. The checklist provides more thorough verification of not only the patient but completion of documents used in assessing patient throughout the process.

UNIVERSAL PROTOCOL
Non-Operating Room Procedure Verification Checklist
(Used for Procedures Performed Outside the Operating Room)

When completing the Non-Operating Room Procedure Verification Checklist ensure the following:
- Procedure must match consent form
- Consent form is signed by a licensed independent practitioner directly involved with procedure
- Identify Provider or Surgeon performing procedure
- Identify Nurse and or technician assisting with procedure
- Annotate date and time of procedure

Universal Protocol Checklist

____ **(Provider's Initials) Attending Provider/Residents discussed procedure and care management**

____ **(Provider's Initials) Attending Provider/Residents discussed case with assisting team member(s)**

Pre-procedure Verification: Confirm correct patient, procedure, consent, positioning, side/site marked *(includes alternative marking method)*; blood products and special equipment needs *(as applicable)*.

Final Time Out Accomplished: Verbally confirm with personnel immediately prior to incision and prior to start of second procedure. Confirm procedure, procedure site, patient position, relevant images and lab, antibiotics, fluids, and safety precautions.

Team Agrees:

Procedure: ____________________

Provider/Surgeon: ____________________

Nurse/Technician: ____________________

Date/Time: ____________________

PATIENT IDENTIFICATION

Figure 1–24. Universal Protocol nonoperating room checklist.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

007. Disinfection and sterilization procedures

1. What general tasks are included in the sterilization procedure?

2. For what purpose is low-level disinfection useful?

3. What type of disinfection is done by placing small items in boiling water for a specified period of time?

4. What is the method of choice for chemical disinfection?

5. What does the EPA classify chemical disinfectant solutions as?

6. What are the disadvantages of formaldehydes?

7. What special precaution must be taken when using ultraviolet irradiation?

8. For sterilization puroses, what type of patient use items are classified as semicritical?

9. What factors determine the cleaning method to be used for equipment?

10. When cleaning equipment, what things should you do to prevent self-contamination?

11. Briefly describe how ultrasonic cleaning works.

12. What characteristics should wrapping material for sterile packs have?

13. Why should you avoid adding extra supplies or equipment to a sterile pack?

14. Which wrapping method is used for *most* packages?

15. Why should you avoid using pins, clips, or staples to secure sterile packages?

16. What type of instrument should you use to label a sterile package?

17. What information should be included on the label?

18. What are the three basic methods of sterilization?

19. Which type of sterilization uses gravity displacement sterilizers, prevacuum sterilizers, and washer-sterilizers?

20. When does a steam sterilizer begin timing the actual sterilization cycle?

21. What are disadvantages of steam sterilizers?

22. What is the difference between the gravity displacement sterilizer and the prevacuum steam sterilizer?

23. What is the primary function of washer-sterilizers?

24. A washer sterilizer cycle should only be used for what type of sterilization?

25. How should items be loaded in a steam sterilizer?

26. When monitoring the sterilization cycle, what are some problems to look for?

27. What should you always do *before* opening a sterilizer door?

28. How many types of processing trays are there for the parectic acid sterilizer?

29. What are some disadvantages of the peracetic acid sterilizer?

30. As a *minimum*, how often should biological testing be conducted on a peracetic acid sterilizer?

31. What are the four methods used to monitor and control the sterilization process of a hydrogen peroxide plasma sterilizer?

32. When unloading a hydrogen peroxide plasma sterilizer, you must first check to make sure the chemical strips have changed to what color?

33. For what purpose is ionizing radiation primarily used?

34. What are three methods of disinfection?

008. Universal Protocol concepts

1. What are NPSG used for?

2. What are the two standard identifiers associated with the NPSG?

3. What are the key components that the UP is built on?

Answers to Self-Test Questions

001

1. Set-up minor surgery, set-up/maintain sterile field, perform height and weight, record temperature, assess pain scale, perform and label venipuncture, assess APGAR score, obtain body measurements, perform immunizations, collect and label emesis, urine, stool samples, assess respiratory rate, and perform intake and output measurements.
2. Outlines how infection control programs should be developed and operated, assists in solving infection problems, analyzes infection survey data, and investigates the outbreak of serious infections and diseases. The CDC also researches and publishes guidelines on a variety of infection control topics.
3. Usually a registered nurse with training and background in epidemiology, microbiology, statistics, and research methods.

002

1. They destroy surrounding tissue or produce toxins (poisons).
2. From exposure to various sources within our environment. They are usually found in a specific body area; they are considered normal flora for that area alone.
3. Commensalism.
4. The pathogen inhabits the carriers but does not produce any symptoms of infection.
5. Parasitic, or infectious agents that act parasitic.

6. Bacterial cells divide every 30–120 minutes.
7. Size, shape, and attachments.
8. Spherical, rod-shaped, and spiral-shaped.
9. Rickettsiae.
10. Some are edible; others are involved in fermentation of breads and alcoholic beverages; and still others are used to produce antibiotics.
11. The cell wall is flexible and allows the cell to form a variety of shapes.
12. Pseudopods or false feet.
13. The virus.
14. One of the larval stages.

003

1. Causative agent, reservoir, portal of exit, mode of transfer, portal of entry, and susceptible host.
2. Respiratory tract, gastrointestinal tract, skin and mucus membranes.
3. Indirect contact is touching contaminated objects such as forks, spoons, coffee cups, and medical equipment.
4. Occurs when infectious agents are transmitted through the air short distances (less than three feet) by a person coughing, sneezing, or talking.
5. Incubation, prodromal, illness, and convalescence.
6. Anywhere from a few hours to a few days.
7. Intact and unbroken skin.
8. The moist surfaces of the membranes in the nose, throat, respiratory and genitourinary trap microorganisms. This is enhanced in some areas, as in the nose and trachea, by hair or cilia growing out of the membranes that help filter and trap foreign matter. Also, the mucous membranes are highly vascular, enabling white blood cells to be rapidly supplied to the area of pathogen invasion. They may also harbor normal flora that combat pathogens.
9. They wash away dirt, debris, and microorganisms that could cause infection.
10. The lymphatic system contains special nodes and glands that produce large leukocytes, called lymphocytes, which engulf and destroy invading pathogens. Also, the lymphatic system transports pathogens to regional lymph nodes where they are trapped and destroyed, before they can enter the bloodstream.
11. Substances created in the body to attack specific foreign substances classified as antigens.
12. An infection that has spread to the lymph nodes.
13. Standard precautions and transmission-based precautions.
14. To prevent nosocomial infection.
15. When splattering or splashing of blood or body fluids is possible.
16. Airborne, droplet, and contact precautions.
17. Place patient in a private room that has monitored negative air pressure, keep the door closed, and personnel should wear protective respiratory equipment (such as a mask).
18. When working within three feet of the patient.
19. To control the spread of infection.

004

1. Inflammation of the liver that can be caused by bacteria, viruses, protozoa, helminths, chemicals, or drugs.
2. Inflammation of the meninges covering of the brain and/or spinal cord; bacterial meningitis.
3. Viral meningitis.
4. AIDS is a group of symptoms that usually result from an infection caused by the retrovirus HIV.
5. PID.
6. (1) Primary.
   (2) Secondary.

(3) Latent.

(4) Late.

(5) Congenital.

7. By phone or locally derived form.
8. AFI 48–105.
9. The PH office.

005

1. Freedom from infection (absence of all microorganisms), but only as applied to inanimate objectives.
2. Clean technique.
3. Sterile technique.
4. Disinfecting.
5. Disinfectants are designed to destroy pathogenic organisms and usually are used on inanimate objects. Antiseptics are designed to inhibit the growth of microorganisms on living tissue, but do not necessarily kill them.

006

1. Prevent the spread of microorganisms among staff, patients, and visitors.
2. Refusal to believe that they can be contaminated, so they ignore the precautions; lack of understanding what they are supposed to do and they become contaminated without knowing it; individuals who are illiterate or don't read English and become infected due to their inability to understand the caution signs posted on isolation room doors.
3. They are in a hurry and try to take shortcuts; they don't understand how to follow the precautions; they think the precautions don't apply to them.
4. If both patients have the same disorder and are the same gender. A patient with an infectious disease may sometimes be placed with a patient without an infectios disease if they are both cooperative, understand the infectious process, and have been taught how to use the isolation techniques.
5. To prevent contamination of the general environment and other people.
6. Routine cleaning is general cleaning that's done every day and usually is performed the same as in other areas of the hospital; terminal cleaning is directed primarily toward objects the patient has actually had contact with.
7. The cleaning equipment should be disinfected with an approved solution before going on to another room. If cleaning cloths and mop heads are grossly contaminated, bag and label them appropriately before sending them to be laundered.
8. They are selected by the local infection control committee according to EPA standards.
9. Gown, mask, and gloves.
10. The patient is physically separated from other people and personnel are more likely to remember to wash their hands before going on to other patients.
11. They prevent inhalation of large droplets and small droplet nuclei. They might also prevent personnel from touching their mucous membranes and contaminating themselves.
12. Put it on before you enter the room and take it off before you leave.
13. To provide a protective barrier and prevent gross contamination of the hands when touching blood, body fluids, secretions, excretions, mucous membranes, and non intact skin; to reduce the likelihood that microorganisms present on the hands will be transmitted to patients during invasive or other patient care procedures that involve touching a patient's mucous membranes and non intact skin; and to reduce the likelihood that hands contaminated with microorganisms from a patient or fomites can transmit these organisms to another patient.
14. Bag, label, and dispose of it according to local policy.
15. No special precautions are needed; hospital dishwashers are capable of decontaminating dishes.

007

1. Cleaning, disinfecting, wrapping, and sterilizing.

2. General cleaning.
3. Pasteurization.
4. Sterilization.
5. Sporicides, general disinfectants, hospital disinfectants, sanitizers.
6. The solution is irritating to the skin, eyes, and mucous membranes; gloves and face protection must be worn when using it. Instruments must be thoroughly rinsed in sterile water after disinfection, and items that may absorb the solution should not be disinfected in formaldehyde. The fumes are highly toxic and prolonged inhalation must be avoided. In fact, the fumes are so toxic that formaldehyde is *not suitable* for housekeeping use.
7. Wear protective garments such as gowns, gloves, and protective glasses when using this process to prevent injury.
8. Items that come into contact with intact mucous membranes, but do not penetrate body surfaces.
9. Local policy, type of object to be cleaned, and amount and type of organic material on the object.
10. Avoid splashing, wear gloves, eye protection, and adhere to locally required protection.
11. It cleans by passing ultrasonic waves through a fluid. This produces submicroscopic bubbles, which collapse and pull dirt from objects by suction.
12. The wrapper must be constructed so that it allows the sterilizing agent to enter and leave, but does not allow microorganisms or dust particles to enter. It must be durable enough to withstand conditions in the sterilizer and in storage, and it must provide physical protection for delicate items. The wrapper must also be flexible enough to adapt to the shape of the object and allow the package to be opened without contaminating the contents. Finally, the wrapper must be cost-effective.
13. Sterile packs are designed for one-time use. Adding materials is a waste of time and space.
14. Use the diagonal method or straight method to double wrap the package to create multiple layers.
15. Such objects make holes in the wrapper that allow microorganisms to enter and they may cause the package to be too tightly wrapped.
16. Preprinted indicator tape, or use an indelible-ink, felt-tipped marker to write the information on the "external chemical indicator" tape.
17. Contents of the package; preparer's initials; designation for the receiving unit; a sterilization control number that usually consists of the sterilizer number, load number, and Julian date of sterilization. Depending on the local policy on shelf life, the label may also include an expiration date.
18. Physical sterilization, chemical sterilization, and ionizing radiation.
19. Pressurized steam sterilization.
20. When all the air is removed and the heat reaches a preset point.
21. They produce great amounts of heat and cannot be used for delicate items made of plastics and rubber.
22. The sterilization cycle.
23. Decontaminate/terminally sterilize used patient care items.
24. Terminal.
25. On their sides.
26. Unsaturated (superheated) steam, wet (over-saturated) steam, incomplete air removal from the chamber, automatic timer failure and other mechanical failures.
27. Check the chamber pressure.
28. Two types.
29. Peracetic acid must penetrate or directly contact all surfaces of items being sterilized, in order for peracetic acid to effectively sterilize, all items must be thoroughly clean and free of grease and oil, cannot be used for long-term storage, this process is designed for "just-in-time" sterilization, you cannot sterilize items that cannot be submersed in liquid, you must avoid contact with the skin because peracetic acid is corrosive and may cause skin irritation.
30. At least weekly.
31. Message screen, status indicator lights, paper printout, and beeps.
32. Yellow.

33. Bulk sterilization of commercial products.
34. Pasteurization, exposure to chemical germicides, and ultraviolet irradiation.

008

1. It reliably identifies the individual and matches the service or treatment to that individual.
2. The patient's full name and date of birth.
3. Preprocedure verification, site marking, and preprocedure time out.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to the Air Force Career Development Academy (AFCDA).

1. (001) What organization is responsible for establishing the hospital accreditation evaluation criteria?
   a. The Joint Commission.
   b. Infection Control Committee.
   c. American College of Surgeons.
   d. Center for Disease control and Prevention.

2. (001) As a minimum, how frequently should area-specific general operating instructions (OI) be reviewed?
   a. Quarterly.
   b. Annually.
   c. Every two years.
   d. As needed.

3. (002) Which of the following most accurately describes an organism that causes infection and disease?
   a. Antigen.
   b. Antibody.
   c. Pathogen.
   d. Micro-organism.

4. (002) Which infectious agents are primitive one-celled, plant-like organisms that reproduce rapidly?
   a. Helminths.
   b. Viruses.
   c. Bacteria.
   d. Fungi.

5. (002) Which infectious agent includes two structural categories known as yeasts and molds?
   a. Fungi.
   b. Virus.
   c. Bacteria.
   d. Chlamydiae.

6. (002) What condition must be present for a virus to multiply?
   a. Water and soil.
   b. Cool and dry.
   c. Warm and moist.
   d. Susceptible tissue.

7. (003) Which stage of infection is the period of time between the invasion of the infectious agent into the body and the onset of symptoms of the particular disease?
   a. Illness.
   b. Virulence.
   c. Incubation.
   d. Convalescence.

8. (003) Which of the following best states the purpose of the standard precautions recommended by the Centers for Disease Control (CDC)?
   a. Prevent the risk of transmission of blood borne pathogens.
   b. Reduce the spread of infectious agents by interfering with the organism's known method of transmission.
   c. Prevent the spread of infectious agents by interfering with the organism's known method of reproduction.
   d. Reduce the risk of transmission of micro-organisms from both recognized and unrecognized sources of infection in hospitals.

9. (003) What should you do if the clothes you are wearing at work become contaminated?
   a. Change into clean clothes before leaving work and throw the clothes in the trash.
   b. Change into clean clothes, bag the dirty clothes and launder them in hot soapy water.
   c. Wipe off the affected area before leaving work and launder clothes in hot soapy water.
   d. Wipe off the affected area, change into clean clothes and throw dirty clothes in the trash.

10. (004) One of the most common and serious complications a female may develop from gonorrhea is
    a. pelvic inflammatory disease.
    b. irregular menstral cycles.
    c. vaginal discharge.
    d. Chlamydia.

11. (004) A health care provider notifies Public Health of a suspected communicable disease by
    a. using the telephone or locally derived form.
    b. completing an Air Force (AF) Form 422, Physical Profile.
    c. paging a Public Health representative to report to the clinic.
    d. faxing a Standard Form (SF) 600, Chronological Record of Patient Care.

12. (005) Which medical term means the absence of infection?
    a. Antimicrobial.
    b. Antiseptic.
    c. Asepsis.
    d. Sepsis.

13. (005) Which substance is used to inhibit the growth and development of microorganisms on living tissue?
    a. Disinfectant.
    b. Antiseptic.
    c. Detergent.
    d. Antitoxin.

14. (006) When using a mask in an isolation unit, put the mask on
    a. after entering the unit, and take it off before leaving.
    b. after entering the unit, and take it off after leaving.
    c. before entering, and take it off before leaving.
    d. before entering, and take it off after leaving.

15. (007) What is the shelf life for sterilized equipment using the event-related method?
    a. 30 days.
    b. 45 days.
    c. 6 months.
    d. When package integrity is compromised.

16. (007) Which is not a commonly used disinfecting agent?
    a. Formaldehydes.
    b. Hydrochloric acid.
    c. Phenolics.
    d. Alcohol.

17. (007) What is the temperature range of the sterilization cycle in a peracetic acid sterilizer?
    a. Between 112 and 121 degrees F.
    b. Between 122 and 131 degrees F.
    c. Between 215 and 230 degrees F.
    d. Between 270 and 285 degrees F.

18. (007) Which item may not be placed in a hydrogen peroxide plasma sterilizer?
    a. Plastic trays.
    b. Count sheets.
    c. Metal instruments.
    d. Nonmetal instruments.

19. (008) What are the standard identifiers associated with the National Patient Safety Guidelines?
    a. Patient's full name and date of birth.
    b. Patient's full name and Social Security Number.
    c. Patient's Social Security Number and date of birth.
    d. Patient's last name, age, and Social Security Number.

20. (008) What are the foundations of safe and effective healthcare?
    a. Risk assessment and control.
    b. Risk management and patient safety.
    c. Proactive risk identification, assessment, and control.
    d. Competent patient-centered care and a culture of safety.

Please read the unit menu for unit 2 and continue ➔

Student Notes

Unit 2. Human Growth, Development, and Health

UNDERSTANDING the principles of human growth and development is a valuable knowledge tool for all health care workers. To provide the best patient care possible, it is also necessary to know about other various concepts relating to health.

2–1. Human Growth and Development

This section addresses the concept of human growth and development, basic needs and body defenses. The first lesson addresses human needs common to all people regardless of their stage in life.

009. Basic human needs

As you provide nursing care for your patients by meeting their needs as a whole person, you are able to achieve a higher level of health for them. Whether a patient is admitted into the hospital or cared for in the clinic, people respond better when treated as a "whole" person. Everyone has certain needs present throughout life. A *need* is defined as *something necessary or desirable for maintaining life and mental well-being.* A noted psychologist, Dr. Abraham Maslow, developed the "Hierarchy of Needs" theory (fig. 2–1). According to this theory, certain basic needs must be met if a person is to survive and function. He proposed a hierarchy of human needs as an explanation for the forces that motivate human behavior. With any hierarchy, the lowest levels are met in succession to reach the top. These needs are arranged in order of importance. The lower level needs must be met before the higher level needs can even be considered. In other words, if the first need in the hierarchy is not met, it does not matter if the others are met, because a person will be focused solely on the lowest unmet need. These basic needs, from the lowest level to the highest, are *physiological (or physical) needs*, *safety and security*, *love and belonging*, *self-esteem*, and *self-actualization.* You may remember how this was applied when you were in tech school. Remember how Maslow's hierarchy of needs was integrated throughout all the patient care processes? As you progress as a Journeyman, you will obtain skills and perform more specialized patient care than the apprentice level. Once those skills are mastered, you will move up to the Craftsman's level where you will be involved in meeting more of the patient's needs as a whole person and incorporate and complete all aspects of their care. In this example, you are moving

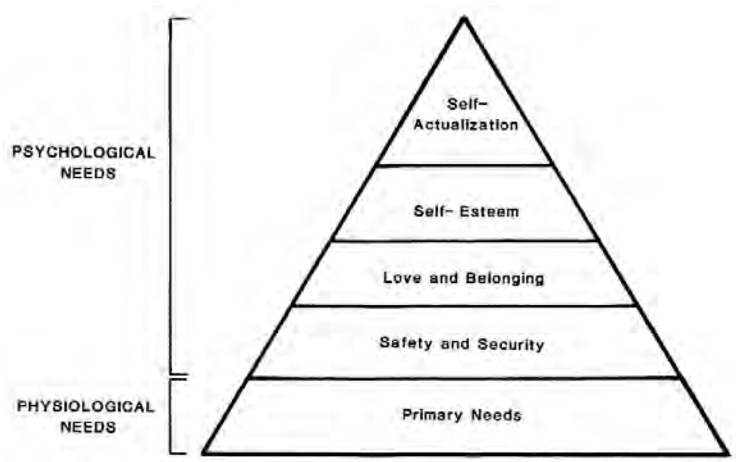


Figure 2–1. Hierarchy of needs.

up the hierarchy of needs at the same time you are enhancing patient care.

Most of the low-level needs are met everyday; however, when they are not, the reason can often be attributed to illness or injury. When these situations occur, people usually seek the assistance of health care professionals. The following information explains each need from lowest to highest in more detail.

Physiological and biological needs

Once a particular need is met, it does not remain satisfied forever. This is most obvious when we are talking about the physiological needs of nutrition, rest, and oxygenation. These elements are met repeatedly. The physiological needs required for life are oxygen, food, water, elimination, and rest. These needs are the most important for survival, and they must be met before higher level needs can be considered. People cannot survive without oxygen but can survive for a short amount of time without food or water, experiencing negative (and eventually life-threatening) effects if the need is not met. Elimination is included with the physiological needs because the kidneys and intestines must function properly to prevent a buildup of poisonous waste in the bloodstream. Finally, without the proper amount of rest, an individual would become completely exhausted and unable to function. When we care for the sick and injured, we not only care for their physiological needs but also provide security, belonging, and self-esteem. The following chart shows an illustration of an evolving hierarchy of needs we can apply to planning our patient's care.

Oxygen and circulation

Basic physical needs are essential to maintaining life. The most important of these basic physiological needs is oxygenation. The body must have adequate oxygenation for proper cardiovascular function to supply the tissues with oxygen. Respirations are the source for oxygenation. Everything begins at the cellular level and oxygenation and the circulation of this oxygen is no exception.

A patient's physiological need for oxygenation can be affected by many things, such as altitude and disease processes. Diseases such as emphysema and chronic obstructed pulmonary disease (COPD) are two examples where the physiological need for oxygen could be compromised. In both disease processes the alveoli lose their shape and become floppy. Less air gets in and less air goes out because:

- The alveoli lose their elasticity (like an old rubber band).
- The walls between many of the alveoli are destroyed.
- The walls of the airways become thick and inflamed (swollen).
- Cells in the airways make more mucus (sputum) than usual, which tends to clog the airways.

Signs and symptoms can include the patient's use of accessory muscles, monitor tracings, and through bloodwork results. Bloodwork results offer significant clues to a health care provider about the patient's ability to oxygenate and what treatment to implement for the patient's recovery. Without circulation, the body can inhale and exhale air all day long, but it will not sustain life. The blood is what transports the oxygen and carbon dioxide between the lungs and the body cells. As these gasses enter the blood, they dissolve in the plasma or combine chemically with other atoms or molecules. The alveoli provide the capillary network necessary for this exchange of gasses.

The PaO_2 determines the amount of partial pressure of oxygen that combines with hemoglobin. The greater the PaO_2, the more oxygen that can combine with the hemoglobin for circulation. Almost all oxygen in the body (98 percent) is carried in the blood, bound to the protein hemoglobin in the red blood cells. The remaining 2 percent is dissolved in the blood plasma. For the circulatory system to carry oxygen to the body tissues, we must be able to produce enough red blood cells (RBC). The good nutrition of an individual greatly increases the body's ability to produce the RBCs we need to carry the vital oxygen throughout the body.

Nutrition and elimination

Following closely behind oxygenation and circulation is nutrition and elimination. Good nutrition enables proper body functions and the end result is to help ease recovery time for the patient.

Nutrition covers a broad spectrum of vitamins, minerals, chemical reactions with cells, and of course, the ability to eliminate the excess waste the body does not need. Many diseases affect the physiology of the body's cells and their function. As discussed previously, all things begin at the cellular level. Nutrition is the basis for most cells, acquiring the necessary molecules they need for proper function. The body relies on RBCs to produce hemoglobin for oxygen to bond to. The hemoglobin then is transported to the body tissues and cells in need of the oxygen. The availability of two B-complex vitamins significantly influences RBC production.

Vitamin B_{12} and folic acid are the B-complex vitamins necessary for the production of RBCs. These vitamins are also required for deoxyribonucleic acid (DNA) synthesis, thus being needed for the growth and reproduction of all cells. Cellular reproduction occurs at such a high rate in hematopeitic tissues that tissue is extremely vulnerable to the deficiency of either of these vitamins. The lack of B_{12} is usually due to a disorder or disease process that prevents the stomach lining from absorbing the B_{12} rather than a dietary deficiency.

Along with B-complex vitamins, iron is necessary for hemoglobin synthesis. Iron is absorbed slowly from food in the small intestine. Just a small portion is absorbed even when the food contains an abundance of iron. The rate of absorption is directly related to the amount of iron the body currently has in it. If the body is low on iron, the absorption rate will increase. When a patient is anemic, this reduces the oxygen-carrying capacity of the blood, giving the person a pale appearance and a lack of energy.

Nutrients in the plasma portion of the blood are also very important. Plasma nutrients include amino acids, simple sugars, nucleotides, and lipids absorbed through the digestive tract. Blood plasma transports glucose from the small intestine to the liver where it may be stored as glycogen or altered to form fat cells. Amino acids are also carried to the liver where the amino acids are synthesized into proteins to be used as an energy source.

Plasma lipids include triglycerides, phospholipids, and cholesterol. Because lipids are not water soluble, the lipids combine with proteins in lipoprotein complexes. Lipoproteins are classified into four groups based on their density, which reflects their composition. *Chylomicron* consists mainly of triglycerides absorbed from the small intestine. *Very low-density lipoproteins* (VLDL) consist of a relatively high concentration of triglycerides. *Low-density lipoproteins* (LDL) consist of a relatively high concentration of cholesterol and are the major cholesterol-carrying lipoprotein. *High-density lipoproteins* (HDL) consist of a high concentration of protein and a lower concentration of lipids. The following table reviews the characteristics and functions of each of these lipoproteins.

Lipoprotein	Characteristics	Functions
Chylomicron	High concentration of triglycerides	Transports dietary fats to muscle and adipose cells
Very low-density lipoprotein (VLDL)	Relatively high concentrations of triglycerides; produced in the liver	Transports triglycerides synthesized in the liver from carbohydrates to adipose cells
Low-density lipoprotein (LDL)	Relatively high concentrations of cholesterol; formed from remnants of VLVL molecules that have given up their triglycerides	Delivers cholesterol to various cells, including liver cells
High-density lipoprotein (HDL)	Relatively high concentrations of protein and low concentrations of lipids	Transports remnants of chlyomicrons that have given up their triglycerides to the liver.

The chlyomicrons transport dietary fats to both muscle and adipose tissues. The chlyomicrons are then used as energy or stored as fat. In a similar manner, VLDL transport triglycerides that have been synthesized from excess dietary carbohydrates to adipose cells; the remnants are converted to LDL. Because most of the triglycerides have been removed, the LDL molecules have the higher cholesterol content. Cholesterol content is one of the contributing factors to many coronary disease processes. The HDL molecules formed in the liver and small intestine transport the chylomicron remnants back to the liver. The liver disposes of most of the cholesterol by secreting it into the bile. These bile secretions are later reabsorbed largely by the small intestine and back to the liver. The secretion-reabsorption cycle of the cholesterol and bile secretions are constantly repeated. During each cycle some of the by-products of bile salts and cholesterol reach the large intestine and are eliminated with the feces.

Activity and rest

The physiological need for rest is not just the action of “lying around” but also includes the freedom from pain. Patients constantly in pain are unable to fully rest. Lack of rest may increase their fatigue and possibly inhibit their recovery time. Medications are just one way to promote pain-free rest for a patient. Another avenue of meeting the physiological need for rest may be as simple as good personal hygiene. For patients who have been on bed rest, either partial or complete, may be unable to take a full shower, wash their hair, or just simply brush their teeth. When we as health care providers take the extra time to assist them in accomplishing these tasks patients are more comfortable and feel rested. The better individuals feel about themselves, the more we can promote a speedy recovery. Following pain-free rest, good hygiene also helps provide rest and comfort. This adds a measure of safety and protection against the invasion of bacteria.

Musculoskeletal activity is also a basic physiologic need. Through proper ambulation or range-of-motion (ROM) exercises we can promote a quick recovery for our patients who suffer from possible muscle atrophy or contractures. Therefore assisting or even teaching our patients these movements helps to provide normal function of the muscles and joints. The guideline to providing/teaching ROM exercises is as follows:

- Move the body part enough to stretch the muscles and keep the joint flexible. Avoid moving the body part to the point of discomfort.
- Perform ROM exercises as prescribed, usually at least twice a day, or more if tolerated.
- Support the extremity above and below the joint when performing passive exercises of arms and legs.
- Each exercise should be performed a minimum of 3–5 times, either actively or passively.
- Involve patients in planning their exercise routine and encourage active performance of the exercises, if allowed and when recovery returns to normal.

As patients feels their physiological needs are being met by the health care team, they begin to progress to the next stage of the hierarchy of needs. According to Maslow, safety is one aspect in the second tier of hierarchy. When integrating Maslow’s hierarchy and the patient care plan, safety can be considered as one of the basic psychological needs. If patients cannot be protected from the dangers of a battlefield or the environment attending, their safety and security as well as potential physiological needs may not be met. Protection from physical harm, whether from themselves or an outside source, fits the security Maslow is referring to in his hierarchy of needs in the second level of safety and security.

Safety and security

After all physiological needs are met, the need for a safe environment takes precedence. Safety and security needs are simply the need for shelter, clothing, and protection from harm and danger. The need for safety has both physical and psychological aspects. Everyone needs to be and feel safe in his or her own physical and emotional environment. Security for most adult patients mainly depends on the reassurance that their physiologic and safety needs will be met. When there is a structured recovery process established along with a peaceful environment, we as health care providers increase the sense of security for the patient. This security will help to decrease anxiety and fear of being in the hospital. Both children and elderly patients are particularly susceptible to stress created by an unfamiliar, disorderly, or hazardous environment. People value order, routine, and rhythm in their daily lives and thrive better in an environment in which they believe these things to be true.

Adults who suddenly become ill might be anxious about finances, loss of control, change in their body image, and what may happen to them in the future if they must cope with the effects of a permanent disabling illness or injury. For the nursing staff, emotional support for the patient is very important. Active listening on the part of the medical technician and health care staff is essential to meeting the patient's security needs. When patients feel that their needs are being accurately perceived, they feel secure with the health care provided.

Love and belonging

The next level—once physiological, safety, and security needs are met—is the need for love and belonging. To meet this need, a person must feel love, closeness, and affection. He or she must also be able to establish and maintain meaningful relationships with others. Communication is the method by which human social interaction takes place and is therefore very important. Meeting the patient's need for belonging can be provided through the means of communication, encouraging, sharing thoughts and feelings, and answering as many of the patient's questions as possible. This is the primary principle of good nursing practices. A health care provider can frequently meet the basic physiologic needs (oxygenation, nutrition, limited activity) of a conscious, coherent patient without communication. It is very difficult to meet the other levels of their needs (self-esteem, belonging) without good communication. Through adequate feedback, clarification and validation of the communication, patients are able to play a part in their own health care. Patients who take part in their rehabilitation and recovery are given the sense of belonging necessary to move to the next level of self-esteem.

Self-esteem

Once the physiological, safety, security, and love and belonging needs are met, we can move onto self-esteem. Esteem is the worth, value, or opinion one has of another person. Self-esteem relates to both how they feel about themselves as well as how others feel about them. When an individual receives praise for a job well done, it helps to establish a sense of self-worth, which aids in building self-esteem.

Self-esteem and love are interrelated. It is apparent that one cannot truly love others until one first loves and accepts oneself. Self-esteem is developed from feelings of independence, competence, self-respect and recognition from others. Many people achieve these goals through various roles in life (e.g., husband, wife, father, mother, community leader), which all contribute to self-esteem. For many, spiritual belief systems are an integral part of their sense of self and their ability to maintain relationships as they fulfill the need for love. Within the hospital setting, patients may look to their health care team to provide some levels of self-esteem and love.

Mental stimulation, motivation to seek knowledge, and learning all play a role in personal self-esteem. You and the health care team must take on the teacher role when performing all aspects of the patient care plan. By teaching the patient and the family the plan, you offer the building blocks for the patient to reach the final goal of the care plan. This is instrumental in helping the patient rebuild feelings of competence, independence, and self-respect. While you do not provide the patient with the love through a personal relationship, you are able to provide the necessary tools to promote the patient's involvement in his or her care while in the hospital and at home.

Love consists of both the giving and receiving of that love. An example of the need for love is the bond between an infant and the parents. An infant will withdraw and spiral to a deteriorating state without love despite having its physiologic needs met. You may have heard this described as a “failure to thrive” baby. In other cases, prolonged deprivation of love and nurturing can bring about neurotic behavior and organic illness. The nursing team needs to assist patients in finding a way to fulfill the need for love. Your responsibility is to make sure you listen and observe your patients and report findings to the nurse or health care provider. Once identified, appropriate treatment, counseling, or referral service appointments can be initiated. Mental health professionals are often able to assist the patient in this area.

Self-actualization

The highest level in the hierarchy is the need for self-actualization. Self-actualization cannot be reached until the lower levels of the hierarchy are met. This level is seldom reached. However, once reached, self-actualization is normally limited to a short period of time, due to the ever-changing goals and decisions of an individual. Nursing actions that facilitate the self-actualization of an individual are pertinent mainly during rehabilitation. This is when the nursing care team assists the patient to strive to achieve full *potential* of recovery, not necessarily full recovery. Keep in mind, the patient’s behavior is based on what he or she perceives to be a need and how highly the patient values the satisfaction of that need. A patient who is severely injured and knows he or she will endure significant hours of rehabilitation to walk may work very hard to meet the goals or he or she may be satisfied in being confined to a wheelchair the rest of his or her life. In this case, the need/goal for recovery set out by the health care team (to walk) is not the need of the patient (content to stay in a wheelchair), and the patient’s behavior will convey this belief.

Meeting the patient’s basic human needs is only part of treating and caring for your patient. Implementing interventions to aid in his or her recovery are also very important. For the patient admitted onto the unit, the nursing process is a systematic method used to identify a patient’s problem and methodically organize interventions needed to assist the patient to the expected outcome of recovery. This means experiencing one’s full potential. Self-actualization involves reaching one’s full potential by learning, understanding, and creating to the highest limit. As previously stated, this need is rarely met in its entirety, which, in reality, is probably a good thing. It is good because it inspires people to continue to learn, grow, and accomplish more all the time.

Determining where an individual is on the hierarchy

It is important to understand the entire hierarchy of needs is a continuum. In other words, at any given moment, an individual might be completely involved in the need for self-actualization and suddenly be at a lower level on the pyramid. On the other hand, people can frequently be elevated to concerns for the higher levels when the lower level needs are automatically met. The following example will assist in illustrating these points:

> *A man who works for a computer software design company is on the verge of creating a revolutionary new product. His company is fully supporting him, as are his coworkers. He is involved in what may be the most creative period of his life up to this point. He is obviously focused on the need for self-actualization.*
>
> *During a lunch break, the man begins choking on a piece of food and cannot breathe. On which need is his attention solely focused now? Obviously, his attention is devoted to the primary, lowest level of the hierarchy. His immediate physiological need for oxygen causes him to completely disregard any of the higher level needs. Once he is able to breathe again, his attention can jump back up the pyramid.*

Here is an overview of what we have covered in this lesson starting at the top of the hierarchy and working our way down to the basics. Remember, Maslow’s theory is just that—a theory—; however, it has been accepted for many years as a logical part of human nature. Being aware of these human needs will heighten the awareness level of all medics, and your increased awareness will result in excellent patient care, a high degree of patient sensitivity, and the ability to understand and improve your own well-being.

010. Human growth and development

The terms *growth* and *development* are both dynamic processes. Growth refers to the physical changes that can be measured and occur in a steady and orderly manner. Height and weight are two examples. Development relates to changes in psychological and social functioning. Different age groups generally act appropriately for their age. Certain developmental tasks should also be accomplished during each stage. Each stage lays the foundation for the next.

Growth and development occur from the moment of fertilization until death. The processes proceed from simple to complex. There is a sequence, order, and pattern to growth and development. This lesson explains nine age groups and the growth and development stages that usually occur in each stage. Though some people may either be slightly ahead of or behind these general expectations, an average view of each group is covered in this lesson. Understanding these expected characteristics is important for those involved in patient care. Knowing appropriate growth characteristics can help to identify abnormalities. Awareness of expected developmental characteristics serves to anticipate behavior for patients of various ages.

Infant growth and development—birth to one year

Rapid physical, psychological, and social development characterize this period. The developmental tasks that have been identified for this period are developing stable sleep patterns, beginning to have emotional relationships with parents and siblings, beginning to talk and communicate with others, learning to eat solid foods, and learning to walk.

Average newborns weigh seven to seven and one-half pounds and are 20–21 inches long. Their birth weight usually doubles by the fifth or sixth month, and by the end of the first year, their weight triples and they should also grow 10–12 inches in the first year.

The newborn's central nervous system is not well developed. Movements are uncoordinated and generally without purpose. As the nervous and muscular systems develop, the infant develops specific voluntary and coordinated movements. Certain reflexes and involuntary movements normally are present and disappear as the central nervous system develops.

Reflex	Explanation
Moro **(startle reflex)**	Occurs when an infant is frightened by a loud noise or sudden movements. The infant reacts by extending the arms and legs outward, then suddenly retracting the limbs.
Rooting	Is necessary for feeding; it helps guide the infant's mouth to the nipple. This is accomplished when the infant's cheek is touched.
Sucking	Occurs when the infant's lips are touched.
Grasping	Is present at birth and occurs when the palm of the infant's hand is stimulated, causing the fingers to close around an object. This reflex begins to subside around the second month and disappears around the third month.

Infants can see at birth, but their vision is not clear. They respond to bright objects. They can also hear well and are startled by loud noises and soothed by soft sounds. At birth, they respond to touch and their senses of smell and taste are developed.

During the first six months of life, the infant's diet usually consists of breast milk or formula. Solid foods, such as strained fruits and vegetables, are gradually added to the diet about the sixth month. Around the eighth month, the infant normally advances to junior foods, still remaining on breast milk or formula until one year of age. Table food usually is introduced at the end of the infant stage. Note the various stages of development during the first 12 months of an infant's life:

Months	Infant Development
1	Can hold their head up while lying on their stomach.

Months	Infant Development
2	Can smile and follow objects with their eyes.
3	Can raise their head and shoulders while lying on their stomachs, sit for a short time, and hold an object in their hand.
4	Can roll over, sit up when supported, and may sleep all night. The Moro and rooting reflexes have disappeared by this time. The infant can hold objects with both hands, puts objects in the mouth, and babbles when spoken to.
5	Can grasp objects and play with their toes. Teeth begin to erupt at this point.
6	Usually have two lower front teeth and begin to chew finger food. They are able to hold a bottle for feeding and can sit alone for short periods of time. By this time, the infant can manipulate small objects and can vocalize one-syllable sounds.
7	Upper teeth begin to erupt. Infants can respond to their name and begin to show a fear of strangers. They can transfer objects from one hand to another. They also begin to imitate simple acts and sounds.
8	Can usually stand while holding onto something, they respond to the word "no," and cry when scolded. They can feed themselves finger food and reach with open arms to be picked up. At this point, the infant is usually bashful and nervous with strangers.
9	Crawls and can pull to a standing position. They comply with simple verbal commands and can communicate with hand gestures (such as waving). They also show a fear of being left alone, which may be evident when going to bed.
10	Can walk while holding onto objects, will look under objects for a toy, and can pull themselves to a sitting position. Infants are also aware of their own names by this age.
11	Can stand momentarily and can play interactive games using body language. They also communicate disapproval by shaking their head "no."
12	Begins to walk with help and can hold a cup for drinking. Demonstrates emotions such as anger and affection, and cling to parents in unfamiliar situations.

Toddler growth and development—one to three years

Physical growth is not as rapid during the second year of life as it is during the first year; however, the rate of development increases dramatically.

At one year, visual acuity is fairly well established. Between the ages of one and two years, toddlers grow approximately four to five inches. Fine muscle coordination and gross motor skills improve during the toddler years. At about 18 months, they can walk up stairs with assistance and pick up small objects and place them in a receptacle.

Several other things also occur with toddlers at the two-year point:

- Can be expected to weigh four times the birth weight.
- Lose most of their "baby look"; they are usually chubby, with relatively short legs and a large head. They have a protruding abdomen, which flattens as the child grows and the abdominal muscles develop.
- Can use a spoon correctly, are able to run, balance on one foot, and ride a tricycle.

Toilet training is a major developmental task for the toddler. Bowel and bladder control is directly related to the development of the central nervous system. By three years, most children are toilet trained, although they may still have accidents while playing or during the night.

Speech and language skills begin to increase by age three. Speech becomes clearer, and the vocabulary increases as words are learned by imitating others. Toddlers understand more words than they use and are capable of constructing two- to three-word sentences. They begin to play alongside other children but not with them. They are very possessive and do not agree with the concept of sharing. The word "mine" is used frequently. Temper tantrums are the way toddlers deal with frustration. They often respond to discipline by kicking and screaming.

At three years, the integration of visual and neuromuscular mechanisms is fairly well developed. This allows a child to look away from an object prior to reaching out and picking it up. Also, the senses of hearing, taste, smell, and touch become more developed and associated with each other. Hearing in the three year old is at adult levels. Touch is extremely important to toddlers; they are often soothed by tactile sensations.

Preschool growth and development—three to six years

The preschool stage is characterized by less physical growth than the toddler stage. Both gross and fine motor skills are fairly well developed. In this stage, the child shows increased independence and intellectual development. Preschoolers are less quarrelsome than the toddler; they are developing a sense of right and wrong, and they usually try to comply with the rules.

Growth is steady but slow at this stage. Height usually increases by two to three inches per year and weight increases about five pounds per year.

At three years old, play is very important. They usually play in a group of two or three children and are able to share toys. They play simple games and can follow simple rules. They may create imaginary playmates if there is no one to play with. They may also begin to imitate adults by playing “house” and “dress-up.” Three-year-olds also begin to understand time and begin to speak in the past, present, and future tenses. They become less fearful of strangers and can tolerate separation from their primary caregiver for short periods of time. At age four, children can hop, skip, jump, and catch a ball. They can lace their shoes, draw faces, and try to print letters. Four-year-olds can bathe with supervision and take care of toileting needs with some help. Their vocabulary increases to about 1,500 words. They ask numerous questions and exaggerate when telling stories. They can sing simple songs, count to (at least) three, and name a few colors.

At four years, children tend to verbally attack others by teasing or tattling on them. They may also physically attack others. They are proud of their accomplishments but can be very moody. They have a strong preference for the primary caregiver of the opposite sex, and rivalries exist between siblings.

At five years, coordination continues to develop. These children can jump rope, skate, dress, and bathe. They can print a few letters and numbers and their first name. The ability to communicate also increases. Vocabulary consists of about 2,100 words. Sentences now consist of six to eight words, and more meaningful questions are asked. They may request definitions for unfamiliar terms and try to participate in conversations. Five-year-olds can name the days of the week, the months, and four or more colors. They are more responsible, truthful, and quarrel less. They strive to do things the right way and begin to develop manners. These children also enjoy simple games. They enjoy adults during play and have a greater interest in watching television. They also enjoy spending time with their parents as well as activities such as housecleaning, shopping, yard work, and sports. They are more tolerant of younger siblings and are usually protective of them. Although they have fewer fears, they may experience occasional nightmares.

Middle childhood growth and development—six to eight years

Physical growth during this stage is rapid. School is the greatest event that takes place during this stage. The child is exposed to a whole new world with new values, ideas, and challenges. Height increases at a rate of one to two inches per year, and weight increases at a rate of three to six pounds per year. Body proportions continue to change and become more adult-like. Body fat decreases and muscle and bone mass increase. Primary teeth are replaced by permanent teeth.

At six years, children have a vocabulary of about 2,500 words. They know all the letters of the alphabet and can usually read and spell. They play well with others but prefer playing with children of the same sex. Their play interest includes collections, cards, paints, games, and so forth.

At seven years, excellent eye-hand coordination is evident. Children learn to write in cursive rather than print. They enjoy quiet time alone and are more serious and concerned about being liked by other children. They are very sensitive and do not like being teased or criticized; they enjoy school and learning, especially reading; and their play activities include swimming, biking, working puzzles, and playing ball.

At eight years, children continue to be physically active. Movements become faster and more graceful. The process of learning continues to develop as they become curious about science, history, geography, and so forth. Social opportunities with peers are enjoyed. This age group has interests in fads, opinions, and activities involving peer groups. Eight-year-olds develop manners, relate well to adults, and participate in adult conversations. They are also friendly and affectionate.

Late childhood growth and development—nine to twelve years

Late childhood is also known as preadolescence. During this stage, males grow at a rate of one inch per year and gain about three to four pounds per year. Females grow at a rate of about two inches per year and gain between four to five pounds per year. Body movements are more graceful and coordinated, and there is an increase in physical skill.

The developmental tasks are similar to middle childhood; however, the preadolescent is expected to be more mannerly and refined. By age 12, the child uses about 7,000 words and can understand about 50,000 when reading. Interest in science, history, and geography continues and the use of reference books, such as the encyclopedia and dictionary, increases.

The preadolescent begins to question the authority of adults and often rebels against authority. The peer group is the center of the preadolescent's activities. The group influences the attitudes and behaviors of the child. They still prefer companions of the same sex; however, the association between girls is stronger than that of boys.

Adolescent growth and development—12 to 20 years

Adolescence is the stage of life between school age and adulthood. The adolescent is neither a child nor an adult, yet has characteristics of each. It is a period of growth, change, and emotional crisis. This is usually the period of separation from the parents and the establishment of lifetime goals. Adolescence is the last period of significant physical growth during the lifetime of a person. You grow in height and weight and mature sexually.

Usually, females have entered into puberty by age 12, but boys usually enter puberty around age 13. Body changes begin to occur due to the onset of puberty. Girls begin to develop breasts, the pelvis broadens, and fat appears on the hips and chest. Boys show fewer signs of maturing sexually at this time.

Some females may experience the onset of puberty as early as 10 years of age; most begin at age 12. This period is marked by *menarche*, the beginning of menstruation. Secondary sex characteristics appear, including increase in breast size, the appearance of pubic hair, and a slight deepening of the voice. During this stage, girls grow an average total of two to eight inches and gain anywhere from 15–50 pounds. They usually stop growing around age 18, but some will continue to grow until 21 years of age.

Puberty in males is signaled by *nocturnal emissions*, which occurs during sleep when the penis becomes erect and semen is released. Other secondary sex characteristics begin to develop, such as the appearance of facial hair, axillary hair, hair on the arms, chest, legs, and deepening of the voice. During this stage the male will grow an average total of four to twelve inches and gain about 15–60 pounds. The male will usually stop growing around age 21, but some may continue to grow until age 23.

The adolescent is often awkward and clumsy. This is due to the uneven growth of muscles and bones. As the muscles and bones develop, so do more graceful and coordinated movements.

Emotions vary in the adolescent from high to low. They can be happy one minute and sad the next. Teenagers begin to control their emotions as they progress toward adulthood.

Adolescents need to become independent of adults, especially parents. Many work towards adulthood by having a part-time job, baby-sitting, and dating. Adolescents usually begin dating at this time and become more concerned with personal appearance. They spend a lot of time talking to friends on the phone, listening to music, and reading popular magazines. They still need guidance, discipline, and support from parents, although arguments and disagreements are common at this stage of development. Teenagers often would rather be with their peers than with their parents.

Adolescents begin to think about careers and college. Their interests and skills influence the choice of further education or seeking employment. Many social factors influence adolescents, such as parents, friends, television, culture, and school. In cases of troubled teens, common problems may include alcoholism, drug abuse, unwanted pregnancy, and criminal acts.

Normally, at the end of this stage, adolescents have developed into young, self-sufficient adults. They usually are totally emancipated from parents and have established goals and individual lifestyles.

Young adult growth and development—20 to 40 years

During this stage, the young adult continues to mature physically and emotionally. One of the main goals in young adulthood is choosing a career or occupation. Many career choices involve extensive education. The young adult may still be in school when he or she reaches this stage. Education enhances employment opportunities and helps to ensure economic stability. Entering a career usually means starting at the bottom and working upward. The young adult is faced with proving his or her abilities to older adults.

Another goal for the young adult is choosing a partner. Most young adults need to feel a sense of love and belonging that comes from having a long-term relationship. Many factors influence the selection of a partner, such as age, interest, religion, and most importantly, love. These two people must work together to build a loving relationship based on trust, respect, caring, and friendship. Most couples decide to have children. They must agree on child-rearing practices and discipline methods. Starting a family involves a major change in lifestyle, and both must be ready to accept these changes.

During young adulthood many changes occur, both mentally and physically. After age 30, some physical deterioration will start, but it is usually gradual and not very noticeable. At the end of this period, young adults are close to accomplishing the goals of youth. They have made their place in society and are ready to move toward the next stage of life.

Middle adult growth and development—40 to 65 years

Middle adulthood is usually a time when people look back at the goals that have been accomplished so far. The adult is now mature mentally and physically. He or she has usually met most of his or her goals and now must guide others in doing the same.

During this time, many physical changes begin to occur. The hair begins to turn gray. Metabolism slows, resulting in a potential weight problem. Women experience *menopause*, which is the cessation of menstruation. They can no longer bear children. Calcium loss is common among women in this age group. Men experience a decrease in hormones, which can lead to a decrease in sex drive as well as thinning of the hair.

Adults have more time for themselves during this stage. Their children are growing up or have already grown up. Another factor middle adults may have to contend with is caring for elderly parents. This may result in the parents either moving in with them or possibly being relocated to a nursing care center.

Late adult growth and development—65 years and older

An increase in life expectancy has led to the creation of gerontology, which is the scientific study of the problems of aging. This science includes biological, psychological, and sociological aspects.

A change in the appearance and the texture of the skin is a normal process of growth. The skin of the elderly person is usually thin and delicate and extremely sensitive to trauma. Proper skin care for the elderly is very important. As the aging process occurs, there is a normal loss of subcutaneous (SC) fat near the skin surface. The loss of fat and the hardening of small arterioles cause the skin to become wrinkled. Decreases in blood supply and a gradual atrophy of the sweat glands and excretory functions result in the skin becoming dry and more susceptible to infection.

Another physical change is the decline in stamina. With age, all body cells change and undergo progressive deterioration. Body tissues gradually become less active. Unused muscles begin to atrophy and contribute to the decline of physical stamina.

There are also changes in the blood vessels. A loss of elasticity and/or the buildup of fatty deposits will limit the amount of oxygen that can get to the cells. The veins lose their strength, and valves weaken and often become distended. The loss of muscle tone and reduced physical activity will also affect the efficiency of the vessels. It is unknown if the changes that occur are due to simple aging or some other pathological cause. Some contributing factors may include trauma, obesity, malnutrition, and stress.

Psychologically, the aging adult needs respect, security, and self-esteem. The elderly need to feel appreciated and valued by others. There may be many emotional adjustments that the elderly have to deal with, such as the death of a spouse, children, or friends. Socioeconomic losses and the loss of health are also major psychological adjustments the elderly have to make.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

009. Basic human needs

1. According to Maslow's "Hierarchy of Needs" theory, in what category would the ability to breath without problems be located?

2. What vitamins are necessary for RBC production?

3. What lipids are found in blood plasma?

4. Which type of lipoprotein has characteristics of having relatively high concentrations of cholesterol?

5. What is the *minimum* number of times ROM exercises should be performed?

6. Shelter is a consideration that falls into which need category?

7. What is the third level of needs on Maslow's Hierarchy?

8. Which need is satisfied when people are able to establish and maintain meaningful relationships?

9. What need relates to how others feel about you?

10. Define self-actualization.

010. Human growth and development

1. During what stage of life does the development of stable sleep patterns occur?

2. During late childhood, how many words are children capable of understanding?

3. What ages are included in the adolescent stage?

4. At what stage of life does physical deterioration start?

5. During what stage of life do people often look back at the goals they have accomplished so far?

2–2. Factors that Influence Health

Health is more than a concept. Humans are concerned continually with their own health and the health of family and friends. This section addresses human health in a broad perspective, with the primary focus on various factors that influence health.

011. Environmental and community health

Some factors that negatively influence health are inborn, or hereditary. Some of these factors are not within the specific control of individuals, while others are controllable. This lesson addresses one of the categories of factors that influence health.

The health of patients, as it relates to both the environment and community health, includes areas where health care personnel can be very involved. Many programs currently in place are designed to help ensure a healthy patient care environment. Additionally, programs designed to improve the health of a community are relied on as important preventive programs.

Environmental health

Florence Nightingale established a theory linking health with various environmental factors. This theory links the health of patients to the following controllable factors:

Environmental Factor	Examples of Ensuring a Positive Outcome in Patient Care Areas
Pure or fresh air	• Keep windows closed; allow hospital ventilation system to filter air. • Promptly report ventilation system problems to proper personnel. • Perform routine cleaning to eliminate unfavorable odors. • Assist patients to designated outside break areas when permitted.
Pure water	• Ensure patient water pitchers are only used for drinking water. • Keep water pitchers covered. • Change drinking water in pitchers frequently.
Efficient drainage	• Remove waste from patient rooms/care areas frequently. • Remove food trays promptly after use. • Promptly report mechanical problems in restrooms to proper personnel.
Cleanliness	• Ensure patient hygiene standards are strictly adhered to. • Ensure health care workers and patient visitors are in observance of proper hygiene. • Ensure appropriate aseptic techniques and infection control guidelines are followed.
Light (especially direct sunlight)	• Open curtains to patient rooms during daytime when practical. • Ensure adequate and proper functioning of artificial lighting in patient rooms/care areas.

Additionally, Nightingale stressed the following important considerations that health care personnel must be attentive to when caring for patients:

Environmental Factor	Examples of Ensuring a Positive Outcome in Patient Care Areas
Keeping the patient warm	• Report any heating/cooling problems to proper personnel; follow-up to ensure necessary adjustments are made. • Ensure adequate hospital clothing is available for patients. • Use blankets as needed. • Eliminate drafts wherever possible.
Maintaining a noise-free environment	• Keep doors to patient rooms/care areas closed whenever possible. • Ensure patients are not disturbed by other patients, visitors, or televisions in combined or adjacent rooms. • Enforce quietness in hallways.
Proper diet	• Ensure diet orders are followed. • Report patient preferences and/or dissatisfaction with meals to proper personnel. • Ensure diet counseling by proper personnel is offered when needed.

These tables include (but are not limited to) examples of how a medic can be actively involved in promoting a healthy patient care environment.

Medics are able to directly control some of the factors listed above. For those factors not within the direct capability to be controlled by medics, it is important to keep in mind that responsible offices or departments must be notified through proper channels when problems are noted.

Community health

Various programs have been established that are designed to enhance the health of a community as a whole. When a community is healthy, the chances of a widespread health problem diminish greatly. The Office of the Air Force Surgeon General is very concerned with implementing programs that can improve the health of the military community. The same is true in the civilian sector.

Heart disease is a major concern of the health care community. A key point to keep in mind is that various factors can increase the risk of heart disease in an individual. Some of these factors cannot be controlled, while others can. The following table includes a list of these factors:

Risk factors that cannot be changed	Risk factors that can be changed or modified in most cases	Additional contributing risk factors that may or may not be changed
• Heredity • Gender • Age	• Cigarette smoking • High blood pressure • High blood cholesterol • Physical inactivity	• Diabetes • Obesity • Stress

Some of the programs that are in place to help ensure a healthy community are shown here in this table:

Programs	Include
Work-site wellness	Such programs as air quality standards for businesses and classrooms, high blood pressure screenings, and specific accident prevention programs.
Environmental control	The monitoring and/or eliminating of various environmental hazards. Specifically, contaminants that can have an adverse effect on air, food, or water are concerns that are addressed in an environmental control program.
Health and wellness	One of the most effective ways to educate a population on health hazards and healthy living is through the dissemination of information. This technique includes the use of pamphlets, advertisements, or briefings designed to increase the awareness level of a community on various topics. Health and wellness programs are designed to accomplish two major objectives. The first is to assess the current health status of people. This includes an assessment of current fitness status, as well as an individual medical history (to include a history of illness in the family). The second major objective of a health and wellness program is to provide the education and services necessary to help an individual attain and maintain the healthiest lifestyle possible.
Immunizations	Are important on both an individual and community basis. Advances in medicine have made it possible to immunize people against many diseases that could either be life threatening or costly to treat if incurred. Additionally, the outbreak of many contagious diseases can be prevented through established immunization programs. When the majority of a population is adequately immunized, the risk of an epidemic is reduced greatly.

012. Nutrition and exercise

Nutrition and exercise play key roles in an individual's health. Various trends can be predicted for a population as a whole by studying the nutritional and exercise habits of the people. For example, in a country such as the United States, an over consumption of fast foods is believed to be a contributor to the amount of heart disease cases due to an unhealthy intake of fats and preservatives. Some third-world nations that are continuously plagued by a lack of available nutrition will often exhibit a lowered life expectancy for their populations.

Nutritional facts

Just as a car needs gasoline as its fuel to run the engine and warm the car, the body must be furnished food (calories) to meet energy requirements and release the heat required to regulate body temperature. A calorie is a unit for measuring energy. We use kilocalorie (1000 calories) when food is involved because the amount of energy is much larger; therefore, the energy requirement of the body is expressed as the *caloric requirement*.

The calorie is the name of a standard unit for measuring heat. Since the body produces heat in energy expenditure, the calorie can serve as a measure of energy metabolism. In addition, each food has a specific caloric value: a given amount of a specific food will yield a certain amount of heat when metabolized (burned). This amount of heat is expressed as the number of calories. Of all the nutrients; proteins, fats, and carbohydrates are the only ones that the body can use as fuel sources; however, other nutrients must be present to release the energy. The caloric yield of a food depends on how much of these four nutrients it contains. The following values have been established:

- One gram of protein yields four calories.
- One gram of carbohydrate yields four calories.
- One gram of fat yields nine calories.
- One gram of alcohol yields seven calories.

Nutrients

Nutrients are substances provided primarily by food. Nutrients function to provide heat or energy (as we have seen), build and repair tissue, and regulate life processes. Failure to include even one of these nutrients in the diet can result, over a period, in severe health problems that may eventually lead to disease and/or death. In this section, we discuss carbohydrates, proteins, fats, vitamins, minerals, water, and fiber. We will also review the recommended allowances and identify sources for obtaining these nutrients.

Nutritional guidelines are established to help provide information pertaining to the body's essential needs. Water is the body's most basic and necessary nutrient.

Guide to healthy eating

The United States Department of Agriculture (USDA) developed a chart that shows the six food groups and serves as a guide for making healthy eating choices (fig. 2–2). Even though this chart is several years old, it serves as a good visual aid of what an average diet should look like. Adjustments to the servings per day and serving size should be made for individuals who are participating in intensive athletic or physically demanding activities (hence the large amount of calories in the MREs [Meals Ready to Eat] used in field situations). Adjustments

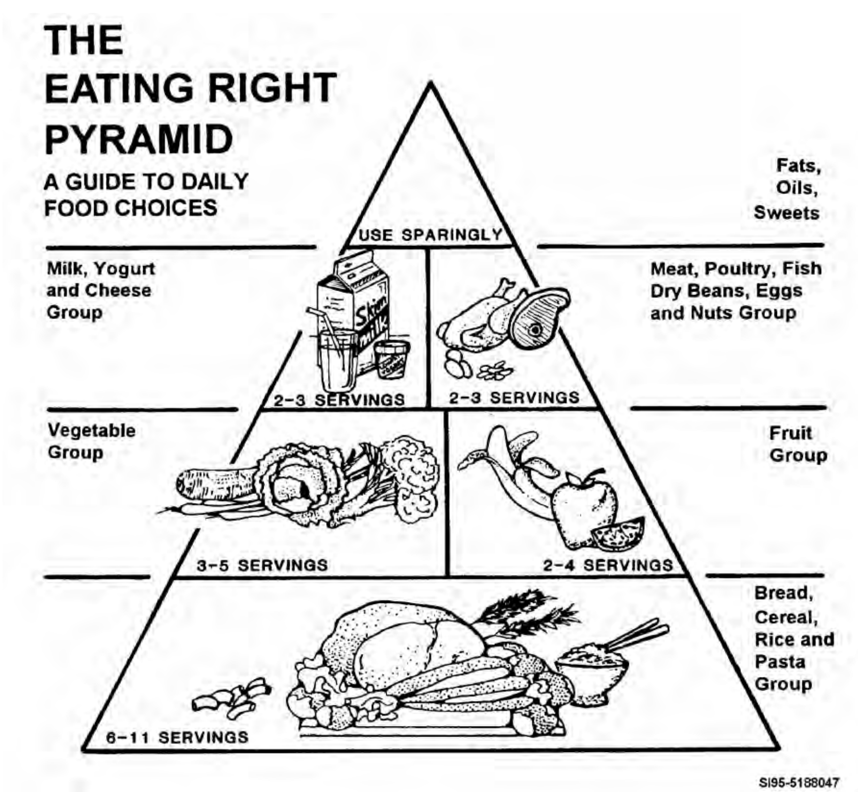


Figure 2–2. Food groups pyramid.

also need to be made for individuals with certain diseases (like diabetes), age and other factors. New food pyramids show a different design but the basics remain the same except more emphasis is given to tailor its use for each person. Everyone should want to know what and how much they should eat! The new 2005 Food Guide Pyramid guidance, referred to as "MyPyramid", will give you all the information you need. The pyramid calls for eating a variety of foods to get the nutrients you need and, at the same time, the right amount of calories to maintain a healthy weight while considering your physical activity level. The pyramid also focuses on fat and sweets because most American diets are too high in fat.

Certain nutrients are essential for the body. These nutrients are obtained through proper consumption of the various food groups. An over consumption of any one nutrient can be unhealthy, as can a deficiency in certain nutrients. A proper balance is the goal of any dietary plan. The following table contains information on the basic nutrients:

Nutrient	Facts
Protein	• All cells contain protein. • Essential for tissue growth and repair. • Sources include dairy products, meat, fish, poultry, eggs, cereals, some vegetables, and nuts.
Carbohydrates	• Essential for energy. • Provide fiber for bowel elimination. • Sources include fruits, vegetables, cereals, breads, and sugar.
Fats	• Provide energy. • Assist in maintaining body temperature. • Help the body to metabolize some vitamins. • Sources include dairy products, eggs, meat, oils, and nuts.
Vitamins	• Various vitamins needed to assist in body metabolism. • Each vitamin necessary for specific body functions. • Vitamins A, D, E, and K can be stored by the body when ingested. • Vitamins B and C cannot be stored by the body and must be ingested daily. • Sources vary depending on the vitamin.
Minerals	• Necessary to support various body functions. • Especially essential for bone and tooth formation, muscle function, nerve function, and fluid balance. • Examples include calcium, iron, sodium, potassium, phosphorus, magnesium, chloride, and zinc. • Sources vary depending on the mineral.

In addition to the nutrient content of food, new dietary guidelines focus on activity, moderation, personalization, proportionality, variety and gradual improvement.

- Activity: Reminder that daily physical activity is important to health.
- Moderation: Focuses on eating larger amounts of foods with little or no solid fats or sugars added. These types of foods should be selected over foods higher in fats and sugars. However, the more physically active you are, the more you can fit these foods into your diet.
- Personalization: Used to identify that each person needs to formulate a diet and exercise program tailored to that person's body and goals.
- Proportionality: This refers to the amount of food a person should eat from each of the food groups.
- Variety: Foods from all food groups is required for a healthy diet.

- Gradual Improvement: Each person should take small steps to improve his or her diet, exercise and lifestyle each day. See figure 2–3 for an example of daily food choices.

A Pattern for Daily Food Choices

FOOD GROUP	SUGGESTED DAILY SERVINGS	WHAT COUNTS AS A SERVING?
Breads, Cereals, and Other Grain Products Whole-grain Enriched	**6-11** servings from entire group *(Include several servings of whole-grain products daily.)*	1 slice of bread 1/2 hamburger bun or english muffin A small roll, biscuit, or muffin 3 to 4 small or 2 large crackers 1/2 cup cooked cereal, or pasta 1 ounce of ready-to-eat breakfast cereal
Fruits Citrus, melons, berries Other fruits	**2-4** servings from entire group	a whole fruit such as a medium apple, banana, or orange a grapefruit half a melon wedge 3/4 cup of juice 1/2 cup of berries 1/2 cup cooked or canned fruit 1/4 cup dried fruit
Vegetables Dark-green leafy Deep-yellow Dry beans and peas (legumes) Starchy Other vegetables	**3-5** servings from entire group *(Include all types regularly; use dark-green leafy vegetables and dry beans and peas several times a week.)*	1/2 cup of cooked vegetables 1/2 cup of chopped raw vegetables 1 cup of leafy raw vegetables, such as lettuce or spinach
Meat, Poultry, Fish, and Alternates (eggs, dry beans and peas, nuts, and seeds)	**2-3** servings from entire group	Amounts should total 5 to 7 ounces of cooked lean meat, poultry, or fish a day. Count 1 egg, 1/2 cup cooked beans, or 2 tablespoons peanut butter as 1 ounce of meat.
Milk, Cheese, and Yogurt	**2** servings from entire group *(3 servings for women who are pregnant or breastfeeding and for teens; 4 servings for teens who are pregnant or breastfeeding)*	1 cup of milk 8 ounces of yogurt 1 1/2 ounces of natural cheese 2 ounces of process cheese
Fats, Sweets, and Alcoholic Beverages	Avoid too many fats and sweets. If you drink alcoholic beverages, do so in moderation.	

Figure 2–3. Daily food choices and portions.

In a hospital setting, medics need to be aware of the various types of diets ordered by providers for their patients. The reason this is important is to ensure the diet ordered matches the food actually being served to the patient. The following table lists the most common types of therapeutic diets. Application of the type of diet required is covered in volume 2, but this will give you a quick overview of what the common types of diets a provider may recommend.

Diet	Common Reasons	Diet Content Examples
Clear liquid	• Acute illnesses • Nausea • Vomiting • Postoperative patients	Water, tea, black coffee, carbonated beverages, juice, jell-o, broth, hard candy, and/or popsicles.

Diet	Common Reasons	Diet Content Examples
Full liquid	• Progression from clear liquid diet • Nausea • Vomiting • Fever • Stomach irritation • Postoperative patients	All clear liquid diet items, soups, strained fruit and vegetable juices, milk, creamed cereals, custard, ice cream.
Mechanical altered (soft)	• Progression from full liquid diet • Gastrointestinal disorders • Infections • Patients with difficulty chewing	All liquids, pudding, poached eggs, meat, chicken, fish (not fried), mild cheeses, bread, crackers, cooked vegetables, fruits (without skins).
Fiber residue restricted (low fiber)	• Diarrhea • Colon disorders	All liquids, jell-o; pudding, custard, ice cream, bread, crackers, some cereals, rice, some cheeses, fruit (without skins), cooked vegetables, plain pasta, poached eggs.
High fiber residue	• Constipation • Colon disorders	All fruits, all vegetables, wheat bread, whole grain cereals, dairy products, meats, fried foods.
Bland	• Ulcers • Some intestinal disorders • Gallbladder disorders • Postoperative abdominal surgery	No fried foods, breads, cereals, jell-o, pudding, butter, cakes, cookies, some fruits and vegetables (without skins), juices, pasta, some soups, rice, poached eggs, lean meat.
Calorie restricted (low calorie)	• Weight reduction	Lean meat; low fat/low carbohydrate foods.
High calorie	• Weight gain • Some thyroid disorders	Increased diet in all foods.
Fat Restricted (low fat)	• Heart disease • Gallbladder disorders • Liver disorders • Difficulty with fat metabolism	Skim milk, breads, cereals, jell-o, broth, soups, margarine, cottage cheese (no other cheeses), fruits, vegetables, rice, pasta, potatoes, meat, chicken, fish (not fried).
High protein	• Some liver disorders • Burns • High fever • Infections	Milk, eggs, cheese, breads, cereals, meat, chicken, fish, green leafy vegetables.
High iron	• Anemia • Blood loss • Females (during reproductive years)	Some breads and cereals, dried fruits and beans, green leafy vegetables, peanut butter, egg yolks, liver, lean meat, shellfish.
Sodium restricted	• Heart disease • Some kidney disorders • Fluid retention	Fruits, vegetables, unsalted butter, restricted use of salt during cooking, no table salt.
Diabetic	• Diabetes mellitus	As determined by provider on a case-by-case basis.

Factors that affect nutritional habits

Health care personnel should be aware that various factors can and will affect the eating habits of patients. There are six general areas that should be taken into consideration:

Factor	Considerations
Illness	• Though desire (appetite) to eat decreases during illness, nutritional needs also increase. • Special diets often required. • Various methods of feeding are often implemented to provide nutritional needs.

Factor	Considerations
Appetite	• Hunger may result in over consumption of foods. • Anorexia (loss of appetite) can have adverse effects on the body.
Personal preference	• Most likes/dislikes established during childhood. • Some foods may be avoided if associated with illnesses (such as history of abdominal pain associated with a food, allergic reactions, and so forth).
Culture	• Types of foods regularly consumed are often influenced by an individual's ethnic background. • Food preparation habits often vary between different ethnic groups.
Religion	• Some religious beliefs observe complete or occasional avoidance of certain foods. • Method of food preparation is sometimes a necessary consideration.
Financial status	• Lower incomes often result in an over consumption of less expensive foods containing carbohydrates and an under consumption of foods containing proteins, vitamins, and minerals.

Physiology of nutrition

There are many factors that affect the natural reactions of the body. The functions of the cells are the primary factors that affect the body's processes. A proper diet is one of the building blocks for the body's ability to perform properly. Our ability to ingest, digest, use, and eliminate all of the nutrients we need are vital.

There are two major components of *nutrients* we will discuss: vitamins and minerals. Both of these are vital to the body's ability to process the chemicals needed for cellular functioning, healing, fighting disease processes, and interacting with medications. Vitamins are organic compounds that must be present in order for the normal metabolic process to occur in the body. It is essential to obtain these nutrients through a well balanced diet because the body cannot synthesize adequate amounts for normal metabolic process. Our focus will be to understand how these nutrients interact with the cells functions and the disease/injury processes.

Water-soluble vitamins

Water-soluble vitamins help to oxidize carbohydrates, lipids and proteins. Since the B vitamins often occur together in foods, they are usually referred to as the vitamin B-complex. Previously you learned that B-complex vitamins such as B_{12} and folic acid are important to the circulation of oxygen through the body, but how does the body obtain these vital nutrients?

B_{12}—cobalamin, cyanocobalamin

Vitamin B_{12} is found in meats (especially found in organ meats), poultry, eggs, fish, shellfish and some dairy like milk and cheese. B_{12} is normally absorbed through the stomach, but it is dependant on a particular substance (intrinsic factor) secreted by the gastric mucosa. Without the intrinsic factor for the B_{12} to bond the body would be unable to produce RBCs and synthesize DNA. The recommended daily allowance (RDA) of B_{12} is 2 μg.

Deficiencies can be associated with patients who have had intestinal resections, gastrectomy, or other malabsorption syndromes. Vegetarians must also be aware of their B_{12} intake, and supplement their diet depending on the degree of their vegetarian diet. As previously stated, most B_{12} deficiencies are generally due to the lack of absorption because of the body's inability to produce the intrinsic factor, not from a lack of diet.

Patients without a confirmed deficiency should avoid taking large doses of vitamin B_{12}. Taking mega doses may mask symptoms of folic acid deficiency or cause complication in patients with cardiac or gout conditions.

Clinical signs of B_{12} deficiency are noted at first by pernicious ($\mathcal{L}$-destructive) anemia and weakness. Progressing deficiency can proceed to include poor muscle coordination, numbness of hands and feet, mental confusion and irritability.

The treatment for pernicious anemia consists of monthly injections of vitamin B_{12} ordered by the health care provider. With any medication order there are side effects and interactions to consider. Side effects of B_{12} treatment include transient diarrhea along with itching and urticaria. Interactions may occur with anticonvulsants, slow-release potassium and colchicine (gout medication), and aminoglycoside antibiotics (gentamicin).

Folic acid—folacin

This vitamin is included in the B-complex group and is found in leafy and green vegetables, avocado, orange juice and kidney beans. One problem with many of these sources is the loss of the folic acid vitamin when they are cooked or reheated. The RDA is 400 μg per day.

Folic acid is used for the production of RBCs and DNA synthesis. During pregnancy, a deficiency of folic acid can result in neural tube defects, such as spina bifida in newborns. Some of the reasons an individual may be deficient are due to improper diet or disease processes that affects the liver: cirrhosis from chronic alcoholism, or renal dialysis. Malabsorption syndromes, malnutrition, or an intestinal obstruction may also cause a deficiency of folic acid.

Some of the signs of a folic acid deficiency may include sore mouth, diarrhea, and anorexia resulting in weight loss, irritability, and possible behavior disorders. Many disease processes have these same signs, so individuals are advised not to take folic acid supplements in doses larger than 0.4 mg (400 μg) found in most over the counter (OTC) vitamin supplements. When taking high dose supplements with out the diagnosis of a folic acid deficiency, there is the potential of masking other disease processes as pernicious anemia.

Individuals diagnosed with a folic acid deficiency may be treated with a 1mg dose prescription. Taking more than the recommended amount of folic acid without proper diagnosis, could interfere with the action of other medications as Phenytoin (Dilantin), estrogen, as found in oral contraceptives, or barbiturates.

B_6—pyridoxine

Vitamin B_6 is a coenzyme used in the metabolism of carbohydrates, fats, protein, and amino acids. It is found in meats, legumes, peanuts, whole-grain cereals, and bananas. When calculating daily doses of B_6 you must account for foods that are frozen, as there is a significant loss of B_6 through this process. The RDA is 1.6–2 mg/day.

Deficiencies of B_6, as with folic acid deficiencies, are from improper diet or disease process affecting the liver. Additionally, some drug interactions cause a deficiency of B_6. Individuals taking isoniazid (INH) therapy (used to treat tuberculosis) or even oral contraceptives may incur B_6 deficiencies. B_6 supplements should not be taken without proper diagnosis of a true deficiency. Patients under treatment for Parkinson’s disease who are taking the medication levodopa (L-dopa) must be cautioned not to take B_6 supplements. The B_6 vitamin will antagonize the action of the levodopa producing more problems with the disease.

Signs of deficiencies can include peripheral neuropathy, oral sores, and depression in adults. For infants, the deficiency may cause seizure activity. An overdose of B_6 in pregnant women may result in seizures among newborns with a developed need for greater than normal amounts of pyridoxine.

Vitamin C—ascorbic acid

Vitamin C is found in fresh fruits and vegetables, especially citrus fruits, tomatoes, and broccoli. It is unstable when exposed to heat or air or combined with alkaline compounds such as antacids. Adding baking soda to vegetables for color retention also destroys the vitamin C. The RDA for vitamin C is 60 mg/day.

Vitamin C is necessary for cellular metabolism and intercellular substances (collagen), and normal growth of teeth, gums and bones. Without this vitamin, iron is unable to be absorbed by the body properly. Vitamin C also promotes the healing of wounds and bone fractures.

Deficiencies are associated with pregnancy and lactation, gastrointestinal (GI) track diseases, smoking and, of course, a lack of fresh fruits and vegetables in an individual's diet. Other contributing factors to a deficiency are alcoholism, infections, and even stress.

Signs of a vitamin C deficiency (scurvy) can include muscle weakness and cramping, lethargy, sore and bleeding mouth and gums, or degenerative changes in bone and connective tissue. As with any suspected deficiency, a health care provider must confirm it and order treatment as necessary.

Treatments of scurvy, when ordered, follow different regiments based on the individual's disease process affecting the body. Ascorbic acid is available in capsule, tablets (extended release), solution, chewable or injection form. Treatment for scurvy may be seen in the following regiments. For adults with no other disease processes, a dose of 100–250 mg twice a day (BID) may be ordered. A hemodialysis patient may follow 100–200 mg daily. For an infant, beginning at two to four weeks of age, the dosage would be 20–50 mg per day. Many adults use vitamin C as a preventative supplement or treatment of a common cold with a dose of 1–2 mg per day. Since ascorbic acid is a water-soluble vitamin, more than 50 percent of the dose is excreted in the urine for individual with out any kidney disease processes. Excretion of less than 20 percent of the dose over a 24-hour period may also suggest a vitamin C deficiency. Doses larger than that recommended are to be avoided because of the potential side effects.

Side effects of large doses of vitamin C, more than the RDA, can include increased urinary calcium; (precipitating kidney stone formation) and elevated uric acid levels (precipitating gouty arthritis). It may produce side effects of heartburn, abdominal cramps, nausea, vomiting and diarrhea. Consistent large doses of vitamin C can also produce a false negative result for colon cancer testing.

Vitamin C may interact with other medications an individual is currently taking. Taking aspirin with vitamin C may cause elevated blood level of aspirin in individuals. Individuals taking barbiturates, tetracyclines, estrogen or oral contraceptives may be required to take a vitamin C supplement.

Vitamin C may not be a vital component for circulation or oxygenation, but without this particular vitamin the body is deprived of the essential iron needed through out the body. Use the following table as a quick reference for water-soluble vitamins.

Water-soluble vitamins			
Name	**Food Source**		**RDA**
	Animal 	Plant 	
Vitamin B_{12}	Seafood/shellfish, meat, poultry, eggs, milk, cheese	None	2 μg per day
Folic Acid	Organ meats	Green leafy vegetables, avocado, beets, kidney beans, broccoli, orange juice	400 μg per day
Vitamin B_6	Pork, beef, chicken, tuna, salmon	Whole grain cereals, wheat germ, legumes, peanuts, soybeans, bananas	1.6–2 mg per day
Vitamin C	None	All citrus, cantaloupe, broccoli, tomatoes, green peppers, cabbage, brussle sprouts	60 mg per day

Fat soluble vitamins

Since fat-soluble vitamins dissolve in fats, they are influenced by the same factors that affect lipid absorption. For example, the presence of bile salts in the intestine promotes the absorption of these vitamins. As a whole, fat-soluble vitamins are stored in moderate quantities within various tissues, and because they are fairly resistant to the effects of heat, they are not usually destroyed by cooking or food processing as are water-soluble vitamins.

Vitamin A—retinol, retinal, beta carotene

Vitamin A is processed in the body from the carotene of plants, especially yellow-orange and dark-green leafy vegetables. You will find the vitamin in oily saltwater fish, dairy products and eggs. The RDA is 800–1,000 international units (IU) per day.

Vitamin A is necessary for proper visual function at night, helps in the development of bones and soft tissue and maintaining healthy epithelial tissue. Many times you will see vitamin A (retinal, retinol) prescribed for acne, and for promoting the healing of wounds.

Deficiencies of vitamin A may be a result of an obstruction of bile, prolonged infection or fever, the malabsorption of fats or diarrhea. Vegetables can lose vitamin A due to over cooking in an open container, as heat and air cause oxidation.

Signs of a deficiency may include night blindness or photosensitivity, slow growth, bone and teeth deformities, along with impaired hearing. Of course these symptoms alone do not prove a deficiency, as health care providers must diagnose the deficiency. Once a deficiency is diagnosed, supplements may be necessary for infants fed unfortified skim milk or mild-substitute formulas, persons with prolonged infection or fever, or diabetics with hypothyroidism.

Individuals being treated with Accutane (a synthetic vitamin A product), should be cautioned and have it explained that pregnancy is contraindicated during treatment, as this product can cause fetal abnormalities. Accutane may also cause increased intracranial pressure, possible liver changes and other adverse side effects associated with hypervitaminosis A. Symptoms of overdose (hypervitaminosis A) occur from a greater than 50,000 IU (15,000 mcg of retinol) include irritability and psychiatric symptoms, fatigue and lethargy, along with insomnia and headaches. Acute toxicity is denoted by increased intracranial pressure, vertigo, and coma. Caution must be taken with individuals with kidney or liver problems and diabetics.

Vitamin D—calciferol, cholecalciferol, ergocalciferol

This is one vitamin the body is capable of synthesizing in small amounts through the action of the sunlight on the skin. Not every one lives in a climate where this is possible throughout the year. Examples include individuals who may live in Washington state, or England, UK. The dietary sources include fish oils and food products fortified with vitamin D, such as milk and cereals. The RDA is 400 IU/day.

Vitamin D is necessary for the maintenance of normal nerve and muscle functioning. It assists in regulating the absorption and metabolism of calcium and phosphorus for healthy bones and teeth, making it important during pregnancy and lactation.

Signs of deficiency are seen with the rickets disease process characterized by poor teeth and bone structure; osteoporosis as characterized by loss of bone density. Tetany is another disease process that is characterized by cramps, convulsions, twitching of the muscles and sharp flexion of the wrist and ankle joints. Prevention and treatment for vitamin D deficiencies include supplements prescribed such as calcifediol, calcitriol, or ergocalciferol which are carefully regulated. Some of the symptoms that may be present with a vitamin D overdose and toxicity include cardiac arrhythmias, vertigo, tinnitus, kidney damage or kidney stones. Severe symptoms may lead to hypocalcaemia and convulsions. For individuals with known cardiovascular disorders, kidney diseases, or are pregnant or lactating, extreme caution must be taken not to exceed the RDA of vitamin D.

Vitamin D treatment may interact with individuals who are taking digitalis and thiazide diuretics such as hydrochlorothiazide (HCTZ). An overdose of vitamin D may antagonize the actions of these drugs causing more damage to the individual. An additional interaction is mineral oil; it may interfere with the intestinal absorption of the vitamin.

Vitamin E

Vitamin E (tocopherol) is abundant in many natural forms. It is found especially in cereals, wheat germ, seeds, nuts, vegetable oils, eggs, meat and poultry. The RDA for vitamin E is 30 IU per day.

Vitamin E is necessary for normal metabolism, the protection of tissues of the eyes, skin, liver, and lungs. It assists in the regulation of vitamin A use and storage. Vitamin E protects RBCs from damage and decreases platelet clumping. Research is ongoing in the use and benefits of vitamin E supplements as one of the treatment protocols for the management of early Alzheimer's disease and for possibly slowing the progress of such memory loss symptoms. However, the supplement will neither cure nor prevent this debilitating disease.

Since this vitamin is so abundant, deficiency is related with other disease processes versus a lack of ingestion of the vitamin. The deficiency is found in association with alcohol abuse, malabsorption syndromes such as cystic fibrosis, pathologic conditions of the liver and pancreas, and sickle-cell anemia. Premature infants or low-birth weight neonates have also been found to be susceptible.

The signs of a vitamin E deficiency are not concretely established because of the other disease processes it is associated with. Premature infants may show irritability, edema or hemolytic anemia. Adults may show signs of muscle weakness or abnormal lab values with low RBC counts. The sign of an overdose of the vitamin (1200 IU per day) is more readily seen through prolonged clotting times. Because of this potential side effect, vitamin E supplements should be discontinued 10 days before surgery, and should not be taken while on anticoagulant therapy because of the increased risk of bleeding. Vitamin E interacts with an excessive use of mineral oil, decreasing the absorption of the vitamin.

Vitamin K—phytonadione

Vitamin K is most often found in green or leafy vegetables. It is also found in cheese, eggs and vegetable oils. The RDA for vitamin K is 60–80 mg per day.

Vitamin K is necessary for blood clotting. This is prevalent in the use as prophylactic treatment for newborns at birth. The American Academy of Pediatrics recommends this course of treatment to prevent hemorrhagic diseases of the newborn. Vitamin K is also necessary for individuals with malabsorption syndromes, ulcerative colitis, coumarin overdose, and prolonged use of salicylate and long-term hyperalimentation antibiotics.

Signs of a vitamin K deficiency are increased clotting time, petechia and bruising, and blood in both urine (hematuria) and in stool (melena). Treatment is prescribed as phytonadione (Mephyton tabs or Aquamephyton IM or SC). This course of treatment is only effective for bleeding disorders that are due to low concentrations of prothrobin in the blood. It is not effective for bleeding from other causes, such as heparin overdose or trauma. Use the following table as a quick reference for fat-soluble vitamins.

Fat-soluble vitamins			
Name	**Food Source**		**RDA**
	 Animal	 Plant	
Vitamin A	Oily saltwater fish, whole milk, cream butter, cheese, egg yolks, fish liver oils	Dark-green leafy vegetables, deep yellow or orange fruits and vegetables	800–1,000 IU per day

Fat-soluble vitamins			
Name	**Food Source**		**RDA**
	 Animal	 Plant	
Vitamin D	Fish oils, salmon, herring, mackerel, sardines, eggs, butter, milk	Fortified cereals	400 IU per day
Vitamin E	None	Vegetable oils, seeds, nuts, wheat germ, cereals	30 IU per day
Vitamin K	Egg yolk, cheese, liver	Vegetable oil, green leafy vegetables, cabbage, broccoli	60–80 mg per day

Minerals

Carbohydrates, lipids, proteins and vitamins are all organic substances, but dietary minerals are inorganic elements that are essential to human metabolism. Minerals are usually extracted from the soil by plants, and we in turn obtain these minerals from the plant food sources or from the animal sources that have eaten the plants. The correct balance of each mineral is required for the maintenance of health (chemical balance homeostasis). Minerals are responsible for approximately four percent of the body weight and are concentrated in the bones and teeth. The two minerals abundant in bones and teeth are calcium and phosphorus, nearly 75 percent of the body's minerals. Minerals dissolved in the body fluids are called electrolytes because they carry positive or negative electrical charges required for body activities. These activities include simple nerve impulse conduction to the blood formation, and the beating of the heart.

The principal minerals in the body and their chemical symbols are sodium (Na), chloride (Cl), potassium (K), calcium (Ca), and iron (Fe).

Sodium and chloride

Both sodium (Na) and chloride (Cl) are the principal minerals in the extracellular body fluids. Through experience we understand that blood contains approximately 0.9 percent sodium chloride, and the best source of these minerals is through table salt (NaCl).

The sodium element is readily absorbed from foods by active transport, and the kidneys, under the influence of the adrenal cortical hormone aldosterone, regulate the blood concentration of the sodium. When this hormone is released, the kidneys reabsorb sodium while expelling potassium.

Like sodium, chloride is widely distributed throughout the body, although it is seen in the highest concentration in the cerebrospinal fluid and gastric juices. Together with sodium, chloride helps to maintain the electrolyte balance (homeostasis) and regulate the ph level through the concentration of extracellular fluids in the body's cells.

Since these elements are readily available, a deficiency of these minerals is due to starvation or an extended time of fasting. The signs of a deficiency can be seen through an excessive amount of fluid loss from bleeding, diarrhea, and vomiting or excessive perspiration.

Treatment consists of intravenous (IV) therapy with the necessary amounts of sodium chloride (NaCl) according to the need. NaCl can be administered in full strength of 0.9 percent sodium chloride, half-normal saline solution 0.45 percent sodium chloride, and quarter-normal saline solution 0.2 percent sodium chloride. With these solutions, other minerals may also be added as required for IV therapy.

NOTE: Caution is still taken when administering these fluids; fluids must not be added too fast. If this occurs, a body becomes overloaded with fluid.

Potassium—K

Potassium tends to be concentrated inside cells rather than in the extracellular fluids. Natural sources of potassium include meats, citrus, bananas, tomatoes, potato skin, avocadoes, milk peanut butter, cooked dried beans and peas. Potassium is necessary to help maintain the intracellular osmotic pressure and pH balance and normal muscular irritability (heartbeat regulation). Dietary potassium deficiency is rare, but may occur for other reasons. Insufficient oral intake may be due to anorexia, weight-reduction diets, or surgery. Deficiency may occur in individuals taking diuretics, long-term use of corticosteroids or laxatives, or possibly digitalis toxicity. Diarrhea or vomiting, diaphoresis, diabetic ketoacidosis or kidney diseases may also be associated with a potassium deficiency. Signs include muscular weakness, paralysis, cardiac arrhythmias, lethargy and fatigue, along with mental apathy and confusion.

Treatment primarily consists of giving KCL (potassium chloride) via IV postoperatively or for severe dehydration (diluted according to directions). Potassium is also available through several oral products as well. They include K-Lyte (tablet or powder dissolved in water or juice and taken after meals, Micro-K (capsule), or K-Dur or Slow-K (extended-release tablets). Patients may experience side effects of nausea vomiting or diarrhea, GI bleeding or abdominal pain through this method but hyperkalemia is not likely with routine oral administration, unless there is a case of severe renal impairment.

When administering potassium through an IV treatment, always run the fluid at a slow rate to prevent phlebitis or pain at the site. When mixing potassium in an IV solution, it must be mixed thoroughly by inverting and agitating the bag before the solution is hung for administration.

CAUTION: never add potassium to an infusing IV solution as it may result in an overdose of potassium in the blood, known as hyperkalemia.

Symptoms of hyperkalemia may be identified by listlessness, confusion, weakness or paralysis of extremities, a fall in blood pressure and/or cardiac arrhythmias with possible heart block. Because of the action potassium has to the body systems, caution must be taken when administering potassium to individuals with known cardiac disease, renal impairment, gastric or intestinal ulcers (especially extended-release tablets) or mental confusion.

Calcium

Most people associate calcium (CA) with bones and teeth, true, but not the only function of calcium. This mineral is also essential for nerve impulse conduction, muscle fiber contraction and blood coagulation. Calcium absorption is based on the body's need for the mineral, but calcium needs the help of vitamin D and proteins to promote the calcium absorption. Natural sources of calcium include milk and milk products and fish with bones such as salmon or sardines. Other sources are green vegetables such as mustard, turnip greens and kale.

Women, who are pregnant or lactating, postmenopausal or have estrogen deficiencies, may need to take calcium supplements in addition to normal dietary calcium intake. Deficiencies may also be associated with hypoparathyroidism, long-term use of corticosteroids, pancreatitis, renal failure, chronic diarrhea, and some diuretics or anticonvulsants. Signs of deficiency may include rickets in children, increased clotting time, osteoporosis, or osteomalacia (including frequent fractures in the elderly), or cardiac myopathy. As with all deficiencies, the signs are not enough to diagnosis a deficiency, a health care provider must diagnose it.

For individuals with calcium deficiency, treatment may consist of taking oral supplements 400–600 mg daily. A higher dosage supplement is required for those not including calcium-rich foods in their daily diet. Calcium supplements should be administered one to one and one half hours after meals, unless otherwise specified. Calcium supplements are available in combination with other products including calcium gluconate, calcium carbonate, or calcium lactate. Of the three, calcium carbonate delivers the highest amount of calcium per tablet. Remember, calcium is dependent on vitamin D for metabolism, thus adding vitamin D or exposure to sunlight may be necessary.

Side effects of calcium salts can include constipation from oral products and tissue irritation from IV administration can occur. This treatment should be administered very slowly to prevent tissue necrosis or possible cardiac arrhythmias. Caution should be taken when administering calcium to individuals with known cardiac or renal diseases, and respiratory conditions (e.g., sarcoidosis). Interactions of treatment may occur with digitalis, resulting in potentiation (causing arrhythmias) and tetracycline, resulting in antagonism (inactivates the antibiotic).

Iron

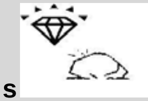
Iron (FE) is the oxygen-carrying component of blood. It is stored in the liver, spleen, and bone marrow. Iron enables hemoglobin molecules in the RBCs to carry the oxygen to the body's cells. Iron is a mineral found in meat (especially liver), egg yolk, beans, spinach, prune juice, fish, poultry and oysters.

Deficiencies that an iron supplement is recommended for include: hemorrhage and excessive menstrual flow, GI tumors, internal bleeding and ulcers. During pregnancy, infancy, puberty (at time of growth spurt), and patients undergoing hemodialysis are recommended to take iron supplements. Signs of an iron deficiency may include paleness of the skin and/or mucous membranes, lethargy and weakness, vertigo and a decline in mental status. In addition, an irregular heartbeat and function or cravings for nonfood items such as ice, clay, or starch (pica) may also be signs of a deficiency.

As with all treatments, diagnosis from a health care provider is necessary. Treatments of anemia due to iron deficiency consist of oral or injectable iron depending on the severity, and the cause of this deficiency. Oral iron products, ferrous sulfate (Fiosol, Fer-in-Sol) are common. Dosage for adults consist of 50–100 mg TID after meals and not taken with milk, coffee, or tea. For infants and children 4–6 mg daily divided into three doses in juice or with meal but not with milk. Injectable iron, dextran, is ordered in 50–100 mg *deep* IM using the *Z-track method* only. (Injection techniques will be discussed in Volume 3.) Extreme caution must be taken when administering iron through this route to prevent the solution from coming in contact with the subcutaneous tissue because of the severe irritating effect. After drawing the medication, a fresh 2-inch needle is recommended for the administration. Iron dextran also can be given IV *slowly* after testing for sensitivity with a small trial dose.

Side effects of taking iron supplements can include black stools, constipation or diarrhea, and nausea and vomiting. Taking the iron supplement after or with meals can minimize the nausea and vomiting. In severe cases phlebitis with IV administration or anaphylactic reaction may occur. There are contraindications for patients with known peptic ulcers, ulcerative colitis. Interactions may occur when taking vitamin C or orange juice; it enhances the iron absorption producing too much at one time into the body system. Coffee or tea should not be taken within two hours of iron; it reduces the iron absorption by as much as 50%. Antacids also decrease the iron absorption and should not be given at the same time. When taking tetracycline, oral iron preparations should be taken two hours after the antibiotic. The iron inhibits the absorption of the tetracycline.

With all these side effects, contraindications, and interactions, you must still be aware of the symptoms of acute overdosing of iron. The overdose may occur within minutes or be delayed for days. Signs include lethargy, shock, vomiting and diarrhea, erosion of the GI tract, or damage to the liver or kidneys. Use the following table as a quick reference for the actions and possible side effects associated with minerals.

Minerals 			
Name	**Necessary for**	**Deficiency association**	**Side effects or overdose effects**
Sodium (Na) and Chloride (Cl)	Principal minerals in the extracellular body fluids. Helps to maintain the electrolyte balance and regulate the ph level.	Starvation or an extended time of fasting.	
Potassium (K)	Maintains the intracellular osmotic pressure and pH balance. Normal muscular irritability (heartbeat regulation).	Insufficient oral intake due to anorexia, weight-reduction diets, or surgery Diuretics Long-term use of corticosteroids or laxatives Digitalis toxicity Diabetic ketoacidosis	Hyperkalemia; may be identified by: - listlessness - confusion - weakness - paralysis of extremities - fall in blood pressure - cardiac arrhythmias with possible heart block
Calcium (CA)	Bones and teeth formation Essential for nerve impulse conduction Muscle fiber contraction Blood coagulation.	Pregnancy or lactating Postmenopausal Estrogen deficiencies Hypoparathyroidism Long-term use of corticosteroids Pancreatitis, renal failure, chronic diarrhea Some diuretics or anticonvulsants	Constipation Tissue irritation Tissue necrosis Cardiac arrhythmias
Iron (FE)	Oxygen-carrying component of blood. Hemoglobin formation.	GI tumors Ulcers Puberty at time of growth spurt Hemorrhage Excessive menstrual flow GI tumors, internal bleeding as well as individuals with ulcers Pregnancy Hemodialysis	Phlebitis Black stools Constipation or diarrhea, and nausea and vomiting Anaphylactic reaction

Cell metabolism

There are two pathways of cell metabolic reactions, anabolism and catabolism. Anabolism is when larger molecules are constructed from smaller ones, requiring *input* of energy. In catabolism, larger molecules are broken down into smaller ones, *releasing* energy.

Before a cell can perform its function, it must have the energy necessary for the job. Heat is one form of energy (a catalyst) used to increase the rate of chemical reactions in a laboratory. A catalyst is a particular molecule that can change the rate of a reaction without itself being consumed. Heat energy increases the rate at which molecules move and the frequency of the molecular collisions. The temperature of a body cell is usually too mild to promote the reactions of life; the body uses enzymes to make these reactions possible. Enzymes promote specific chemical reactions within cells by lowering the activation energy needed to start these reactions. Enzymes can speed, or catalyze, metabolic reactions by a factor of a million or more.

Enzymes are required in very small quantities because they are not consumed as they work, therefore, function repeatedly. Cellular metabolism includes hundreds of different chemical reactions, each controlled by a specific kind of enzyme. There are hundreds of different kinds of enzymes present in every cell, and the speed of the enzyme-catalyzed reaction depends on the number of enzymes present in the cell. The reaction occurs more rapidly if the concentration of the enzyme increases. The body regulates the enzyme production based on the body's need. The body is able to recognize when there is an increased amount of a particular enzyme product and shuts down the function.

When the body recognizes a deficiency, the body begins production of the enzyme to produce the necessary molecule product. Enzyme molecule names are often derived from the name of the substrate molecule it binds with and has the suffix *–ase* added. Example, a lipid-splitting enzyme is called *lipase*, a protein-splitting enzyme is *protease*, and a starch-splitting enzyme is called *amylase*. Similarly there are also sugar sucrose-splitting enzymes that result in *sucrase*, sugar lactose-splitting enzymes produce *lactase*, and sugar maltose-splitting enzymes are called *maltase*.

NOTE: A common enzyme catalase can be seen when you use hydrogen peroxide to clean a wound. Injured cells release enzymes; when hydrogen peroxide comes in contact with the enzymes, oxygen bubbles are released. The visual reaction of the foaming is the result of debris being removed from inaccessible parts of the wound.

From cell division, to cell metabolism, and the catalyst of energy of the enzymes, we come to the molecule products that the human body must balance. This balance is a delicate operation within the body that can be affected by many different chemical imbalances beginning with the acid, base, and salts balance.

Chemical balance homeostasis

Chemical reactions are bonded or broken through a reaction called synthesis either through dehydration synthesis or hydrolysis. Some compounds release ions when they are dissolved in water or when they react with water molecules. When this reaction occurs, the resulting solution contains electrically charged particles (ions); this solution will then conduct an electric current. These substances that release ions in water are known as *electrolytes*. When table salt, sodium chloride (NaCl), hydrolyzes with water; the molecules break down into sodium ions (Na^+) and chloride ions (Cl^-). The reaction is written $NaCl \rightarrow Na^+ + Cl^-$. The molecule product of this chemical reaction is seen in figure 2–4.

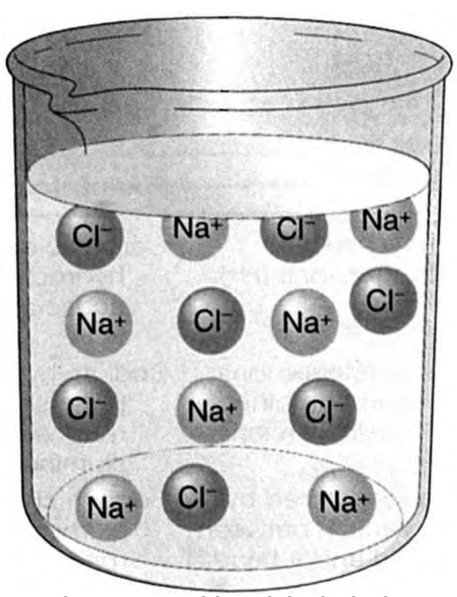


Figure 2–4. Table salt hydrolysis.

Electrolytes

Electrolytes that release hydrogen ions (H^+) in water are called *acids*. An example is when hydrochloric acid (HCl) is hydrolyzed with water, the molecule products are hydrogen ions (H^+) and chloride ions (Cl^-) written $HCl \rightarrow H^+ + Cl^-$.

Electrolytes that release ions that combine with hydrogen ions are called *bases*. The compound sodium hydroxide (NaOH) in water it releases hydroxyl ions (OH-). These hydroxyl ions in turn, can combine with hydrogen ions to form water through dehydration synthesis, making sodium hydroxide a base. The written composition of this synthesis is $NaOH \rightarrow Na+ OH-$. The OH- bond that has been broken can bond with hydrogen to make water (H_2O) when it reacts with an acid. Enzyme systems operate at an optimal hydrogen ion concentration ($[H^+]$), any variation from this optimal concentration can markedly affect enzyme activity. The enzyme is the catalyst for the cell to perform its particular function in order to maintain the chemical balance in the body. The hydrogen ion concentration is a vital link to keeping this balance.

When acids and bases combine, they will react to form water and electrolytes called *salts*. This can be seen through the example of hydrochloric acid and sodium hydroxide. This synthesis reaction is written HCl + NaOH → H2O + NaCl. The following chart summarizes the three types of chemical compounds and their characteristic actions.

Types of chemical compounds		
Characteristics		Examples
Acid	Ionizes (separate) to release hydrogen ions (H^+).	Carbonic acid, hydrochloric acid, acetic acid, phosphoric acid.
Base	Ionizes to release ions that can combine with hydrogen ions.	Sodium hydroxide, potassium hydroxide, magnesium hydroxide, aluminum hydroxide.
Salt	Substance formed by the reaction between an acid and a base.	Sodium chloride, aluminum chloride, magnesium sulfate.

Strictly speaking, hydrogen ions are protons and do not exist in the naked state in body fluids; instead they react with H_2O to form hydronium ions. For clinical purposes H^+ can be used to represent these hydrated protons. Because H^+ is so critical to enzyme function, difficult to manipulate and has an absolute concentration that is so small, the concept of pH was developed. This is now universally used to represent H^+.

PH scale

The concentration of acids and bases affect the chemical reactions that make up many of life processes, such as those that control the breathing rate. This is why it is important to understand that the concentrations of these substances in body fluids are of special importance.

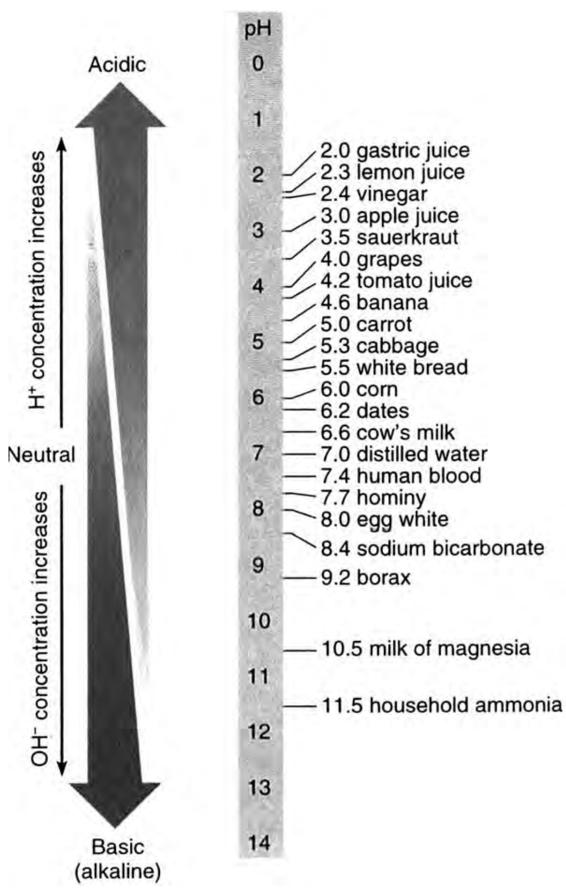


Figure 2–5. pH Scale.

Hydrogen ion concentration can be measured in grams of ions per liter of solution. To make it easier to understand the true concentration of the hydrogen ions, the pH scale was developed (fig. 2–5).

When you look at the pH scale, you find that gastric juice is 2.0 on the scale and is written out as .01 grams H+/liter. Household ammonia, 11.5 on the pH scale would be written as .00000000001 grams H+ /liter. This is an impractical way of writing out pH levels, thus the pH scale was developed to provide a universal system of keeping track of the decimal place in a H+ concentration. As you can see on the pH scale, solutions with more hydrogen ions (H+) than the hydroxyl ions (OH-) are said to be acidic, having a ph value of less than 7.0 (neutral). Distilled water is the neutral solution because the water synthesizes and releases an equal number of acid hydrogen ions (H+) and basic hydroxyl ions (OH-). Solutions that have more hydroxyl ions (OH-) and fewer hydrogen ions (H+) are said to be *basic* (*alkaline*) because they have pH values of more than 7.0.

Many of the fluids with in the human body function with such a narrow pH range, and any type of illness can result in a change to the pH balance. The normal pH of blood is 7.35 to 7.45 (these numbers vary slightly from text to text, but the range is fairly consistent). Blood pH in the range of 7.5 to 7.8 is called *alkalosis*, making one feel agitated and dizzy. The cause for this can be as simple as breathing rapidly at high altitudes, taking too many antacids, or a high fever. *Acidosis* on the other hand is when the blood pH level falls down into the range of 7.0 to 7.3. This can make an individual feel disoriented and fatigued, making breathing difficult. This change in pH level can be attributed as a result from severe vomiting, diabetes, brain damage or lung and kidney diseases.

Adaptation of cells

Any chemical that enters into metabolic synthesis (anabolism or catabolism) or are a product of the reaction, can be divided into two large groups briefly discussed before. Those that contain both carbon and hydrogen atoms are called organic; the rest are called inorganic. Generally, inorganic substances dissolve in water or react with water to release ions; this places them in the category of *electrolytes*. Organic compounds as a group are more likely to dissolve in organic liquids such as ether or alcohol. The organic compounds that do dissolve in water generally do not release ions, placing organic compounds in the category of *non-electrolytes*.

Inorganic substances

Inorganic substances are divided into two categories, molecules and ions. The ions are released through the ionizing of organic salts in water. The three main molecules are of course, water, oxygen, and carbon dioxide. Of these three molecules, water is the most abundant and is responsible for about two-thirds of the weight of an adult human.

Water

Because this is the most abundant molecule, most of the metabolic reactions occur in water. Water plays an important role in the transportation of chemicals within the body. Blood plasma is made up of 90–95 percent water, enabling vital substances to be transported throughout the body. Substances carried by the blood are sugars, salts, vitamins, and of course oxygen. Do not forget blood also transports the waste products of carbon dioxide, and urea out to the lungs and kidneys, respectively.

Oxygen

Of course we all know oxygen is received into the body through inspiration, and transported throughout the body by the red blood cells. Within the cell, the oxygen is used to release energy from nutrient molecules; the released energy is used to drive the cell's metabolic activities. Without a continued supply of oxygen, the cells do not survive, and ultimately, the body does not survive.

Carbon Dioxide

This is a simple carbon-containing inorganic compound that is produced as a waste product of expiration. As it moves from the cells into the surrounding body fluids and blood, most of the CO_2 hydrolyzes with the water to form a weak acid (carbonic acid). This carbonic acid (H_2CO_3) ionizes releasing hydrogen ions (H+) and bicarbonate ions (HCO_3-), which are carried to the respiratory organs. At the respiratory organs, the chemical reactions reverse and carbon dioxide gas is produced, and finally exhaled. The following table below summarizes the specific function of each of the components of the inorganic molecules:

Inorganic Molecules		
Substance	**Symbol or Formula**	**Functions**
Water	H_2O	Major component of body fluids where most biochemical reactions occur, helps to regulate body temperature.
Oxygen	O_2	Used in the release of energy from glucose molecules.
Carbon dioxide	CO_2	Waste product that results from metabolism; reacts with H_2O to form carbonic acid.

Inorganic Salts

The other portion of inorganic substances is the inorganic salts. Inorganic salts are produced when chemical compounds are synthesized with water and then ionized (separated) to produce the inorganic ions. The inorganic salts are abundant in body fluids. Each one of the inorganic salts plays a necessary role in the metabolic processes. These electrolytes must be present in certain concentrations both inside and outside the cells to maintain homeostasis. This gives the body the electrolyte balance needed to maintain good health. The following table summarizes the specific function of each of the components of the inorganic ions:

Inorganic Ions		
Substance	**Symbol or Formula**	**Functions**
Bicarbonate ions	HCO_3^-	Helps maintain acid-base balance.
Calcium ions	CA^{+2}	Necessary for bone development, muscle contraction and blood clotting.
Carbonate ions	CO_3^{-2}	Component of bone tissue.
Chloride ions	CL^-	Helps maintain H_2O balance.
Hydrogen ions	H^+	Determines blood pH.
Magnesium ions	Mg^{+2}	Component of bone tissue; needed for certain metabolic processes.
Phosphate ions	PO_4^{-3}	Needed for the synthesis of nucleic acids; component of bone tissue.
Potassium ions	K^+	Needed for polarization of cell membranes.
Sodium ions	Na^+	Helps to maintain H2O balance, and needed for polarization of cell membranes.
Sulfate ions	SO_4^{-2}	Helps to maintain acid-base balance, and needed for polarization of cell membranes.

Organic substances

As previously stated, any chemical compound that enters into metabolic synthesis and the product contains both carbon and hydrogen atoms are called organic. This can incorporate a large number of substances; we are going to focus on three groups. These groups will be carbohydrates, lipids, and proteins.

Carbohydrates

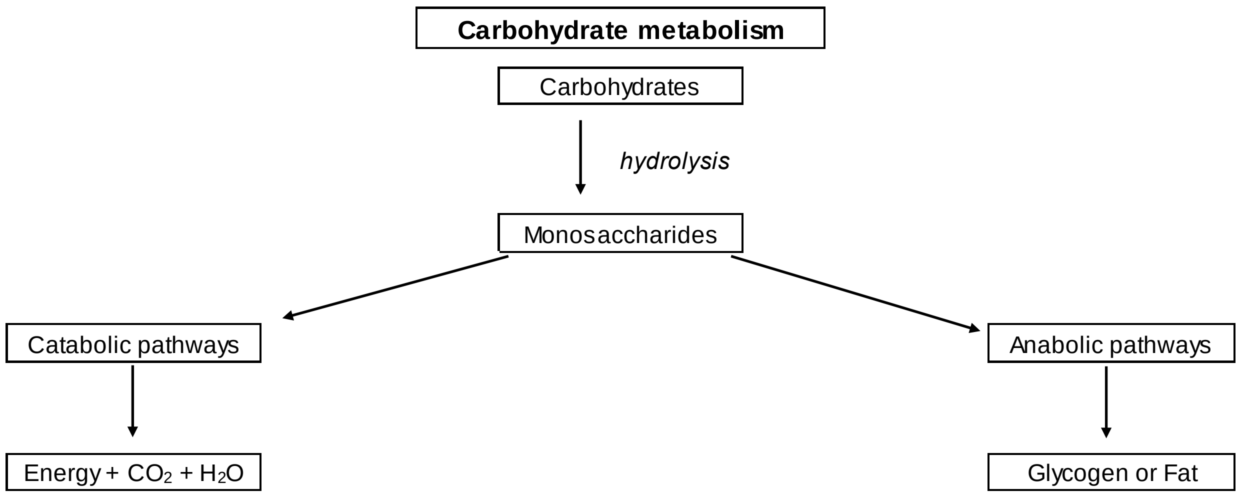
What do you think of when you hear the word carbohydrates? Do words such as starch; sugars, complex fibers or even the no-carb diets come to mind? If they did you are correct, but your understanding and comprehension of the word carbohydrate must reach farther than just simply sugar. Carbohydrates provide much of the energy that cells require to function.

Carbohydrates are water-soluble molecules that contain atoms of carbon, hydrogen, and oxygen and classified by size. Not by the size grain of sugar, but the size of the chemical compound that makes up the different carbohydrate molecules. Carbohydrates usually have twice as many hydrogen atoms as oxygen atoms, just as you see in water (H_2O). This ratio is evident when you look at the molecular formulas of the carbohydrates glucose ($C_6H_{12}O_6$) and sucrose ($C_{12}H_{22}O_{11}$).

Simple carbohydrates, or sugars, include the monosaccharides (single sugars) and diaccharides (double sugars). Monosaccharides include glucose (dextrose), fructose, and galactose. The disaccharides include sucrose (table sugar) and lactose (milk sugar). Carbohydrates that are more complex are called polysaccharides. These polysaccharides are built from simple carbohydrates synthesized together through the metabolic reaction. An example of a polysaccharide is a molecule of starch. The starch molecule consists of highly branched chains, each containing about 12 glucose (simple sugar) units. The synthesized polysaccharide starch molecule is called glycogen.

Most cells can produce glycogen; however, muscle cells and the liver store the greatest amounts. After meals, when the blood glucose concentration is relatively high, the liver cells obtain glucose from the blood and convert it to glycogen. Between meals, when the blood glucose concentration is lower, the metabolic reaction is reversed and glucose is released back into the blood. This enables the body cells to maintain a continual supply of glucose to support the functions of the cells.

The simple carbohydrates (glucose) can also be converted into fat molecules, which are later deposited into the subcutaneous tissue. This occurs when an individual takes in more carbohydrates than can be stored as glycogen that would be needed for normal activities. Unfortunately, the body has an almost unlimited capacity to perform this type of metabolic reaction (anabolism), so over-eating results in becoming obese, see below.

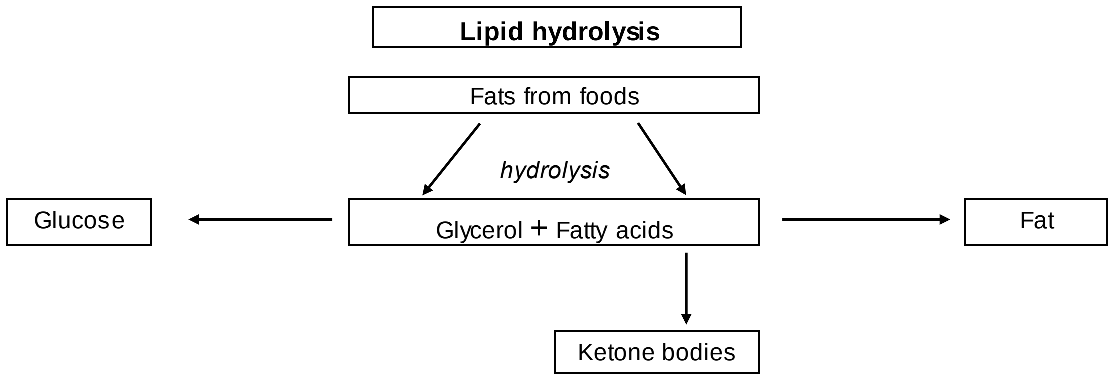


Lipids

Lipids are a group of organic chemicals that are insoluble in water, though they are soluble in organic solvents as ether and chloroform. Lipids include a wide variety of compounds such as fats, phospholipids and even steroids. Each of the compounds has a vital function in cells and is an important part of the cell membranes. The most common lipids are the fats. Primarily the fats are used to supply energy for cellular activities. Actually fat molecules provide more energy gram for gram than can a carbohydrate or a protein molecule. This is the reason why eating a diet high in fat leads to weight gain (when the energy is not used it continues to be stored as fat).

As with carbohydrates, fat molecules are composed of carbon, hydrogen, and oxygen atoms. Unlike carbohydrates, fat molecules contain a much smaller proportion of oxygen to hydrogen ratio. The building blocks of fat molecules begin with fatty acids and glycerol. These smaller molecules are united so each glycerol molecule combines with three fatty acid molecules, resulting in a single fat molecule called a triglyceride.

The liver controls lipid metabolism, removing lipids from the circulation and altering their molecular structures. Lipids provide a variety of physiological functions, mainly to supply energy. Before energy can be released from the triglyceride molecule, the molecule must undergo hydrolysis:



Once the fatty acid molecules have been activated, other enzymes located in the mitochondria of the cell, break the fatty acid down further and convert them into compounds called ketone bodies, such as acetone. When ketone bodies form faster than they can be decomposed, some are eliminated through the lungs and kidneys. This can result in the breath or urine to develop a fruity odor due to the presence of the ketone acetone. This sometimes happens when an individual fasts (does not eat), this forces the body cells to metabolize the fat to maintain body function. Diabetics are also likely to metabolize excessive amounts of fats resulting in the acetone in the breath and urine. When this occurs, they may develop a serious imbalance in their pH balance resulting in acidosis.

Proteins

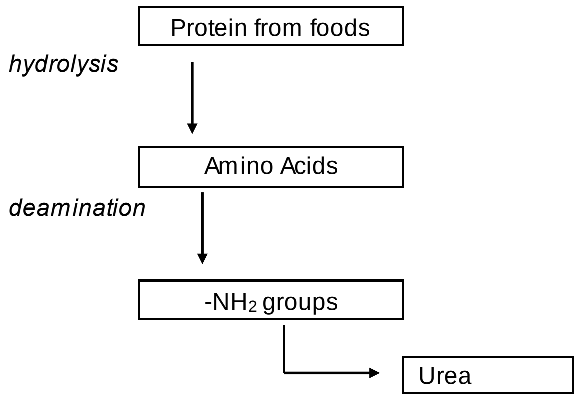
Proteins serve many purposes within the body functions, from structural materials, energy sources and chemical messengers (hormones). Others still may function as receptors on cell surfaces, or act as weapons (antibodies). Proteins play vital roles in the metabolic process of enzyme catalysts in the living systems. The building blocks of proteins are smaller molecules called amino acids.

Amino acid chains vary in length from less than 100 to more than 50,000 amino acids. Each amino acid chain has a different shape that is related to their particular function. Long fibrous chains, such as keratin proteins form hair, the threads of fibrin protein that form a blood clot. Many of the proteins are globular in form. Hemoglobin and myoglobin transport oxygen in blood and muscles, respectively.

Various treatments can cause a change or a break in the protein structure. High temperatures, radiation, pH changes and certain chemicals (such as urea) can cause changes to the structure. Sometimes the proteins can regain shape when normal conditions return. An example of irreversible protein change can be seen when cooking an egg. The egg white (protein) reacts to the heat causing a permanent change. An example of a reversible change is when an individual gets a permanent wave in their hair. The hair curls as a result of the protein change. As the chemical washes out, the sulfur bonds reform, possibly in different places, changing the appearance of the hair even when the proteins regain shape.

When dietary proteins are digested and hydrolysis splits the protein into two similar parts. The amino acids that result from this process are absorbed and transported throughout the body or undergo deamination. Deamination is a process that occurs in the liver in order to remove the nitrogen containing proteins. These nitrogen proteins are then converted to the waste called urea:

Protein hydrolysis



The liver produces urea from nitrogen groups formed bydeamination of amino acids. The urea is carried to the kidneys through the blood stream, where it is excreted in urine. This process is inhibited by certain kidney disorders that impair the ability to remove the urea from the blood. This will raise the blood urea concentration that can be detected by the blood test called blood urea nitrogen (BUN) level, to evaluate the kidney functions.

Thermal regulation of body cells

Body temperature regulation is vital to homeostasis. Even the slightest shift in body temperature can disrupt the rate of the metabolic reactions in the cells functions. Normal body temperature is 98.6 degrees F. For the body to maintain this constant temperature it must balance the amount of heat produced through cellular metabolism and the amount of heat lost that is largely regulated through the skin.

The cellular metabolic heat produced during physical exercise is released from the muscles to the blood where it is carried away from the muscles to the hypothalamus. In turn the hypothalamus will signal the dermal blood vessel walls of the muscle to relax. As the vessels dilate, more blood enters the vessels and the heat in the blood escapes to the outside. This works at the dermal layer of the skin over the muscles being worked. At the same time, the deeper blood vessels of the active muscle vasoconstrict, diverting the blood to the surface of the skin over the muscle producing redness. This will stimulate the heart to beat faster, moving the blood out of the deeper tissue faster.

Radiation

The primary means of heat loss of the body is radiation. Infrared heat rays escape from warmer surface to cooler surroundings. These rays will release the heat in all directions, much like the bulb from a heat lamp. Conduction and convection also allow the body to release heat, but in lesser amounts. During conduction, the heat moves from the body directly into the molecules of cooler objects you are in contact with. Example: when you sit on a cold metal bench in the winter. The heat from your body is lost by conduction into the metal seat.Convection is when there is a continuous circulation of cooler air that is warmed over a surface. As the cooler air becomes heated, it moves away from the body carrying the heat along with it. This air is then replaced with cooler air moving toward the body to be warmed. This continuous cycle of air circulated is heat loss through convection.

Evaporation

There is still one more way the body will lose heat. When the body temperature rises above normal the nervous system stimulates the sweat glands to release sweat onto the skins surface. When the sweat evaporates, it carries the heat away from the surface to cool the skin. This process is evaporation.

The hypothalamus controls the functions to regulate the body temperature; normal regulation of heat loss begins with the blood vessels. As the muscles of the dermal blood vessels contract this decreases the flow of heat-carrying blood through the skin. The result is a reduction of heat loss by radiation, conduction and convection; it is evidenced by a loss of color to the skin. The body will also signal the sweat glands to remain inactive to reduce the heat loss through evaporation. If the constriction of the blood vessels and inactivating the sweat glands is not enough to stop the heat loss, and the body temperature continues to fall, the nervous system may stimulate muscle fibers to contract slightly. This action will increase the rate of cellular respiration to produce heat at the cellular level. If this response still does not raise the body temperature, then small muscle groups will begin to rhythmically contract to cause a person to shiver, generating more heat.

Hypothermia

Unfortunately, the mechanisms do not always function properly. When the body function fails, the consequences can be dangerous. Hypothermia, and excessively lowered body temperature, can result from prolonged exposure to cold or even as part of an illness. Hypothermia begins with the last normal response to cold—shivering. Hypothermia effects continue with the feeling of coldness, and the progression to mental confusion, lethargy, loss of reflexes and consciousness, and eventually the shutting down of major organs. If the temperature of the body core drops even just a few degrees, respiratory failure or heart arrhythmias may occur. On the other hand, your extremities can withstand significant drops in temperature, as much as 20 to 30° F below normal.

With any disease process, certain people are at higher risk for developing hypothermia. The very young, very old, extremely thin individuals and the homeless. The best way to prevent hypothermia is to dress appropriately with layers and stay active in the cold. Any individual being treated, or even just a particular body part, for hypothermia must be warmed gradually. This allows the respiratory, cardiovascular, and circulatory functions to remain stable.

Hyperthermia

Hypothermia is one extreme when the body is unable to regulate the body’s temperature and hyperthermia is the other. Being able to cool the body temperature is done largely through the dilation of the blood vessels and the secretion of sweat. In extremely humid environments, the body has a difficult time reducing the body temperature. Why? Well, air can only hold a limited amount of water vapor, so on the hot humid day; the air becomes nearly saturated with water. During this time, the sweat glands may be activated, but the sweat is unable to evaporate quickly so the skin becomes wet, but the individual remains hot and uncomfortable. In high humidity, the body is unable to release the necessary heat through evaporation due to the humidity level. This can also be compounded with a high ambient air temperature.

When the air temperature is higher than the body temperature, the body will continue to gain heat from the surroundings causing the core temperature to rise even higher. A high core temperature can result in circulatory system collapse. An extreme example of this is seen every summer in the southern states of the US. In Texas and Florida where summer temperatures reach into the 100s, a child left in a closed vehicle for as little as 30 minutes can die from hyperthermia. In this environment, the heat will overwhelm the temperature-regulating mechanism. The child’s body heat will build up faster than it can dissipate. The body temperature rises, even though the set point of the thermostat (hypothalamus) is normal. The child’s body will dilate the blood vessels in an attempt to dissipate the excess heat through sweat. With this extreme blood vessel dilation, the circulatory system collapses within minutes.

Hyperthermia is not always to this extreme and not always a life threatening situation. A *fever* is the body’s attempt to fight an infection by self-inducing a hyperthermic response. In a fever, molecules on the surface of the infectious agent stimulate phagocytes to release a substance called endogenous pyrogen, meaning “fire maker from within.” The bloodstream carries the endogenous pyrogen to the hypothalamus, where the set point controlling temperature is raised. The body responds by signaling the skeletal muscles to increase the heat production, decrease the blood flow to the skin, and decrease the production of sweat gland secretion. This results in the body temperature rising to the new set point, and the person then has a fever. This increase in the body temperature helps the immune system to kill the pathogens, also making the individual uncomfortable. The immune system is the primary defense the body has to fight disease processes. For the system to work effectively, specific body functions must be working together for the immune system to perform. (Figure 2–6.)

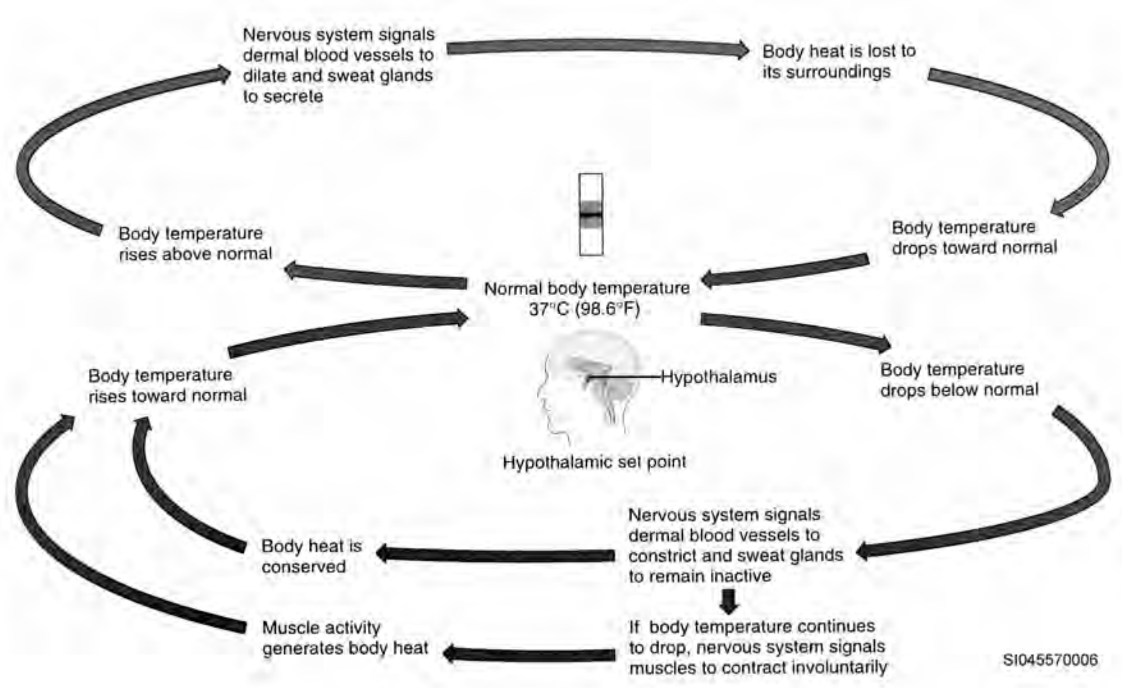


Figure 2–6. Thermal Regulation

Exercise

Exercise is also an important health factor. Various methods are used in patient care, depending on the situation. Some exercises are used to strengthen muscles, while others are used to improve cardiovascular function.

All exercise involves an active contraction and relaxation of muscles. The various categories of exercise are classified according to two factors: the type of muscle contraction involved (isotonic, isometric, or isokinetic), and the source of energy (aerobic or anaerobic). The following table contains information on these general exercise categories.

Type of Exercise	Description	Examples
Isotonic	• Involves constant muscle tension. • Causes muscles to shorten, resulting in muscle contraction and movement. • Increases muscle strength. • Heart rate increases. • Little or no change in blood pressure.	• Walking. • Running. • Swimming. • Cycling. • Pushing or pulling against a stationary object (i.e., push-ups or sit-ups).
Isometric	• Produces a change in muscle tension without changing muscle length. • No muscle or joint movement involved. • Moderate heart rate increase. • Increase in blood pressure.	• Contracting a muscle and holding it for a period of time. • Pushing against a wall or similar stationary object.

Type of Exercise	Description	Examples
Isokinetic	• Involves muscle contraction and joint movement. • Can be either isotonic or isometric in nature. • Useful in building certain muscle groups.	• Moving (isotonic) against a resistant object (isometric). • Lifting weights. • Rowing machine.
Aerobic	• Exercise that involves taking in an amount of oxygen that is equal to or greater than the amount the body requires. • Improves cardiovascular function.	• Brisk walking. • Swimming.
Anaerobic	• Exercise that results in taking in less oxygen than the body needs. • Involves active joint movement. • Usually accomplished in short increments of exertion. • Develops muscles. • Improves cardiovascular function.	• Running up stairs. • Running sprints. • Weightlifting. • Sports.

Exercises frequently used as a therapeutic treatment are called *range of motion* (ROM) exercises. They involve moving the joints in all capable directions. One purpose of ROM exercises is to maintain or increase muscle strength and endurance. Another purpose is to maintain cardiorespiratory status in a patient who is immobilized. ROM exercises are discussed further in Volume 2.

013. Body defenses and healing process

You have reviewed the basic needs, nutrition and physiology of the chemical balances needed for the body to function properly. Now it is time to look at other factors that can influence health. Influences such as age, ethnic background and gender are the influences we cannot change, and have to accept the health risks that may come with these factors. As you may remember, there are some factors we can change or control. Your body will react to the influences it is exposed to and the treatment it may have to undergo. This capability depends on the proper functioning of various organs and systems as well as the nature or extent of the disorder.

The body's defenses are affected by a simple break in the integumentary system or by a major illness or disease. While you may be able to control the break to the skin, an infant born with HIV must deal with this uncontrollable influence. Cells are the basic working functions to all processes, beginning with the white blood cells, the first line of defense to fight disease.

White blood cells

White blood cells (WBC), or leukocytes, do most of their work outside the circulatory system to protect against disease at the cellular level. The WBCs are transported to sites of infection by the circulatory system. There are five types of leukocytes that are distinguished by their size, nature of their cytoplasm and the shape of their nucleus. The five types are grouped into one of two categories, granulocytes and agranulocytes. Granulocytes are leukocytes that have granular cytoplasm, while the leukocytes that lack cytoplasmic granules are called agranulocytes.

Granulocytes

Typical granulocytes are developed in the red bone marrow from hemocytoblasts and consist of three types of leukocytes: *neutrophils, eosinophils and basophils*. These granulocytes have a relatively short life span, averaging only 12 hours. Neutrophils have fine cytoplasmic granules, and a nucleus that consists of two to five sections. For this reason, neutrophils are also called polymorphonuclear leukocytes. Neutrophils account for 54–62 percent of the leukocytes in a typical adult blood sample. Eosinophils contain course uniformly sized cytoplasmic granules with a blobbed nucleus (two lobes).

These cells make up 1–3 percent of the total number of leukocytes. The last granulocyte is the basophil. The basophils are similar to eosinophils in size and the shape of their nuclei. The basophils have fewer more irregular shaped cytoplasmic granules that often obscure a view of the nucleus. These leukocytes account for less than 1 percent of the leukocytes.

Agranulocytes

The agranulocytes make up the last two types of leukocytes, the *monocytes* and *lymphocytes*. Monocytes generally arise from red bone marrow, while the lymphocytes are found in the organs of the lymphatic system as well as in the red bone marrow. Monocytes are the largest cell found in the blood. The nuclei vary in shape, round, kidney-shaped, oval or lobed. They usually make up 3–9 percent of the leukocytes in a blood sample and live for several weeks or even months. The lymphocytes are usually only slightly larger than erythrocytes. Typically, lymphocytes contain a relatively large round nucleus surrounded by a thin rim of cytoplasm. The lymphocytes account for 25–35 percent of the leukocytes. Lymphocytes have an extremely long life span that may extend for years.

Functions of white blood cells

The leukocytes are first line defense in fighting diseases; this is accomplished in various ways. Some leukocytes phagocytize (engulf) bacterial cells in the body, while others produce antibody proteins that destroy or disable foreign particles.

The most active phagocytic leukocytes are neutrophils and monocytes. Neutrophils ingest the particles the size of bacterial cells, while the monocytes can engulf cells much larger. When a microorganism invades the human body, the cells respond by releasing biochemicals such as histamine. The histamine dilates arterioles to allow more blood to flood into the capillaries. The tissue reddens producing the swelling inflammatory reaction where the damaged cells release chemicals that attract the leukocytes to the area quickly. The eosinophils help to control inflammation and allergic reactions by removing biochemicals associated with these reactions. Eosinophils are weakly phagocytic, but are attracted to and kill certain parasites enabling the body to fight disease.

The basophils help to prevent intravascular blood clot formation by releasing heparin, and may increase blood flow to injured tissues by releasing histamine. Lastly, lymphocytes are important in the immunity process. The lymphocytes include B-lymphocytes (B-cells) that produce antibodies, and the T-lymphocytes (T-cells) that produce biochemicals called cytokine. Cytokine is a protein necessary for proper cell reproduction and division and is directly linked to the immune responses. When the T-cells have been invaded, and the cytokine is not released, severe immunocompromised disease may occur.

Lymphatic system and immunity

Lymphocytes are categorized within blood cells of the body, but are the foundational cell for the lymphatic system and the immunity process. Lymphocytes produce antibodies and cytokine protein products to assist the functions of immunity. When there is a break down of these lymphocytes, immune responses are affected. The lymphatic system is closely associated with the cardiovascular system because it includes a network of vessels that assist the circulation of fluid through the body and help defend the body against invasion by disease-causing agents. To understand the functions of immunity, we need to begin with the components of the lymphatic system as a whole.

Components of the lymphatic system

Lymphatic capillaries are the microscopic closed-ended tubes and contain the fluid called *lymph*. This fluid is essentially tissue fluid that has entered a lymphatic capillary. The lymph is carried through the lymphatic vessels that are similar to veins in having semi lunar valves to prevent back flow of lymph, but thinner. These lymphatic vessels lead to the specialized organs called lymph nodes. After leaving the lymph nodes, the vessels merge to form the lymphatic trunk.

Lymph nodes

Lymph nodes, or lymph glands, are located along the lymphatic pathways through out the trunk of the body. The nodes contain large numbers of lymphocytes and macrophages that fight invading microorganisms. Nodes occur singly or in groups associated with the mucous membranes of the respiratory and digestive tracts. The tonsils are an example; they are composed of partially encapsulated lymph nodules. The following table provides you with the region, location, and function of each group of lymph nodes. Figure 2–7 provides a visual reference.

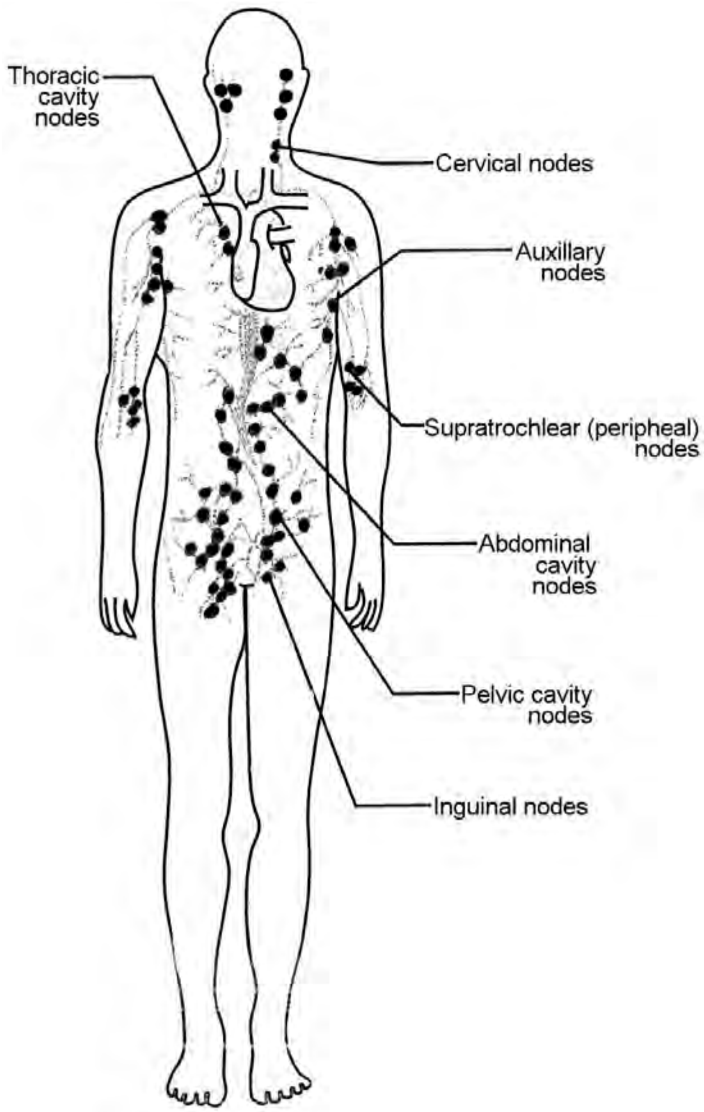


Figure 2–7. Lymphatic trunk.

Major Location Of Lymph Nodes		
Region	**Location**	**Function**
Cervical	Nodes occur along the lower border of the mandible, in front of and behind ears, and deep within the neck along the path of the large blood vessels.	Associated with the lymphatic vessel that drains the skin of the scalp, face and the tissue of the nasal cavity and pharynx.

Major Location Of Lymph Nodes		
Region	**Location**	**Function**
Axillary	Nodes in the armpit region.	Drains lymph into the upper limbs, wall of the thorax, the mammary glands, and the upper wall of the abdomen.
Inguinal	Node in the inguinal region	Receive lymph from the lower limbs, the external genitalia, and the lower abdominal wall.
Pelvic cavity	Within the pelvic cavity, nodes occur primarily along the paths of the iliac blood vessels.	Receive lymph from the lymphatic vessels of the pelvic viscera.
Abdominal cavity	Nodes within the abdominal cavity occur in chains along the main branches of the mesenteric arteries and abdominal aorta.	Primarily receive lymph from the abdominal viscera.
Thoracic cavity	Nodes of the thoracic cavity occur within the mediastinum and along the trachea and bronchi.	They receive lymph from the thoracic viscera and from the internal wall of the thorax.
Supratrochlear (peripheral)	These nodes are located superficially on the medial side of the elbow	In children they are often enlarged as a result of infections from cuts and scrapes of the hands.

There are two primary functions for all lymph nodes, filtering potentially harmful particles from lymph before returning it to the bloodstream and immune surveillance provided by the lymphocytes and macrophages. Remember the lymphocytes and macrophages attack infecting viruses, bacteria and other parasitic cells brought to the nodes through the lymphatic system. The macrophages in the nodes phagocitize and destroy the foreign substances, damaged cells and cellular debris.

Thymus

The thymus gland is a soft, bilobed structure enclosed in a capsule located within the mediastinum, in front of the aortic arch and behind the upper part of the sternum. The thymus is relatively large during infancy and early childhood up to about two years of age. After puberty it shrinks becoming quite small in an adult. The actual size varies from person to person, and in the elderly the normal lymphatic tissue is replaced by adipose and connective tissues.

The thymus is considered the primary central gland of the lymphatic system and functions in association with the endocrine system. The endocrine activity depends on the hormone thymosin; which is composed of biologically active peptides critical to the maturation and development of the immune system. The lobes contain large numbers of lymphocytes that developed from precursor cells (thymocytes) originating in the bone marrow. These thymocytes mature into T-cells that leave the thymus and migrate to the lymph nodes and spleen. T-cells primarily mediate cellular immune responses such as graft rejection and delayed hypersensitivity.

Spleen

This is the largest of the lymphatic organs, located in the upper left quadrant of the abdominal cavity, just below the diaphragm and behind the stomach. The spleen resembles the look of a large lymph node, enclosed in connective tissue, partially subdividing the organ into lobules. Within these lobes there are two types of tissue found, white pulp and red pulp. The white pulp is distributed throughout the spleen as if like tiny islands, with the white pulp containing most of the lymphocytes. The red pulp contains numerous red blood cells, which gives its color, and many macrophages with some lymphocytes. The macrophages engulf and destroy foreign particles and the lymphocytes defend the body against infection that may be carried in the blood as it is filtered through the spleen.

Immune responses

We understand that the B-cells and T-cells are produced by the lymphocytes; these cells are not *activated* until they have encountered the antigen for which they are specialized to react with. This action constitutes a *primary immune response.* During this response, plasma cells release antibodies immunoglobulin M (IgM), followed by immunoglobulin G (IgG) into the lymph. The antibodies are transported into the blood and then throughout the body, where they help to destroy the antigen causing microorganism or bacteria. This production and release of these antibodies continues for several weeks to continue to fight the disease. Detectable concentration of antibodies usually appears in the body fluids within five to ten days following exposure to antigens. The concentration of antibodies is a direct result of the primary immune response.

Following the primary immune response, some of the B-cells produced during the initial release of antibodies, clone and remain dormant to serve as memory cells. If the identical antigen is reencountered, the body uses these clones of these memory cells to enlarge. The B-cell then responds rapidly with the IgG to the antigen to destroy the disease before it produces wide spread disease in the body. This is called a *secondary immune response.* The secondary immune response helps to stimulate a slow releasing of the viral antigen after an initial infection. This constantly stimulates memory B-cells, which present the antigen to T-cells thus maintaining immunity.

Types of immunity

Just a generation ago, it was not uncommon to find school classrooms empty at certain times of the year due to several infectious “childhood diseases,” like measles, pertussis (whooping cough), mumps and even chicken pox. With these diseases, children usually suffered the illness only once due to the *naturally acquired active immunity* developed due to exposure of the illness. Today, most children in the US do not contract these childhood diseases due to vaccinations. A vaccine contains an antigen that can stimulate a primary immune response against a particular disease-causing agent. With the vaccine, it does not produce the severe symptoms of the disease. A vaccine may contain bacteria or viruses that have been killed or weakened so that they cannot cause a serious infection. Vaccines may also contain a toxoid (toxin of an infectious organism that has been chemically altered to destroy its toxic effects). At these low doses of the organism or bacteria, it may be sufficient enough of the foreign antigen to alert the immune response system. The vaccine causes a person to develop *artificially acquired active immunity*. There are cases where a virus changes so rapidly; the body can’t defend against disease and the immune system starts to break down. This happens in cases of HIV, the virus that causes AIDS, which is constantly changing and making it very difficult to produce a vaccine.

There are other instances where a person who has been exposed to an infectious disease and needs protections against the disease-causing agent, but lacks the time to develop the active immunity. This is seen in cases of hepatitis. In some instances it may be possible to inject the person with antiserum (ready-made antibodies of the infectious agent). Usually these antibodies are obtained from gamma globulin that has been separated from the blood plasma of a person who has already developed immunity against the particular disease. The injection of gamma globulin produces an *artificially acquired passive immunity*. It is passive because an individual acquires the antibodies necessary for the body to recognize and fight the disease because the body did not develop them on their own. This type of immunity is relatively short lived, lasting no more than just a few weeks. This individual is still susceptible to the pathogen in the future; their lymphocytes were not involved in fighting against the pathogen that was needed for protection.

The last type of immunity is specific to mother and child during pregnancy. Certain antibodies (IgG) pass from the maternal blood into the fetal bloodstream through the placental barrier. After entering the fetal cells, the antibodies are secreted into the fetal blood. The result is the fetus acquires a limited amount of immunity against the pathogens for which the pregnant woman has already developed active immunities. The fetus has developed *naturally acquired passive immunity* that remains in effect for six months to a year after birth. Use the following table as a quick reference for types of immunities.

Types Of Immunity		
Type	**Stimulus**	**Response**
Naturally acquired active immunity	Direct exposure to live pathogens.	Symptoms of the disease stimulate the individual immune response.
Artificially acquired active immunity	Exposure to a vaccine. Pathogen or its components killed or weakened.	Stimulates the immune response without severe symptoms of the disease.
Artificially acquired passive immunity	Injection of gamma globulins containing antibodies.	Immunity for a short period of time without stimulating the individual's immune response.
Naturally acquired passive immunity	Antibodies passed through the placental barrier from a pregnant woman with active immunity.	Short-term immunity for the infant without stimulating the immune response.

Allergic reactions

When you think of immune responses you may initially only think of the previous section and the types of immune responses. Allergic reactions are also classified as an immune response. The body cells react to pathogens in many of the same ways.

Allergic reactions involve the sensitizing of antigens with antibodies, but with an allergic reaction, tissues may become damaged. Allergic reaction is also called a hypersensitivity reaction. In one form or another, allergic reactions affect everyone, but some people have inherited an ability to produce exaggerated immune responses. The antigens that trigger allergic responses are called allergens.

A *delayed-reaction* may occur in anyone. It is a result from repeated exposure of the skin to certain chemicals; household or industrial chemicals and cosmetics are some causes. When there is repeated contact, the presence of the substance activates the T-cells in large numbers and collects in the skin. The T-cells and macrophages that are attracted release chemical factors that produce an inflammation of the skin (dermatitis). This reaction usually occurs 48 hours after exposure, thus the delayed-reaction.

A common example in the military treatment facility is the tuberculin skin test. The test uses a tuberculin preparation of purified protein derivative (PPD) that is injected intradermally. If the individual T-cells have been sensitized (previously exposed to) to the antigens of the mycobacteria that caused tuberculosis, an allergic reaction occurs within 48–72 hours. This is classified as a positive test result. In this positive reaction, a localized region of the skin and subcutaneous tissue hardens. With this positive reaction it does not necessarily mean the individual has been exposed to active tuberculosis, just that they have been exposed to the mycobacteria causing the disease. In some countries the vaccine prepared from Bacilli calmette-guerin (BCG) is used to immunize against tuberculosis. For these individuals, the tuberculin skin test is contra indicated. The absence of this reaction signifies the person's T-cells have not previously been exposed to the mycobacterial antigen.

Some allergic reactions may occur within minutes after contact with a nonself substance. This individual has inherited the ability to over produce immunoglobulin E (IgE) antibodies resulting in an *immediate-reaction*. With the immediate-reaction, the B-cells become sensitized when the allergen is first encountered and subsequent exposures trigger the allergic reaction. When a subsequent allergen-antibody reaction occurs, these cells release allergy mediators as histamine, prostaglandin D_2 and luekotrienes. These substances cause a variety of physiological effects in the body. The reactions include dilation of the blood vessels, increased vascular permeability that swells the tissues, contraction of the bronchial and intestinal smooth muscles, and the increasing of mucus production. These reactions are indicative of a severe inflammation reaction that is responsible for the symptoms of the allergy. Signs of these symptoms can be seen as hives, asthma, eczema or gastric disturbances.

The most severe type of immediate reaction is anaphylactic shock. The individual may at first feel an inexplicable apprehension, and then suddenly break out in red hives and itch all over the entire body. The face, tongue and larynx begin to swell causing breathing difficulty. At this point of the reaction, if the person does not receive an injection of epinephrine, their airway is sure to close. The only other way of restoring breathing for this person is through a tracheotomy because the airway is so swollen that an endotracheal tube will be unable to pass by the larynx. Once breathing has stopped and unable to be restored, loss of consciousness and death may occur with in five minutes. Most often, anaphylactic shock results from an allergy to penicillin or insect sting. Fortunately, most individuals are aware of their allergy status and avoid these allergens. In addition, prompt medical attention is available in most areas of the country resulting in less than 100 people who die from anaphylactic shock.

Autoimmunity

There are times when the immune system backfires, making autoantibodies that attack the body's own cells. Some of the disorders that will elicit this immune response are rheumatic fever, ulcerative colitis, and Grave's disease. During this response, the virus "borrows" proteins from the body's cells during replication and incorporates them into the virus cell and gives the body cell some of the viral proteins. When the immune system identifies the virus to destroy it, it also recognizes the virus proteins in the body's cell and miss identifies the body cell as a viral cell that should be destroyed. Another way the body's cells become "invaded" with the viral proteins is through T-cells that escaped their "education" process during formation in the thymus. These T-cells were never able to identify "true T-cells" from the invaded cells and accepted the viral proteins only to become identified by the body as a "viral cell."

Wound healing

The body's defenses are automatic responses to disease and the invasion of microorganisms into the body. Some of the microorganisms may be a result to an external cause of injury. With injuries come wounds. The physiological response for the body's healing process of wounds is accomplished in three different wound closure treatments: primary, secondary and tertiary-intention healing. The choice of wound closure will depend on how the injury occurred and how extensive the wound is. With any wound there are three stages of wound healing: inflammation, reconstruction, and maturation.

Healing stages

All wounds heal in much the same manner; inflammation to proliferate the site with blood cells, reconstruction, continued wound debridement and collagen formation, and finally maturation of the wound. Each stage is vital to the result of the scar or in worst case a continued wound with the complication of infection.

Inflammation

Inflammation occurs immediately at the site of injury at the cellular level. Previously, you learned how the blood cells and the immune responses invade the microorganisms at the cellular level. When injury occurs, the body's first step of the healing process is to produce inflammation at the site. The primary purpose of the inflammatory response is to neutralize and destroy harmful agents, limit the spread to other tissues, and prepare the damaged tissue for repair. Changes occur locally at the site of injury and systemically during the inflammatory stage. Systemic changes are seen in vascular alterations, hormonal response and the increased white blood cells (phagocytic actions). Vasodilatation will produce the outward signs of the inflammatory stage seen as edema at the injured site, erythema resulting from the increased blood supply, increased temperature, pain stemming from pressure on the nerve receptors, and possible loss of function resulting from all of the changes.

Whenever a wound occurs, one of two responses occurs as the wound heals: either regeneration or replacement of the cells. The blood vessels will initially vasodilate to produce more circulation to the site, when the site has received enough cell support, platelet aggregation and the formation of fibrin occur producing a clot. A scab forms to protect the wound against the invasion of pathogens. During this saturation of cells, complex chemical reactions bring phagocytic leukocytes to cleanse the wound by removing the cellular debris and engulfing the bacteria. Immature fiber cells and capillaries are formed moving into the remaining space. Epithelial cells migrate from the margins of the wound to the base of the scab forming a layer of epithelial tissue over the wound in about 48 hours. This stage of healing may last up to three to four days.

Reconstruction

Reconstruction of a wound begins on the third or fourth day after injury lasting two to three weeks. Throughout reconstruction, macrophages continue to debris the wound and stimulate the fibroblasts to synthesize collagen. Collagen is the fibrous structural protein found in all connective tissue and is the main ingredient of scar tissue. During the inflammatory stage the immature capillaries are formed, providing oxygen and nutrients to support the collagen and for further synthesis of tissue. As the new tissue grows in, the wound begins to close.

The reconstruction stage is much longer when the secondary or tertiary-intention healing treatment process closes a wound. This is because granulation tissue is being constructed rather than collagen. Granulation tissue needs more of a blood supply than collagen tissue. With granulation tissue, the wound contracts and the skin surrounding the wound are pulled together. The cells are replaced with a different type of tissue versus the regeneration of tissue with similar structure and function.

Maturation

This final stage involves the development of the scar and may take up to two years. Scarring is influenced by the degree of stress on a wound. By 15–20 days, the risk of wound separation or rupture is less likely. Scar maturation is the process of the collagen breaking and synthesizing by the macrophages to produce the strongest scar tissue it can. The formation of a scar appears soft with reddish granulation tissue. As time progresses, the capillaries and connective tissue cells in the wound shrink and become tight, now appearing hard and reddish. Full scar maturation is evident when it becomes white and glossy in appearance. If there is an over growth of the collagen (too much synthesized) a keloid (often has a rope-like appearance) is formed. This is frequently seen in dark pigmented skin.

The three stages of wound healing are interwoven rather than linear. You may have different healing stages seen in one wound. The wound may be open or closed, clean or infected, causing the opportunity for other complications to occur.

Wound closure

Wound closure and wound care will be covered more in-depth in a following unit and in the next volume. However, as wound healing is an integral part of the body’s defense system, we will cover some basic information here. When there is an open wound there are three avenues of treatment used to close the wound: primary-, secondary-, and tertiary-intention closure. With each type of closure additional treatments are used.

Primary-intention closure

When a wound with little tissue loss or damage, such as a surgical incision, is made primary-intention closure is used. The wound edges are approximated (bought together like a puzzle piece) and closure is accomplished by suturing or the use of staple. There are no open areas or dead space left in the wound so the risk of infection is decreased.

Secondary-intention closure

With a wound that has tissue loss such as a pressure ulcer or severe laceration, secondary-intention closure is used for treatment of the wound. The edges of the wound are not approximated and the wound is left completely open to close from the inside to the out with granulation tissue and then scar tissue. With secondary intention, the process takes longer and the chance of infection is higher.

Tertiary-intention closure

This is also known as delayed closure because there is a delay in the suturing of a wound. Such wounds are sutured after the granulation tissue has begun to form. An abdominal wound left open for drainage and then later sutured or stapled closed is an example of the tertiary-intention closure.

014. Mental health and psychological adjustments

Even with all of the medical break-throughs, the mind is a great influence to healing that is still often over looked. The mind has and continues to prove to be one of the best healing components in the recovery process. If the patient believes they will recover and heal, chances are, they will. Just the reverse is also true. Understanding the purpose and expected outcome of medical treatment procedures is necessary knowledge that every medic needs to assist patients in their recovery.

Illness and injury often have an obvious effect on people. However, some adjust and cope with illness, injury and healing positively while others may struggle with despair, depression or other psychological problems. There are various psychological factors that can influence a patient's mental status while under the care of a health care system. Medics should keep in mind there are sources available to assist in improving or maintaining a patient's mental well-being. Most notably, these sources include family, friends, supervisors, co-workers and clergy. Allowing as much time as possible for a patient to visit with such support people is crucial in the therapeutic process.

Medical technician guidelines

Patients often want to talk to the health care personnel whom they see on a frequent basis during clinic visits and hospitalization. This obviously means medics are prime candidates for such sessions. It is important to keep three things in mind whenever conversing with a patient in regard to personal concerns:

1. Be a good listener and demonstrate a genuine concern.
2. Do not offer advice or solutions on matters that only the provider should address.
3. Refer the patient's concerns to the nurse or provider in a timely manner.
4. Finally, it is important to keep the patient's family in mind. Though local policies should be adhered to on matters such as visiting hours, the number of visitors permitted at any one time, restricted patient treatment areas, and so forth, and the staff must make every effort to keep the family informed and comfortable.

Responses to illness or injury

There are so many different types of major injuries and severe medical conditions that can occur we could never cover all the situations known to the medical community. Some of the major injuries and severe medical conditions you may encounter are gunshot wounds, burns, spinal cord injuries, strokes or heart attacks. Although the conditions are very different, the patients may share many of the same feelings, including:

- Shock and disorientation.
- Fear and anxiety.
- Depression.
- Guilt.
- Post traumatic stress disorder.

It has been reported that one third of hospitalized medical patients with chronic medical conditions and major injuries also suffer from psychological disorders such as depression or anxiety. Many psychological components of medical illnesses are still understudied, and often overlooked.

Psychological states, such as anxiety and depression, can alter the adjustment to illnesses, thereby causing poor health practices and interfering with social functioning. Health psychologists stress the importance of identifying and treating psychological disorders in patients with chronic diseases or major injuries. A healthy adjustment to these major changes or life stressors is linked to increased attempts to gain control over one's health. Health psychologists believe it is important to educate people about the variety in responses to negative life events because it allows friends and family to respond in more constructive ways. Understanding and recognizing the patient's response to severe illness or injury is even more important for medical technicians these days. With the number of wounded warriors we see direct from the battlefield or as they continue to heal, it is essential to always keep the patient's mental and spiritual well being in mind while caring for the physical wounds. While volumes have been written on the psychological effects of illness and injury, we will briefly cover a few of the common responses patients may have.

Shock and disorientation

The immediate reaction to a major injury is normally a sense of shock and disorientation relating to the enormity of the event. You may have seen or heard the patient appeared "distant" or felt "numb." This reaction is usually short-term, lasting a few days to a week. Following the initial shock, he or she might experience emotional turmoil exhibited by nightmares of being injured again, sleep problems, mental confusion and disorientation.

The quality of his or her family support and the medical care you provide, are key factors that will influence the patient's healing and adjustment. There may also be local support groups to help the patient with the difficulties of returning to home and work.

Fear and anxiety

There is little question a patient may experience fear and anxiety from a major injury. In fact, excessive anxiety generally contributes to the initial shock reaction. He or she may express fear and anxiety in varied ways:

- Feeling anger and exhibiting withdrawal behavior.
- Expressing a need for safety, security, and nurturing (through words or actions).
- Reverting to childlike behaviors when dealing with stress.
- Becoming aggressive, demanding, tearful, and more dependent on others.
- Focusing on thoughts of survival, comfort, and treatment procedures, which can influence fear.

Don't forget you are actually supporting more than the patient receiving care. The patient's family and close friends may also experience emotional shock, anxiety, fear, panic, and even guilt.

Depression

It is normal for the patient to grieve the loss of function and his or her body image, so depression is a common occurrence following a major injury. The patient may become very discouraged about what he or she can and can't do. Perhaps the patient may think her or she won't be able to play with his or her children, or provide for their emotional needs in the future. The patient might worry that his or her appearance will upset their spouse, thus interfering with their marital and intimate relationship. The patient may think he or she will never work again and will have concerns over financial problems. If the patient remains depressed, has difficulty sleeping, worries about his or her situation, or suffers from a significant loss or gain of appetite, the patient or family should bring the concern forward. Additionally, if you notice the patient appears depressed or seems to be suffering from any unhealthy psychological indicators, notify the nurse or doctor. The health care provider may be able to provide assistance or refer him or her to the appropriate mental health professional.

Guilt

Guilt is another reaction that could be experienced after a major injury. The patient may be thinking, "I should have done something to prevent the accident," "I should have taken just a little more time …" or "I can't do anything right." Feelings of guilt can also be associated with depression. If the patient is suffering from such negative feelings, they need to discuss their emotional condition with their doctor.

Post-traumatic stress disorder

Any patient who has suffered from, witnessed or been in danger of a major injury could be at risk for post-traumatic stress disorder. This is a significant concern if the patient has been in a wartime situation, suffered from a significant injury or even a thermal burn. Signs include:

- Recurrent and intrusive recollections of the injury.
- Dreams of the event.
- Feeling of being wounded again.
- Psychological distress when the memory of the accident/incident is triggered.

Even though the event has ended, the patient may still experience physical and mental suffering that is associated with it.

After a patient has been through inpatient rehabilitation and has been discharged, he or she may begin to feel isolated, depressed, perhaps in despair. Concerns about income, future jobs, and the daily demands of life will take their toll on the patient's well-being. For the patient and family, they have entered a world where there is limited experience. No one in the family may understand all of the patient's emotional responses. This period in recovery is a critical time for the patient and the family. Counseling and support groups are healthy ways to learn how to cope with the changes in life.

Substance abuse

The misuse or overuse of any substance is considered to be substance abuse, and it's seen in many forms. Substance abuse can involve both legal and illegal substances. The two areas of concern addressed here are alcohol and drug abuse. Though alcohol itself is considered to be a drug, we address it separately.

Alcohol abuse

Alcohol abuse is extremely dangerous to an individual's personal health and safety. Additionally, alcohol abuse by an individual can jeopardize the safety of others. A person is usually considered to be intoxicated if the blood alcohol level is greater than 100 mg/dL. A blood alcohol level of over 400 mg/dL is considered a life-threatening emergency requiring prompt medical intervention.

Intoxication dramatically affects the central nervous system. This is often evident by such signs as slurred speech, lack of coordination, impaired sensory capability (especially vision), and behavioral changes.Chronic alcohol abuse (alcoholism) can have a permanent effect on other body organs, the most notable being the liver. A condition that can also result from alcoholism is known as *alcohol withdrawal delirium* (commonly referred to as delirium tremens or DT). This condition occurs most often when someone who has been consuming alcohol on a prolonged, constant basis suddenly stops drinking. Signs and symptoms can be noticed approximately four hours after cessation of drinking and will be at their peak between 24 and 48 hours. The condition results in signs such as shaking, seizures, and hallucinations. Delirium tremens is a true medical emergency requiring immediate care.

Drug abuse

Drug abuse is characterized by the use of any drug for other than a legitimate medical purpose. Sometimes the abuse involves an overdose of a prescription or nonprescription drug. In other cases, an illegal substance may be involved. The four main categories of drugs often abused are *narcotics*, *sedatives*, *central nervous system stimulants*, and *hallucinogens*.

An overdose can be either accidental or intentional. In either case, the effects on the body will vary from minimal to life threatening. Local poison control centers are relied on by health care personnel to provide up-to-date information and treatment guidelines for all types of drug abuse situations.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

011. Environmental and community health

1. According to Florence Nightingale's theory, what are the controllable environmental factors medics should be concerned about?

2. What three health risk factors cannot be changed?

3. Explain the environmental control program.

4. What type of community health program is designed to assess health status and provide services that assist in maintaining a healthy lifestyle?

012. Nutrition and exercise

1. List three sources of protein.

2. Which vitamins cannot be stored by the body and must be ingested daily?

3. What are common reasons for ordering a bland diet?

4. What are the two major components of nutrients?

5. Why should patients without a confirmed Vitamin B_{12} deficiency avoid taking large doses of it?

6. What is the max dosage of folic acid individuals are advised to take?

7. Patients treated for what specific disease are advised *not* to take B_6 supplements?

8. What are the signs of vitamin C deficiency?

9. What is the body deprived of without vitamin C?

10. What is vitamin K necessary for?

11. Minerals are usually extracted from what source?

12. How do sodium and chloride maintain homeostasis of the body?

13. Where is the concentration of potassium found?

14. What is a primary concern when administering potassium intravenously, and how can it be prevented?

15. What triggers the body's need for more calcium intake, and what elements are needed to aid in its absorption to fulfill the need?

16. What are some of the side effects of iron supplements?

17. What is a catalyst?

18. What are the substances that release ions in the water called?

19. What is alkalosis?

20. What are the functions of water in a body?

21. What is the most common lipid?

22. What are the building blocks of proteins?

23. What is our normal body temperature?

24. What controls the functions to regulate the body temperature?

25. What is the body's attempt to fight an infection by self-inducing a hyperthermic response?

26. What type of exercise involves taking in less oxygen than the body needs?

27. State the purposes of ROM exercises.

013. Body defenses and healing process

1. Which cells are the first line of defense to fight diseases?

2. Explain the difference between granulocytes and agranulocytes.

3. Match the types of leukocytes in column A with the correct category in column B. The answers in column B can be used more than once.

Column A	*Column B*
____ (1) Monocytes.	a. Agranulocytes.
____ (2) Eosinophils.	b. Granulocytes
____ (3) Neutrophils.	
____ (4) Short life span of 12 hours.	
____ (5) Lymphocytes.	
____ (6) Basophils.	
____ (7) Extended life span from weeks to years.	

4. What does it mean to phagocyte?

5. Which leukocytes are the most active phagocytes?

6. Which lymphocyte is responsible for producing the biochemical cytokine, and what is the cytokine used for?

7. What are the seven regions of major lymph node locations and their respective functions?

8. Which organ is considered the primary central gland of the lymphatic system?

9. Match column A with the specific type of immunity it corresponds to in column B. The answers in column B may be used more than once.

Column A	*Column B*
____ (1) Directly exposed to whooping cough.	a. Naturally acquired passive immunity.
____ (2) Short-term immunity for an infant without stimulating the immune response.	b. Artificially acquired passive immunity.
____ (3) Received injection of gamma globulins containing antibodies.	c. Naturally acquired active immunity.
____ (4) Symptoms of the disease stimulate the individual immune response.	d. Artificially acquired active immunity.
____ (5) Exposure to a killed or weakened vaccine.	
____ (6) Immunity for a short time without stimulating the individual’s immune response.	
____ (7) Received antibodies through placental barrier.	
____ (8) Stimulates the immune response without severe symptoms of the disease.	

10. Hypersensitivity reaction is also known as what type of reaction?

11. Explain autoimmunity.

12. Match column A with the correct healing stages in column B. The answers of column B may be used more than once.

Column A	*Column B*
____ (1) Granulation tissue is formed.	a. Maturation.
____ (2) Epithelial cells migrate to form a scab.	b. Reconstruction.
____ (3) Scar has a whit and glossy appearance.	c. Inflammation
____ (4) Capillaries are formed.	
____ (5) Final stage of healing.	
____ (6) Healing process takes from four days up to three weeks.	
____ (7) Neutralizes and destroys harmful agents.	
____ (8) Healing stage lasts up to two years.	
____ (9) Limits the spread of infection.	
____ (10) Collagen is formed.	

13. What are the three types of wound closure treatments, and give a brief description of each?

014. Mental health and psychological adjustments

1. What are three important things you should keep in mind when conversing with a patient in regard to personal concerns?

2. What are some of the feelings patients may share in response to illness or injury?

3. What are the signs of post traumatic stress disorder?

4. At what blood alcohol level is a person usually considered to be intoxicated?

5. Intoxication dramatically affects the central nervous system. What signs make this evident?

6. What are the four main categories of drugs often abused?

7. Explain the function of local poison control centers.

Answers to Self-Test Questions

009

1. Physiological.
2. Vitamin B_{12} and folic acid are the B-complex vitamins necessary the production of RBCs.
3. Plasma lipids include triglycerides, phospholipids, and cholesterol.
4. LDL.
5. Each exercise should be performed a minimum of three to five times, either actively or passively; usually twice per day, or more if tolerated.
6. Safety and security.
7. Love and belonging.
8. Love and belonging.
9. Self-esteem.
10. Reaching one's full potential.

010

1. Infant.
2. 50,000.
3. 12–20 years.
4. Young adult, after age 30.
5. Middle adult.

011

1. Pure or fresh air; pure water; efficient drainage; cleanliness; light (especially direct sunlight).
2. Heredity, gender, and age.
3. The monitoring and/or eliminating of various environmental hazards. Specifically, contaminants that can have an adverse effect on air, food, or water are concerns that are addressed in an environmental control program.
4. Health and wellness programs.

012

1. Dairy products, meat, fish, poultry, eggs, cereals, some vegetables, and nuts.
2. Vitamins B and C.
3. (1) Ulcers.
   (2) Some intestinal disorders.
   (3) Gallbladder disorders.
   (4) Postoperative abdominal surgery.
4. Vitamins and minerals.
5. May mask symptoms of folic acid deficiency or cause complications in patients with cardiac or gout conditions.
6. 0.4 mg
7. Parkinson's
8. Muscle weakness, cramping, lethargy, sore and bleeding gums in mouth, degenerative changes in bone and connective tissue.
9. Iron.
10. Blood clotting.
11. Minerals are usually extracted from the soil by plants, and we in turn obtain them from the plant food sources or from the animal source that have eaten the plants.

12. Sodium chloride helps to maintain the electrolyte balance and regulate the ph level through the concentration of extracellular fluids in the body's cells.
13. Concentrated inside cells.
14. Pain at the injection site or phlebitis may occur; potassium should always be run at a slow rate, mixing potassium in an IV solution where it must be mixed thoroughly by inverting and agitating the bag before the solution is hung for administration.
15. Calcium absorption is based on the body's need for the mineral. Calcium needs the help of vitamin D and proteins to promote the calcium absorption.
16. Black stools, constipation or diarrhea, and nausea and vomiting.
17. A catalyst is a particular molecule that can change the rate of a reaction without itself being consumed.
18. Electrolytes.
19. Blood pH in the range of 7.5 to 7.8 is called *alkalosis,* making one feel agitated and dizzy.
20. Helps with the transportation of chemicals within the body. Blood plasma is made up of 90–95 percent water, enabling vital substances to be transported throughout the body. Substances carried by the blood are sugars, salts, vitamins, and, of course, oxygen. Blood also transports the waste products of carbon dioxide, and urea out to the lungs and kidneys, respectively. Water is a major component of body fluids where most biochemical reactions occur and it helps to regulate body temperature.
21. Fats.
22. Amino acids.
23. 98.6° F.
24. Hypothalamus.
25. Fever.
26. Anaerobic.
27. Maintain or increase muscle strength and endurance, as well as to maintain cardiorespiratory status in a patient who is immobilized.

013

1. White blood cells.
2. Granulocytes are leukocytes that have granular cytoplasm; agranulocytes are leukocytes that lack cytoplasmic granules.
3. (1) a.
   (2) b.
   (3) b.
   (4) b.
   (5) a.
   (6) b.
   (7) a.
4. Engulf.
5. Neutrophils and monocytes.
6. T lymphocytes (T-cells) produce cytokine, which is a protein necessary for proper cell reproduction and division and is directly liked to the immune responses.
7. (1) *Cervical*, associated with the lymphatic vessel drains the skin of the scalp, face and the tissue of the nasal cavity and pharynx.
   (2) *Axillary*, drains lymph into the upper limbs, wall of the thorax, the mammary glands, and the upper wall of the abdomen.
   (3) *Inguinal*, receive lymph from the lower limbs, the external genitalia, and the lower abdominal wall.
   (4) *Pelvic cavity*, receive lymph from the lymphatic vessels of the pelvic viscera.
   (5) *Abdominal cavity*, primarily receive lymph from the abdominal viscera.
   (6) *Thoracic cavity*, receive lymph from the thoracic viscera and from the internal wall of the thorax.

(7) *Supratrochlear* (peripheral), in children are often enlarged as a result of infections from cuts and scrapes of the hands.

8. Thymus.
9. (1) c.
   (2) a.
   (3) b.
   (4) c.
   (5) d.
   (6) b.
   (7) a.
   (8) d.
10. Allergic reaction.
11. The virus "borrows" proteins from the body's cells during replication and incorporates them into the virus cell and gives the body cell some of the viral proteins. When the immune system identifies the virus to destroy it, it also recognizes the virus proteins in the body's cell and miss identifies the body cell as a viral cell that should be destroyed.
12. (1) b.
    (2) c.
    (3) a.
    (4) c.
    (5) a.
    (6) b.
    (7) c.
    (8) a.
    (9) c.
    (10) b.
13. (1) *Primary*, little tissue loss or damage, wound edges are approximated and leaving only a slight chance for infection.
    (2) *Secondary*, a wound that has tissue loss such as a pressure ulcer or severe laceration edges of the wound are not approximated and the wound is left completely open to close from the inside to the out with granulation tissue and then scar tissue.
    (3) *Tertiary-intention healing*, delayed closure because there is a delay in the suturing of a wound; wounds are sutured after the granulation tissue has begun to form.

014

1. Be a good listener and demonstrate a genuine concern, do not offer advice or solutions on matters that only the provider should address, refer the patient's concerns to the nurse or provider in a timely manner.
2. Shock and disorientation, fear and anxiety, depression, guilt, post traumatic stress disorder.
3. Recurrent and intrusive recollections of the injury, dreams of the event; feeling of being wounded again, psychological distress when the memory of the accident/incident is triggered.
4. Greater than 100 mg/dL.
5. Slurred speech, lack of coordination, impaired sensory capability (especially vision), and behavioral changes.
6. Narcotics, sedatives, central nervous system stimulants, and hallucinogens.
7. They provide the health care personnel with up-to-date information and treatment guidelines for all types of drug abuse situations.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter.

21. (009) The very low-density lipoproteins transport
    a. glucose from the small intestine to the liver to be stored as glycogen.
    b. amino acids to the liver to dispose of most of the cholesterol through bile.
    c. lipids from the liver to the stomach where they are joined with amino acids.
    d. triglycerides that are synthesized in the liver from carbohydrates to adipose cells.

22. (009) Nursing actions that facilitate self-actualization is pertinent during which aspect of the nursing care?
    a. Illness.
    b. Wellness.
    c. Diagnosis.
    d. Rehabilitation.

23. (010) A toddler is expected to weigh four times the birth weight at
    a. 12 months.
    b. 18 months.
    c. 24 months.
    d. 30 months.

24. (010) Which is a characteristic of late adulthood?
    a. Muscle atrophy.
    b. Caring for elderly parents.
    c. Increased cellular oxygen content.
    d. Calcium loss in females is first noticed.

25. (011) What controllable factor did Florence Nightingale link with health and the environment?
    a. Fitness.
    b. Pure water.
    c. Work site safety.
    d. Psychological wellness.

26. (011) Which of the following is most likely to be a part of a work site wellness program?
    a. Blood pressure screenings.
    b. Assessing current fitness status.
    c. Establishing guidelines for disposal of contaminants.
    d. Providing services designed to maintain a healthy lifestyle.

27. (012) A good source of protein is
    a. fruits.
    b. rice.
    c. poultry.
    d. vitamins.

28. (012) Clinical signs of B_{12} deficiency are first noted by
    a. aplastic anemia.
    b. hemolytic anemia.
    c. pernicious anemia.
    d. sickle cell anemia.

29. (012) Pregnant women who overdose on B_6 may have caused newborns to be born with
    a. anemia.
    b. seizures.
    c. strabismus.
    d. disfigurement.

30. (012) Vitamin C can be found naturally in all of the following foods *except*
    a. citrus.
    b. cheese.
    c. broccoli.
    d. tomatoes.

31. (012) A sign of vitamin A deficiency include
    a. myopia.
    b. presbyopia.
    c. night blindness.
    d. macular degeneration.

32. (012) Which ailment *is not* treated by vitamin K?
    a. Ulcerative colitis.
    b. Heparin overdose.
    c. Malabsorption syndromes.
    d. Prolonged use of salicylates.

33. (012) What percentage of the body's weight are minerals responsible for?
    a. 16.
    b. 8.
    c. 4.
    d. 2.

34. (012) Signs of sodium chloride deficiency can be seen
    a. during a blood transfusion.
    b. as a result of not using table salt.
    c. when a individual is unable to sink in water.
    d. through an excessive amount of fluid loss.

35. (012) When administering potassium intravenously, you should
    a. give in a bolus.
    b. administer directly through a saline lock.
    c. mix the potassium thoroughly before administration.
    d. add the potassium to an IV solution bag that is already infusing.

36. (012) Calcium can be found in all of the following sources *except*
    a. kale.
    b. pork.
    c. salmon.
    d. turnip greens.

37. (012) Which route is injectable iron administered?
    a. Intra muscular.
    b. Intra venous.
    c. Transdermal.
    d. Z-track.

38. (012) Electrolytes that release hydrogen ions in water are called
    a. salts.
    b. acids.
    c. catalyzed.
    d. synthesized.

39. (012) What symptoms may occur with blood pH alkalosis?
    a. Weak and malaise.
    b. Dizzy and agitated.
    c. Emotional and tired.
    d. Short of breath and confused.

40. (012) Complex carbohydrates are called
    a. bisaccharides.
    b. disaccharides.
    c. polysaccharides.
    d. monosaccharides.

41. (012) What organ is primarily responsible for controlling lipid metabolism?
    a. Stomach.
    b. Heart.
    c. Brain.
    d. Liver.

42. (012) Amino acids are the small molecular building blocks of
    a. lipids.
    b. proteins.
    c. glucose.
    d. carbohydrates.

43. (013) Which is an accurate definition of leukocytes?
    a. Protect against disease at the cellular level.
    b. The body's only defense against infection.
    c. Proliferate hemoglobin and carry oxygen to the body.
    d. Carry amino acids to the kidneys for deamination and excretion.

44. (013) The life span of lymphocytes is
    a. 12 hours.
    b. 2 weeks.
    c. years.
    d. days.

45. (013) What cells do lymph nodes contain in large number to fight invading microorganisms?
    a. Lymphocytes and macrophages.
    b. Polyleukocytes and monocytes.
    c. Monocytes and phagocytes.
    d. Neutrophils and leukocytes.

46. (013) The primary central gland of the lymphatic system is the
    a. parathyroid glands.
    b. pituitary gland.
    c. thymus gland.
    d. thyroid gland.

47. (013) Nathan has broken out with the chickenpox for the first time. His body's response is called a
    a. secondary immune response.
    b. primary immune response.
    c. partial immune response.
    d. single immune response.

48. (013) During which stage of healing are immature fiber cells and capillaries formed?
    a. Bruising.
    b. Maturation.
    c. Inflammation.
    d. Reconstruction.

49. (014) For many patients who suffer from severe injuries or medical conditions, their *first* psychological reaction is
    a. guilt.
    b. acceptance.
    c. fear and anxiety.
    d. shock and disorientation.

50. (014) Which signs or symptoms of nervous system impairment would you look for in an intoxicated patient?
    a. Impaired vision, uncoordinated movement, behavioral changes.
    b. Uncoordinated movement, loud voice, sweet smelling breath.
    c. Muscle tremors, behavior changes, rapid pulse rate.
    d. Loud voice, difficulty breathing, muscle tremors.

Please read the unit menu for unit 3 and continue ➔

Unit 3. Maintaining Patient Homeostasis

THE TOPIC OF THIS unit is *homeostasis*, or the state of equilibrium within the human body. The importance of homeostasis cannot be stressed enough. Serious compromise can occur with the slightest deviation in fluids and electrolyte balances; vital signs become abnormal, the patient's level of consciousness (LOC) can become impaired, muscle actions become abnormal, and the impairment of the body's electrical activity can result in the cessation of life itself. You will obviously not be responsible for correcting the patient's deficiencies, but you will be responsible for noting signs and symptoms that the patient may be exhibiting. Let's begin this unit by discussing fluid and electrolyte balance, and then acid-base balance.

3–1. Fluid and Electrolyte Balance

In this lesson we discuss terminology, signs, symptoms, and treatments involved in maintaining the patient's fluid and electrolyte balance. Once again, your main activity as an aerospace medical service technician is monitoring the patient for these signs and symptoms as well as promptly and accurately reporting to the nurse or physician any abnormalities.

015. Fluid and electrolyte imbalances

Fluid and electrolyte balance is maintained by fluids taken into the body and fluids excreted by the body. A normal healthy adult consumes more fluids and electrolytes than required simply by eating and drinking. Since approximately 60 percent of the body is water, an intake of 2,500 mL per day is the normal requirement needed for fluid maintenance. Most of the 2,500 mL is from beverages. A small percentage is from foods and cellular metabolic processes.

Fluid imbalances

Fluids that leave the body do so through respiration, perspiration, urination, and elimination. When there is an imbalance, the patient exhibits signs and symptoms associated with the deficiency or excess. There are two types of fluid imbalances—fluid volume deficit and fluid volume excess.

Fluid volume deficit

Fluid volume deficit (FVD) is also referred to as hypovolemia. Hypovolemia can be caused from not taking in enough fluids, or a loss of fluids from sweating, vomiting, and diarrhea. Other causes are severe burns, bowel obstructions, excessive gastrointestinal suctioning, and severe bleeding.

Signs and symptoms you'll notice include poor skin turgor, concentrated urine, which will result in a high specific gravity, oliguria (diminished urine output), dry mucous membranes, weak and rapid pulse, orthostatic hypotension, and a low central venous pressure (below four cm of H_20). In severe cases of hypovolemia, confusion and restlessness may be observed. The treatment for hypovolemia is to encourage fluid intake, if the patient is conscious, and in severe cases, the administration of intravenous therapy may be necessary. In cases of severe bleeding, maintain the patient's body temperature and give oxygen.

Fluid volume excess

Fluid volume excess (FVE) is also referred to as *hypervolemia*. There are a number of disease processes that cause hypervolemia (e.g., congestive heart failure, renal failure, cirrhosis, and Cushing's syndrome). Other causes of FVE include excessive intake of parenteral fluids, excessive intake of salt, and decreased renal function along with an excess or normal fluid intake.

Signs and symptoms to look for are edema, ascites, and pulmonary edema. The patient will show a weight gain and distended neck veins. The central venous pressure will be high (over 11 cm of H_20) with a full bounding pulse. If the hypervolemia is due to decreased renal function, the patient will exhibit polyuria and diluted urine.

Electrolyte imbalances

To refresh your memory, an electrolyte is a chemical substance (ion), capable of carrying an electrical charge when it is in water. Electrolytes are found in the body's extracellular and intracellular spaces. There must be a unique balance between the intracellular and extracellular electrolytes for the proper transmission of electrical impulses across nerve fibers to occur. Although there are many, we'll discuss three of the major electrolytes that help to keep our many body systems in check—sodium, potassium, and calcium. Remember, as you study electrolyte imbalances, your objective is to be able to recognize the signs and symptoms associated with a deficit or an excess.

Sodium

The sodium (Na) cation (positively charged ion) is the main electrolyte found in extracellular fluid. The importance of this electrolyte cannot be overlooked. It is essential for normal nerve and muscle activity and the regulation of fluid balance. Normal sodium concentration in the blood ranges from 135 to 145 milliequivalent (mEq/L). Any values above or below will cause the patient to have a deficit or an excess.

Sodium deficit

A sodium deficit is referred to as *hyponatremia*. Hyponatremia can occur from profuse sweating (diaphoresis), vomiting, loss of gastric secretions from suctioning, and the administration of nonelectrolyte intravenous fluids. Symptoms to look for include confusion, weakness, restlessness, hyperthermia (elevated body temperature), tachycardia, muscle twitching, and abdominal cramping. In severe cases, convulsions and coma can be the complications.

The treatment prescribed by the physician for mild cases would be the oral administration of sodium. This is accomplished by providing the patient with foods high in sodium or by having him or her drink salt water. For a mild deficit, the intravenous route and giving 0.9 percent sodium chloride would be necessary. For severe cases, the physician will order lactated Ringer's solution intravenously.

Sodium excess

Sodium excess is referred to as *hypernatremia*. Hypernatremia can occur from an excessive intake of salt without the ingestion of water. It can also occur from losing water (e.g., diarrhea, hyperthermia, decreased oral intake of water, excessive administration of parenteral fluids, and severe burns). The signs and symptoms, which are similar to dehydration, include thirst, dry sticky mucus membranes, oliguria (scanty urine output), hyperthermia, dry tongue, and lethargy. If a sodium excess goes untreated, it may lead to coma.

The treatment depends on the cause of the imbalance. In most cases, forcing fluids (FF) may be instituted along with dietary restriction of sodium.

Potassium

The potassium (K) cation found in intracellular fluids is essential for normal nerve and muscle activity. Potassium has the same functions intracellularly as sodium has extracellularly. Just keep in mind, potassium and sodium have a hateful relationship—where sodium goes, potassium leaves.

Normal serum potassium ranges from 3.5 to 5.5 mEq/L. Abnormal levels can cause death. If you work with cardiac patients, you may already be aware of the importance of monitoring serum potassium levels.

Potassium deficit

A potassium deficit is referred to as *hypokalemia*. Hypokalemia can occur with the use of certain diuretics (Lasix), a loss of fluid due to vomiting and diarrhea, and gastric suctioning. Signs and symptoms include fatigue, weakness, anorexia, nausea, vomiting, and dysrhythmias (abnormal heart rate or rhythm). In more severe cases of hypokalemia, hypotension and death caused by cardiac or respiratory arrest can result.

Treatment of hypokalemia includes dietary supplements of potassium rich foods (fruits), to administering oral potassium salt. The physician may also order intravenous administration of potassium in severe cases of hypokalemia.

Potassium excess

A potassium excess is referred to as *hyperkalemia*. Hyperkalemia can result from severe renal failure, severe burns, overuse of potassium supplements, and the over-administration of parenteral potassium. Symptoms associated with hyperkalemia are diarrhea, nausea, muscle weakness, and dysrythmias. Death can occur from cardiac or respiratory arrest due to severe cases of hyperkalemia.

The treatment of hyperkalemia ranges from removing potassium from the diet to special medications that help to lower serum potassium levels.

Calcium

Calcium (Ca) is found mostly in the bones and teeth. Regulated by the parathyroid glands; serum levels of calcium account for only one percent of the body’s calcium level. Calcium is necessary for nerve impulse transmission, blood clotting, and muscle contraction. Normal serum calcium levels range from 9 to 11 mg/dL.

Calcium deficit

Referred to as *hypocalcemia*, calcium deficits can result from an insufficient dietary intake of calcium. Since vitamin D is necessary for the absorption of calcium, a vitamin D deficiency will directly affect calcium levels. Other causes of hypocalcemia are burns and intestinal malabsorption disorders. The patient with hypocalcemia may complain of tingling in the extremities and around the mouth. Other signs include muscle and abdominal cramping, mental changes, possible airway obstructions due to laryngeal spasms, convulsions, bleeding and dysrhythmias.

After diagnosis, treatment would be the administration of calcium and vitamin D to intravenous administration of calcium gluconate, depending on the severity of the case.

Calcium excess

Hypercalcemia is the medical term for calcium excess. Large amounts of calcium in the blood can result from tumors on the parathyroid glands, multiple fractures, excessive doses of vitamin D, prolonged immobilization, and some drugs used to fight cancer (antineoplastics). Symptoms associated with hypercalcemia are deep bone pain, constipation, anorexia, nausea, vomiting, polyuria, polydipsia, fractures, and mental changes.

To treat hypercalcemia, the physician would first determine the cause, and then treat it. In mild cases, limiting calcium intake and forcing fluids would be used. In more acute cases of hypercalcemia, the use of intravenous fluids that would increase calcium excretion would be administered.

016. Acid and base imbalances

Simply speaking, the body’s acid-base balance is essential for life. Have you ever been involved in providing cardiopulmonary resuscitation due to respiratory or cardiac arrest? If you have, you may remember the physician calling out orders for blood gases to be performed. Once the results are obtained, the physician may then give an order for sodium bicarbonate to be given stat. After reading the following lessons regarding acid-base balance, you will understand why the physician ordered the sodium bicarbonate.

You were introduced to acids, bases and pH levels in the previous unit, now we will take the information you learned there a step farther and explore imbalances to help you understand more about resuscitative fluids or IV fluids and the pH levels in the bloodstream. Let's take a moment to briefly review some essential information. The symbol pH refers to the percentage of hydrogen ions (atoms) present in a solution. The more hydrogen ions in a solution, the more alkaline it is. Look at figure 3–1, this shows a pH scale. The less number of hydrogen ions, the more acid () the solution will be. When a physician requests blood gases to be performed, one of the tests performed on the blood is pH. A normal plasma pH is 7.34 to 7.45, or a slightly alkaline state. With results below 7.34, the patient is considered acidic; with results above 7.45, the patient's serum is considered alkaline. We will discuss the four types of acid-base imbalance:

- Metabolic acidosis.
- Metabolic alkalosis.
- Respiratory acidosis.
- Respiratory alkalosis.

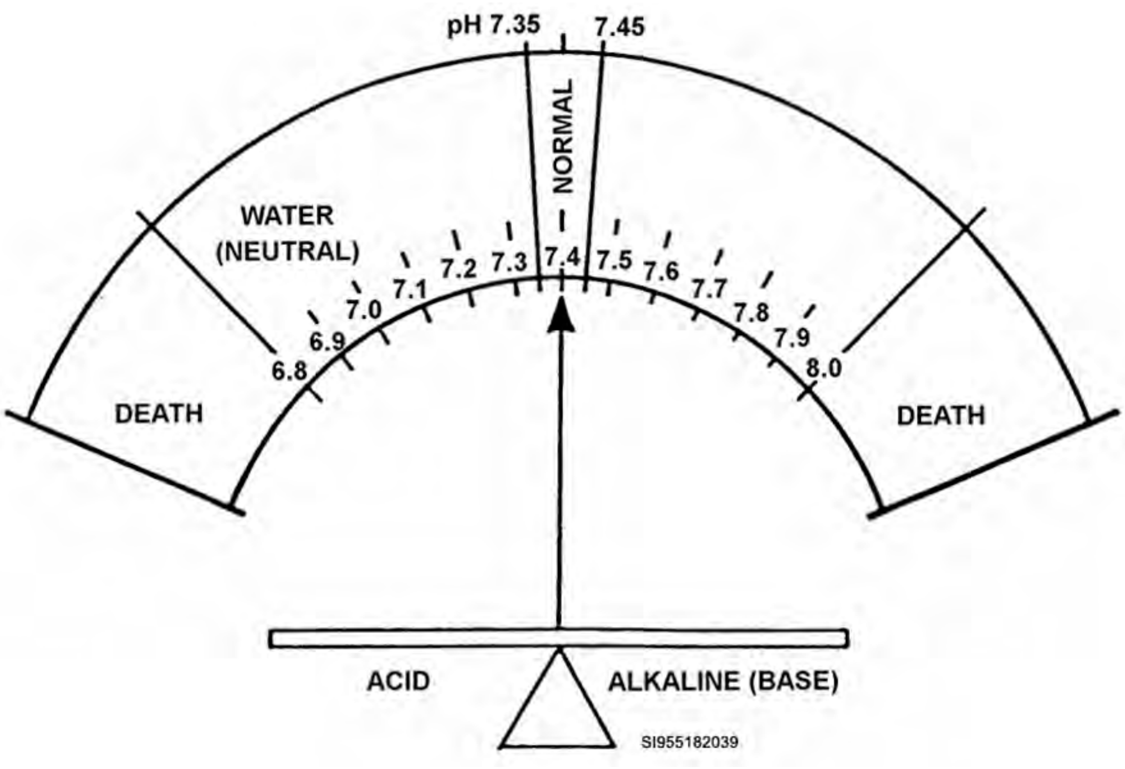


Figure 3–1. Acid-base balance.

Metabolic acidosis

Metabolic acidosis is a deficit of bicarbonate (base) or a gain in an acid in the body fluid. In most cases, metabolic acidosis results from an imbalance in the metabolism of foods or fluids (e.g., usually diabetes). Some causes of metabolic acidosis include starvation, insulin deficiency resulting in diabetic acidosis, diarrhea, renal failure, and an overdose of salicylates (aspirin). Symptoms include nausea, vomiting, headache, confusion, flushing, disorientation leading to unconsciousness, and hyperventilation. The patient's serum pH is below 7.34. The treatment for metabolic acidosis is to eliminate the cause and replace the lost fluids and electrolytes. Bicarbonate may also be administered.

Metabolic alkalosis

Metabolic alkalosis is an excess of bicarbonate (base) in the body fluids. Metabolic alkalosis can be the result of problems with the gastrointestinal tract (e.g., chronic or excessive vomiting) or the ingestion of too many alkalies (i.e., medications used for acid indigestion, antacids). Excessive gastric suctioning can remove too much hydrochloric acid, resulting in metabolic alkalosis. Symptoms include respiratory depression, tetany (sharp flexion of the wrists and ankle joints, muscle twitching, cramps, and convulsions), and hypertonic reflexes. The treatment for metabolic alkalosis is to eliminate the cause.

Respiratory acidosis

Respiratory acidosis results from an excess of carbonic acid in the body fluids. The cause of respiratory acidosis can be any deficiency in respiratory ventilation (e.g., pneumonia, emphysema, asthma, and respiratory obstruction). Because there may be depression of respiratory centers, some drug overdoses and head injuries can result in respiratory acidosis. Symptoms include disorientation to coma, weakness, and shallow, weak respirations. The patient serum pH is below 7.34 along with an increase in partial pressure carbon dioxide ($PaCO_2$). Treatment depends on the cause of respiratory acidosis, and it is very individualized. Patients who are having difficulty breathing may be given medications (e.g., bronchodialators) to improve respiratory sufficiency.

Respiratory alkalosis

Respiratory alkalosis results from a deficiency of carbonic acid. In most cases this is due to hyperventilation, the "blowing off" of excessive amounts of carbon dioxide (CO_2). Patients hyperventilate because of anxiety, high fevers, and hysteria. Symptoms include light-headedness, numbness and tingling of the fingers and toes, diaphoresis (sweating), short periods of apnea, and convulsions. The patient's serum pH is above 7.45 and the $PaCO_2$ is decreased. Treatment for respiratory alkalosis is to correct the hyperventilation. Rebreathing expired air from a paper bag is one method taught in most emergency medical technician courses.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

015. Fluid and electrolyte imbalances

1. What term is used to define a fluid volume deficit?

2. What are the eight signs and symptoms of fluid volume deficit?

3. What are the four disease processes mentioned in the text that can cause a fluid volume excess?

4. What is an electrolyte?

5. What are the symptoms associated with a sodium deficit?

6. What are the signs and symptoms associated with a sodium excess?

7. What electrolyte deficit and excess can cause dysrhythmias leading to cardiac or respiratory arrest?

8. Which electrolyte in excessive amounts can cause fractures?

016. Acid and base imbalances

1. What does the symbol "pH" refer to?

2. What is the normal plasma pH?

3. If a solution has a high "pH," is it referred to as "acidic" or "alkaline"?

4. What type of acid-base imbalance occurs in the metabolism of food or fluids and is usually associated with insulin deficiency?

5. Excessive gastric suctioning that removes too much hydrochloric acid can result in what type of acid-base imbalance?

6. An increase in carbonic acid in the body fluids associated with difficulty breathing can result in what type of acid-base balance?

7. What type of acid-base imbalance is associated with a patient hyperventilating?

3–2. Intravenous Therapy

As an aerospace medical service journeyman, intravenous fluid therapy and blood administration procedures are an important part of your job. We begin this lesson with some general information relating to the purposes, advantages, and disadvantages of infusion therapy. From there, we discuss the different types of IV therapy, and the different intravenous solutions. We also discuss the equipment and procedures used to initiate intravenous infusions and heparin locks, as well as complications associated with that particular type of administration.

017. Fundamentals of intravenous fluid therapy

Are you familiar with infusion (intravenous fluid or IV) therapy? Although an infusion is technically a form of parenteral administration, you should consider it separately from other routes of administration. The procedures and equipment are different and the hazards are greater when administering fluids or medication through a needle into a vein. Excluding approaches such as intra-cardiac or intra-arterial injections, infusion (i.e., intravenous) therapy represents the most direct approach for administering medication.

Purpose

The basic purpose of infusion therapy is to administer fluids—with or without medications—into the circulatory system. Once in the circulatory system, these fluids are quickly absorbed and carried to different areas of the body. IV therapy also is used to supply nutrients, establish and maintain therapeutic drug levels, and maintain fluid and electrolyte balance. There are numerous advantages to this method of administration but also a number of very serious hazards.

Advantages

The advantages of intravenous therapy include rapid absorption and onset of action, increased drug effectiveness, and ready access to the circulatory system for emergency drug administration. Because the fluids are infused directly into the circulatory system, they are not affected by the defensive mechanisms found in the skin, respiratory system, or digestive system. Therefore, the fluids reach their destination faster and in greater quantities than they would with any other method. This increases the effectiveness and shortens the onset of the drug action. In addition to these advantages, intravenous therapy can be used to administer large volumes of medications and can deliver medications that are too irritating to be administered any other way.

Disadvantages

Unfortunately, adverse reactions to intravenous administrations also occur very rapidly, and there is no way to withdraw a medication once it has been administered intravenously. In some cases, the reaction is so fast the patient dies before anything can be done to counteract a substance that was wrongly administered. Patients who have IVs are also very susceptible to infections, circulatory overloads, and damage to blood vessels, nerves, and tissue.

Venous puncture versus arterial puncture

Although medications also can be administered into arteries (intra-arterial administration), veins are preferred for a number of reasons. Veins are thin walled and more flexible than arteries. This allows them to expand to accept large amounts of fluids. Because venous musculature is less, veins are less likely to have a spasm when irritating substances are injected. Venous pressure is less than arterial pressure. When arteries are punctured, the blood spurts out and there is considerable resistance to medication or fluid infusion. If the artery becomes damaged because of poor technique or a muscle spasm, the body area it supplies blood to will be deprived of oxygen and nutrients. When a vein is punctured, there is relatively little bleeding, and what little there is, can be controlled easily. There is also little resistance to the infusion of fluids or medications. Since veins carry blood back to the heart, body tissues are not deprived, if the blood flow is interrupted. In fact, the blood usually just finds an alternate route to travel. Veins are closer to the skin surface and more accessible for injection than arteries.

Types of intravenous solutions

Although you are not personally responsible for selecting the intravenous solution to be administered to the patient, you should have a general knowledge about these solutions to ensure the patient is not harmed. The specific type of solution ordered depends on the patient's condition, fluid and electrolyte balance, and purpose for the IV. A wide variety of intravenous solutions are currently available for an equally wide variety of functions. Crystalloid solutions, colloid solutions, and blood volume expanders are types of intravenous solutions.

Crystalloid

A crystalloid solution is a mixture of water and dissolved crystals such as salt and sugar. These crystalloid solutions can be further broken down into three types—hypotonic, hypertonic, and isotonic. To understand these three types of crystalloid solutions, you must understand the word tonicity.

Tonicity

Tonicity refers to the relative concentration of dissolved substances in a solution as compared to the solution concentration within the red blood cells (RBC). The RBC membrane is semipermeable, which means fluid can pass through it, but dissolved substances cannot. If there is a concentration difference, osmotic pressure moves the fluid in the direction of the greater particle concentration. If the intravenous concentration is higher (*hypertonic*) than the red blood cell concentration, then the RBCs shrink as fluid is drawn out to equalize the concentration. On the other hand, a lower concentration *(hypotonic)* causes RBCs to swell as the fluid is drawn into the cell. Either condition is potentially dangerous. Ideally, the IV solution should be *isotonic* (i.e., the same concentration as the RBCs). The intravenous solutions of sodium chloride injection 0.9 percent and dextrose injection 5 percent are almost isotonic.

Crystalloid Solutions	
Solution Category	**Solution Mixture**
Hypotonic	0.45 percent sodium chloride 5 percent dextrose in 0.45 percent saline
Hypertonic	10 percent dextrose in water called $D_{10}W$ 3 percent saline Hyperalimentation fluids
Isotonic	0.9 percent saline, called normal saline 5 percent dextrose and water, called D_5W Lactated Ringers

These crystalloid solutions are used primarily as a source of fluid and electrolytes. Dextrose solutions are used primarily as a source of fluid and carbohydrates for nutrition. Ringer's solutions are used mainly for fluid replacement and as a source of electrolytes. Ringer's solutions contain only small amounts of potassium and calcium ions. Potassium and calcium deficits should be treated with solutions containing higher concentrations of these ions. The lactate in Ringer's lactate is metabolized to form bicarbonate, which is useful in the treatment of conditions such as metabolic acidosis. These solutions are frequently modified by the addition of concentrated electrolyte solutions, antibiotics, or other medications to treat a variety of disease conditions. Mixing these drugs is not your responsibility, but you must be aware of the increased possibility of adverse reactions when these mixtures are administered to a patient.

Parenteral hyperalimentation

This is a method of providing nutrition to a patient intravenously, bypassing the gastrointestinal tract. It is commonly used to provide nutrition to patients who have some sort of severe gastrointestinal disorder that precludes their obtaining nourishment by other means. This type of therapy provides large amounts of essential nutrients required for growth and repair of body tissues. Since these solutions are designed to meet the body's total needs, they contain a much higher concentration of nutrients and calories than do normal IV solutions. They also contain varying concentrations of vitamins, minerals, and electrolytes. Examples of hyperalimentation solutions include protein hydrolysate basic fluid and crystalline amino acid solution.

Hyperalimentation solutions are extremely hypertonic and irritating to the smaller vessels. To prevent damage and irritation, they are usually infused through a catheter in one of the large central veins (e.g., the subclavian or jugular vein). Volumetric pumps are frequently used to ensure delivery of an adequate volume of the solution. Hyperalimentation solutions also provide an excellent medium for the growth of microorganisms, so infection is a common complication. Follow strict asepsis during insertion of the catheter and during the succeeding dressing changes. To reduce the possibility of infection, change the bag and tubing daily, and do not allow the container to hang longer than eight hours.

Colloid

A colloid solution is a mixture of water and molecules of suspended protein. Examples are whole blood, packed cells, plasma, and plasma proteins.

Blood volume expanders

Blood volume expanders are substances administered to increase the total circulating fluid volume (e.g., hetastarch, dextran, albumin, and plasma). Blood volume expanders are useful in the treatment of hemorrhagic shock and other forms of shock characterized by an excessive plasma loss. This fluid loss results in a decrease in the effective circulating volume and a resulting decrease in oxygenation to the tissues. Treatment is geared toward restoring the circulating volume and replacing the fluid. Unfortunately, fluid is lost from both circulation and the extravascular space. About two-thirds of the replacement fluids (i.e., electrolyte solutions) administered are absorbed out of the circulation space into the extravascular space. As a result, a tremendous amount of fluid must be administered before circulation returns to normal. Blood volume expanders contain molecules that are too large to pass out of circulation into the extracellular space, so they can be used to maintain circulation until the other fluids can be replaced. These solutions are associated with a variety of complications and do nothing to replace extravascular fluid that has been lost. They should be used as a supplement, rather than a replacement, for other forms of fluid therapy.

General precautions

Before you initiate an IV, there are a few general precautions you should take. First, examine the general characteristics of the intravenous solution. These characteristics include clarity, sterility, pH, and tonicity. Intravenous solutions should be clear and free of particulate matter. Cloudiness or particles indicate the solution is either contaminated or has started to break down. In either case, discard the solution and obtain a fresh container. The solution must be sterile. Since you can't "see" sterility, the only way to be sure is to remove the protective devices (i.e., covers, caps, etc.) personally, just before you use the solution. NEVER use a bottle or bag of IV solution that has been opened by someone else or one you opened, but did not use right away. Along the same line, use good aseptic techniques when you prepare the IV.

018. Intravenous fluid therapy procedures

The initial steps for initiating an IV are much like the initial steps for administering any medication (i.e., wash your hands, collect your equipment, and verify the medication order). The doctor is responsible for ordering the IV solution, as well as any medications he or she wants added to it. Such medication are usually added in the pharmacy, but may be added on the nursing unit—either before or after the solution is infused into the patient.

Infusion equipment

The basic equipment you need to initiate and maintain an intravenous infusion includes a solution container, an administration set, and a needle to insert into the patient's arm. In addition to these items, you may also use a variety of electronic infusion pumps or controllers to adjust and control the rate of flow, a standard IV pole to support the solution container and pump/controller, an arm board to immobilize the infusion site, antiseptic cleaning materials, an antiseptic ointment, tape, and dressing materials to actually initiate the infusion.

Solution containers

Intravenous solutions are packaged in glass bottles and plastic bags, which vary in size from 100 to 2,000 cubic centimeters (cc). Both types of containers are safety sealed to prevent contamination.

Intravenous bottles

An intravenous bottle also is vacuum-sealed, much like a multidose vial. The solution will not flow out until air is introduced into the bottle. Intravenous bottles are sealed with a hard rubber stopper, metal disk, and a metal cap. Remove the cap and disk when you are ready to connect the bottle to the administration set. Push the insertion spike into the marked opening on the rubber stopper.

Even if you are unable to read the markings, you should be able to differentiate between the openings. The airway or vent opening is connected to a straight plastic tube that extends the length of the bottle. The port, which gives you direct access to the fluid, is the proper opening for the tubing spike. When you have correctly inserted the spike and inverted the bottle, the solution should flow out into the administration set. Some IV bottles do not have a vent port. While this reduces confusion about which hole to put the spike into, you must remember to use vented tubing with such bottles.

CAUTION: Most rubber stoppers also have an opening to allow air to enter the bottle. If you insert the spike in the wrong opening, the solution will not come out.

Intravenous solution bags

These bags are not vacuum-sealed, but they are closed units. Their safety seal must be broken for the solution to escape from the bag. The intravenous solution bags are safety sealed within other plastic bags. Once you remove the bag from its outer wrapper, you'll notice two external tabs at the bottom end of the bag. The tab with the removable plastic cover is the entry port for the administration set spike. The entry port is sealed with a plastic diaphragm. When you push the spike up into the entry port, it punctures this diaphragm and allows the fluid to flow into the administration set. The other external tab is the entry port for medications. It is sealed with a self-sealing, protective rubber cover.

You must position the intravenous container above the patient so that gravity will make the solution flow through the tubing to the patient. Normally, hang the container on an IV pole between 24 and 36 inches above the patient. If the container is lower, the solution will not flow freely. If it is higher, the solution will flow too fast. Because the system is closed, the patient's blood will flow back into the tubing, if the container is positioned below the level of injection site.

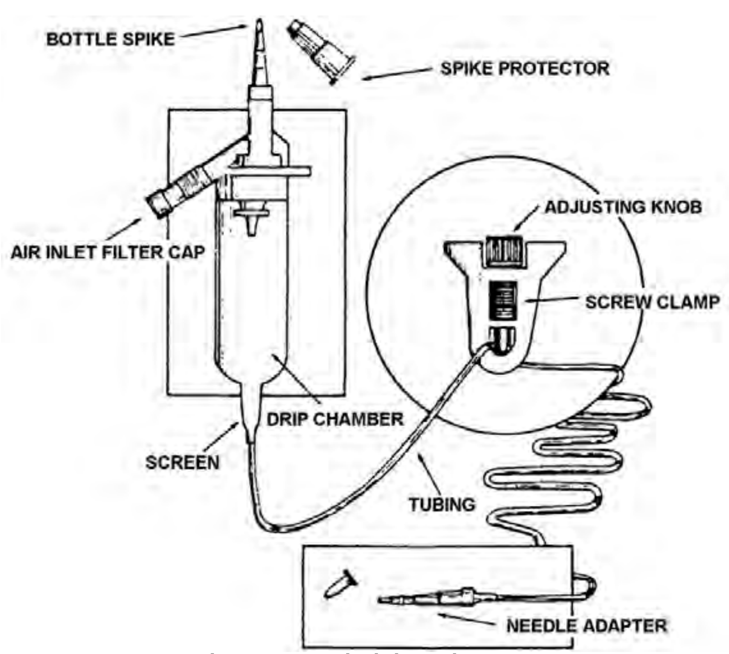


Figure 3–2. Administration set.

Administration sets

The administration set (fig. 3–2) consists of an insertion spike, drip chamber, length of plastic tubing, clamp, vent port, medication port, secondary port, and needle adapter. These sets may differ slightly, depending on the manufacturer. Some administration sets may have an in-line filter to remove contaminants and air bubbles from the solution before it reaches the patient. When you insert the spike into the solution container, the fluid flows through the drip chamber into the tubing and into the patient. You normally position the clamp (roller or pinch) just below the drip chamber. When you tighten the clamp, the tubing is compressed and the flow rate decreases. When you loosen the clamp, the rate increases. You can estimate this rate by timing the drops as they flow through the drip chamber. You can then adjust the rate by either tightening or loosening the clamp.

Depending on the manufacturer, the size of the opening between the drip chamber and the solution container varies from very small (microdrip) to very large (macrodrip). Since the size of the opening regulates the size of the drop that falls through, the drops also vary from small to large.

Once you know how many of these drops there are in each milliliter of solution, you can calculate the flow rate as shown in the following equation:

Step 1. Determine the total number of milliliters to be infused per hour.

Total mL ordered ÷ total number of hours ordered = mL per hour

Step 2. Determine drops per minute.

mL per hour x drip factor divided by 60 min/hr = drops (gtts) per minute

The infusion sets are very precise. Macrodrip sets provide 10, 15, or 20 drops (gtts) per mL, and microdrip sets provide 60 drops per mL. The exact amount is listed on the box label. With this in mind, let's look at an example to see how the calculation works.

Example:
A physician orders an IV of 1,000 cc of dextrose and water to be administered over an 8-hour period for an adult patient. Since you know that the doctor will be adding medications periodically, you decide to use an infusion set with a volume-control chamber and a drop size of 15 gtts/mL. Given this information, what is the flow rate?
Answer: 1000 mL ÷ 8 hours = 125 mL/per hour.
125 mL/hr x 15 gtts ÷ 60 = 31.25 gtts/min.

In addition to the basic setup, there are a variety of infusion setups that allow the nurse to mix solutions, add medications to the solution, or, more precisely, control the amount of solution that the patient receives.

One such arrangement is the *piggyback setup,* as illustrated in figure 3–3. With this arrangement, you connect a small bottle or bag containing a medication, such as an antibiotic or an electrolyte, to the primary tubing by way of the secondary port. You position this bottle so it is higher than the primary container. When you open the clamp on the secondary bottle, the solution flows through and forces the back-check valve on the primary tubing closed. This interrupts the flow from the primary container. The back-check valve remains closed as long as the solution is flowing down through the secondary tubing. When the piggyback container is empty, the back-check valve opens and the solution flows from the primary container.

A slightly different arrangement involves the use of an *in-line chamber* to mix or meter solutions. The infusion set containing this in-line chamber is called a *volume-control set* or *Volutrol, Pediatrol,* or *Buretrol.* A typical volume-control set has a short piece of IV tubing connecting the insertion spike with the smaller (usually around 100 cc) in-line chamber. There is a standard drip chamber immediately below the in-line chamber, and the remainder of the tubing is similar to standard IV tubing. There is also a clamp between the solution container and the in-line chamber. The volume control chamber acts as a mini-solution container. When you release the upper clamp, the solution fills the in-line chamber. The upper clamp is then closed, and the lower clamp is opened, allowing the solution to flow to the patient. By controlling the drip rate, you can control the amount of fluid that the patient receives over a specified period. The in-line chamber also has a medication port so medications can be added and diluted as ordered. Medications also can be added directly to the solution container or the tubing at the medication port.

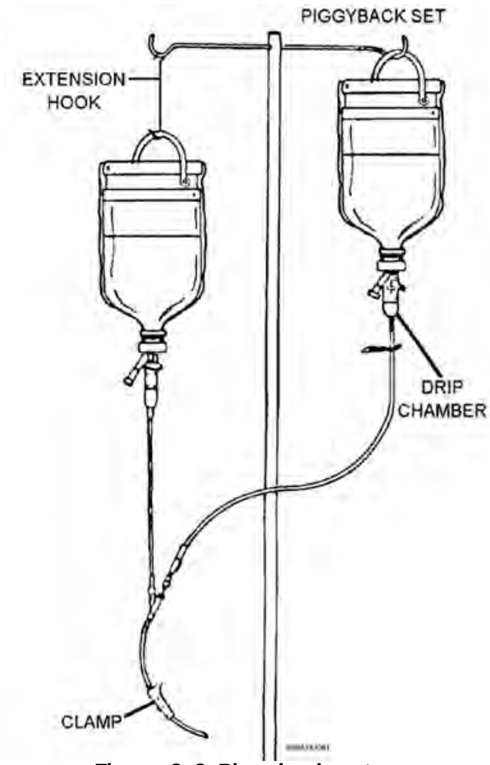


Figure 3–3. Piggyback setup.

Needles

There are three basic types of needles used to initiate IVs—wing-tipped needle, over-the-needle catheters, and inside-the-needle catheters (fig. 3–4). Saline locks, also known as Heparin locks, may be used to initiate IVs, but they'll be considered separately.

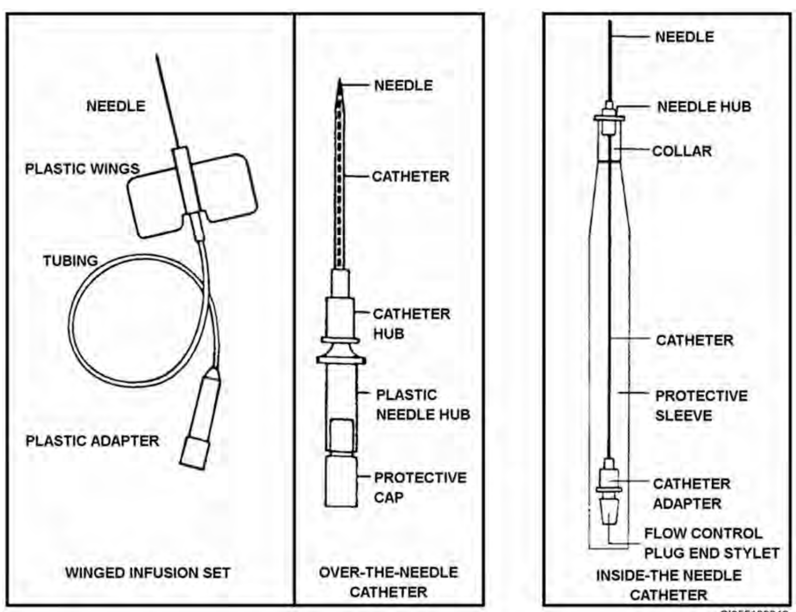


Figure 3–4. Various needles used for IV therapy.

Wing-tipped needle

The wing-tipped needle (also known as the winged infusion set, butterfly, or scalp vein needle) consists of a short, stainless steel needle, plastic wings, a short strip of tubing, and a plastic adapter to attach to the IV tubing. This needle is available in a variety of sizes from 17–27 gauges. It is commonly used to start an IV in small blood vessels (e.g., scalp veins in pediatric patients) and is frequently used for short-term or intermittent therapy. The “wings” can be folded up to provide a handle while the needle is being inserted, then folded down to form a base for anchoring the IV. Wing-tipped needles are inserted and secured easily, and have a low infection rate. They do, however, have a higher rate of infiltration and phlebitis than other IV needles.

Over-the-needle catheters

Indwelling plastic catheters (commonly referred to as over-the-needle catheters) are actually stainless steel needles covered with a plastic Teflon-like sheath. These catheters are available in a variety of gauges and lengths. When the catheter is inserted into a vein, the needle is removed and the plastic sheath is advanced into the vein. The sheath is then anchored and connected to the IV tubing. Indwelling catheters are used for long-term therapy. Although they have a higher infection rate, they are more flexible and less irritating to patients.

Inside-the-needle catheters

These catheters consist of large-bore stainless steel needles and smaller gauge plastic catheters. The needle is used to penetrate into the vein; then the plastic catheter is passed through the needle, and advanced into the vein. The needle is then withdrawn, and the IV tubing is connected to the plastic catheter. One disadvantage of an inside-the-needle catheter is that is creates a larger puncture hole, which can cause leakage of the IV solution. This type of system is best used when the solutions or drugs (especially chemotherapy) being given could cause extravasation, if infiltration occurs.

Electronic infusion devices

Electronic infusion devices (EID), two of which are shown in figure 3–5, can be used to control the volume and flow rate of intravenous fluids. These devices include infusion controllers, volumetric pumps, volumetric controllers, and variable pressure volumetric pumps. Although these devices monitor and adjust the flow rate, they are not infallible! You maintain responsibility for monitoring IVs. Use EIDs in conjunction with, rather than instead of, manual control methods. EIDs are not required for every IV, but you should use them whenever a precise flow rate is required, either because of the patient’s condition or due to the type of medication being administered.

Infusion controllers

Infusion controllers electronically monitor the drip rate by counting the drops as they fall through the drip chamber and adjust the flow rate to a predetermined standard by constricting the tubing. They are gravity fed and sound an alarm if the IV is empty or if the solution is running too fast or too slow. Possible causes of slow-down are infiltration or an obstruction of some sort. Use infusion controllers to monitor the flow rate of solutions containing medications that may cause tissue damage, if they are allowed to infiltrate. Be careful to position the IV according to the manufacturer’s guidelines. Because they are gravity fed, positioning the solution container too high or too low will cause faulty readings on the controller.

Volumetric pumps

These pumps are electronic devices that accurately and consistently deliver a preset volume of fluid under positive pressure. This volume is monitored and metered as it passes through specially chambered tubing. The pump also sounds an alarm if the solution container is empty, if tubing is obstructed, if infusion is complete, or if the battery is low. Volumetric pumps are rarely required, but they may be used for intra-arterial infusions or deep central venous lines (cut-downs). They also are useful for patients who have multiple IV lines and whose condition is such that they could roll onto or otherwise obstruct the line. Volumetric pumps should NOT be used to administer medications that may cause tissue damage (extravasation) if they are allowed to infiltrate.

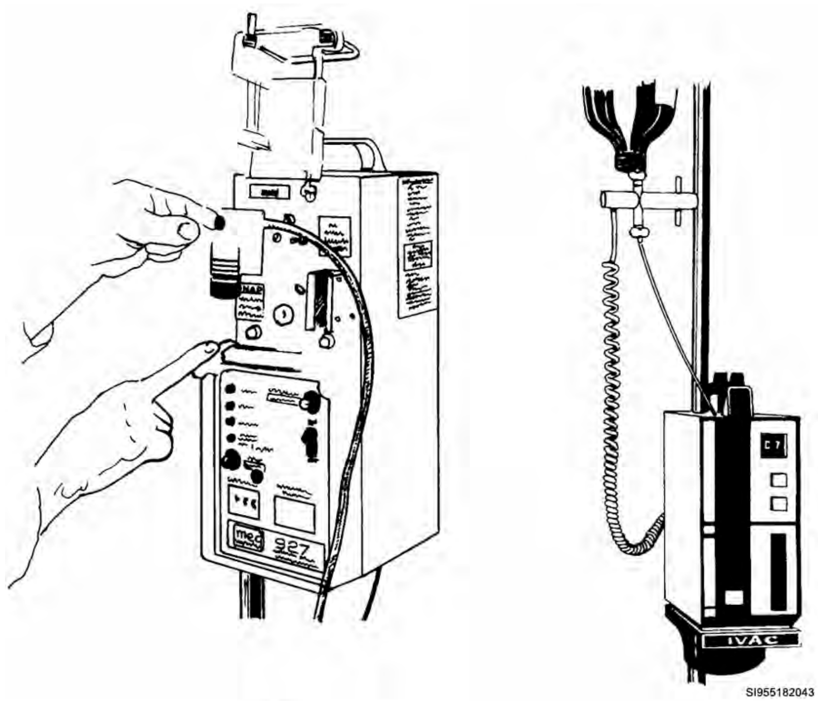


Figure 3–5. Electronic infusion devices: (A) infusion device (B) volumetric controller.

Volumetric controllers

Volumetric controllers are electronic devices that monitor the volume of fluid as it is delivered through specially chambered tubing. The device sounds an alarm if the tubing is empty or if the infusion is running too fast or too slow (e.g., infiltration, kinking, obstruction, etc.). These devices have the same functions and contraindications as the standard controllers mentioned earlier. They are not as precise, but they are capable of delivering a greater quantity of fluid. They also are gravity fed and require exact placement of the solution container.

Variable pressure volumetric pumps

The pumps are used to deliver critical volumes and critical medications to selected patients.These pumps have combined features of both the volumetric pump and the controller. They provide smooth titration of medications and precise delivery of preset volumes through specially chambered tubing. They have an alarm that sounds when the tubing is dry, battery is low, sensor is not positioned properly, air is present in the line, and flow is obstructed for some reason.

Infusion pressure bags

Infusion pressure bags may be required to keep up with a patient's acute blood loss. An infusion pressure bag is simply an inflatable bladder with a nylon mesh front. The unit of fluid or blood is sandwiched between the bladder and the mesh and then suspended from an IV pole. The pump bladder is inflated with a hand bulb just like a blood pressure cuff. The inflated bladder squeezes the unit up against the mesh on the front side of the pump, and the pressure increases the rate of flow out of the bag.

Preparing to administer an intravenous catheter

Once you verify the order and check the sterility of the container, attach the tubing and "prime" the set. To prime (i.e., flush) the administration set, insert the spike into the appropriate opening, fill the drip chamber approximately halfway full, then allow a small amount of solution to flow through the tubing to eliminate air bubbles. Avoid contamination of the adapter tip or insertion spike as you do this, and replace the sterile cover on the tip as soon as the line is flushed. After the line is flushed, clamp the tubing to prevent unnecessary loss of solution. Ensure the drip chamber is still approximately half full to guarantee proper flow rate and allow you to see the drops. Compressing and releasing the drip chamber as the solution is flowing will enable the chamber to fill properly.

NOTE: You remove air bubbles to prevent obstruction of a pulmonary artery (air embolism). The actual possibility of such an obstruction is remote, but it is better to be safe now than sorry later!

Attach a time strip showing the start time, stop time, and hourly intervals. Position this strip on the side of the bottle or bag so the start time is marked at the fluid level when the bottle is full, and the stop time is at the empty level (if you are administering the entire container). Then, mark the tape to show the fluid level for each hour that the IV is running. You can easily calculate how much solution should be delivered each hour by dividing the total amount of solution by the number of hours the IV is ordered to run. Example: Most of the time the doctor's note will read something like, "D5LR at 150 ml/hr." If you divide 1000 ml by 150 ml you end up with 6.66 (the number of hours it should take to infuse 1000 ml of fluid). Keep in mind that even with an IV pump, the actual amount of fluid per hour may not be exact. You should check the IV bag frequently, at least every hour to ensure it is flowing properly, at the correct rate and so the IV does not run dry.

Also, label the administration set with the date and time it was attached to the IV container. It is good practice to attach a time strip even if an infusion controller or pump is used to actually meter the solution. The time strip provides an easy means of verifying the accuracy of the machine.

Once you have verified the doctor's orders and prepared the IV, collect your equipment and go to the patient. The specific antiseptic solutions, taping procedures, etc., are controlled by local policy and vary from one facility to the next. Most facilities require initial certification and annual recertification for any medical specialty journeyman who will start IVs, so you should be familiar with the requirements before you deal with any patients. If you are unsure, check your operating instructions (OI).

NOTE: Whether the medication is added to the IV solution in the pharmacy or in the nursing unit, as 3 or 5-levels 4N0X1s, you are not responsible or allowed to add medications to an IV or hang an IV bag that has medication mixed in it. Technicians are not allowed to mix or hang an IV bag or bottle with medications mixed in them unless all of the following is complete: he or she is a 7 or 9-level, has completed locally developed training programs, and training and certification is properly documented in the technician's training folder. The individual who mixes the medication (normally a nurse or doctor) should label the container appropriately, and connect the tubing, in order to administer the solution to the patient. Refer to newest career field guidelines and local policy for the most updated information on medication administration.

Prepare the patient

Begin the procedure by introducing yourself and verifying the patient's identification (i.e., check ID band). Ask the patient if he or she has any allergies, and explain what you are going to do. If the patient has visitors, it is best to ask them to step out of the room until the IV is in place. Position the patient comfortably in the semi-Fowler's position. If you are working with a pediatric, unconscious, or uncooperative patient, bring enough help and equipment (for example, restraints) to immobilize him or her safely.

Select an infusion site

The next step is to select an infusion site. There are a number of factors you should consider when selecting the IV site, for example, the type of solution, rate of infusion, age and condition of the patient, condition of the veins, duration of the therapy, and type of equipment used. IVs can be started in the hands, arms, legs, feet, or scalp areas. Scalp sites are commonly used for pediatric patients, but because the procedure is somewhat difficult, the physician usually starts the IV. Use the legs and feet only if no other sites are available. Patients who have IVs in their lower extremities are usually confined to bed and have an increased risk of thrombophlebitis (blood clot in the vein). The hand or arm is generally preferred because the IV will not decrease the patient's mobility or activities to any great extent. If at all possible, use the patient's nondominant hand or arm.

As described earlier, there are a variety of intravenous solutions. Most can be infused through any vein, but hypertonic solutions and solutions that contain irritating substances should be infused through a large central vein in order to prevent damage to peripheral vessels and tissues. Large veins also should be used for thick solutions (blood) and solutions that need to be infused rapidly. You may have difficulty finding a suitable vein on elderly patients, pediatric patients, or obese patients. Elderly patients frequently have fragile veins that collapse when punctured with a needle. Pediatric patients have stronger veins, but they are small and hard to find and obese patients usually have a layer of fatty tissue between their veins and the skin surface that can make venous access a little more difficult.

Certain diseases or conditions affect the availability of superficial veins (e.g., peripheral veins usually collapse when a patient is in shock). Certain obstructive diseases, like diabetes and atherosclerosis, may decrease blood flow through the extremities, making it difficult to find a vein. The condition of the veins themselves, or the tissues surrounding veins, also may be a deciding factor. You won't be able to use an area where there is heavy scarring or tissue damage. Also, don't use veins that have been damaged by frequent IV injections (e.g., veins of drug abusers) or veins that have numerous valves or scarring. Occasionally, you may encounter a patient that has had a mastectomy. Mastectomy involves the surgical removal of breast tissue, when this tissue is removed the surgeon also removes lymph nodes that drain the arm on the affected side. Lymph nodes drain excess fluid from tissue. If there are less drains (lymph nodes) for fluid to go into, the fluid will back up and cause edema (swelling), specifically Lymphedema. Trauma to tissues causes fluid to accumulate. Trauma to the right arm of a patient who has had a right mastectomy would cause the right arm to swell. The swelling would take a long time to subside, if at all, due to loss of lymph tissue to drain fluid. In general, it is not recommended to use blood pressure cuffs, compression devices, blood glucose sticks, injections or IV's in the arm on the side of a mastectomy. This is because any type of trauma to that arm may result in swelling and lymphedema. The only time one would consider starting an IV in the arm on the side of a mastectomy would be an emergent situation where IV access is required and the benefit of the IV access (saving the patient's life) outweighs the risk of having lymphedema in the arm on the side of the mastectomy.

You'll have a limited selection of sites if you have a pediatric, unconscious, or uncooperative patient. For such patients, you have to start the IV in a location where the patient won't tamper with it and it won't easily become dislodged. For those reasons, the scalp area is preferred for pediatric patients. You may have to use a foot or leg site for an uncooperative adult patient.

Consider the *length* of therapy when you select a site. If a patient is scheduled for long-term therapy, start the IV in the most distal vein possible to preserve other sites for future use. To reduce the possibility of infection and vessel damage, change IV sites every 48–72 hours. If you damage one of the large veins with your initial attempt, you won't be able to use any of the veins below that site until that vein heals.

The size and type of needle used is also a factor in the selection of an IV site. Wing-tipped needles are short and threaded only a short distance into the vein. Because they are not flexible, they must be completely immobilized so they will not become dislodged or puncture the far wall of the vein. The back of the hand is ideally suited for these requirements. These veins are easily visible and accessible, and there is usually a sufficient length of straight vein available for you to thread the needle. The structures on the back of the hand are relatively fixed. Once the needle is secured, it is unlikely that it will be dislodged. Most arm veins lie near or over muscles. Every time the arm or hand is moved, the veins also move. If you use a wing-tipped needle in arm veins, you should immobilize the extremity with an arm board.

Catheters are longer and usually larger in diameter than winged-tipped needles. Catheters also are threaded into the vein for most of their length. You may not be able to find a vein on the back of the hand that is large or straight enough to accommodate the catheter. On the other hand, since a catheter is flexible and moves with the vein, it does not require as much immobilization as the wing-tipped needle. Any arm vein can serve as an insertion site.

Figure 3–6 illustrates potential sites in the arm and hand. Remember to select the most distal site possible. The metacarpal, cephalic, and basilic veins are usually good targets, but you also can use the radial or basilic veins if you immobilize the arm properly. Although they are easily accessible, avoid using the veins in the antecubital (bend of the elbow) area if at all possible. If you do use antecubital veins, immobilize the patient's entire arm because damage to these vessels would limit future use of lower hand and arm veins. Also, avoid using any vein that lies directly over a joint or bony prominence.

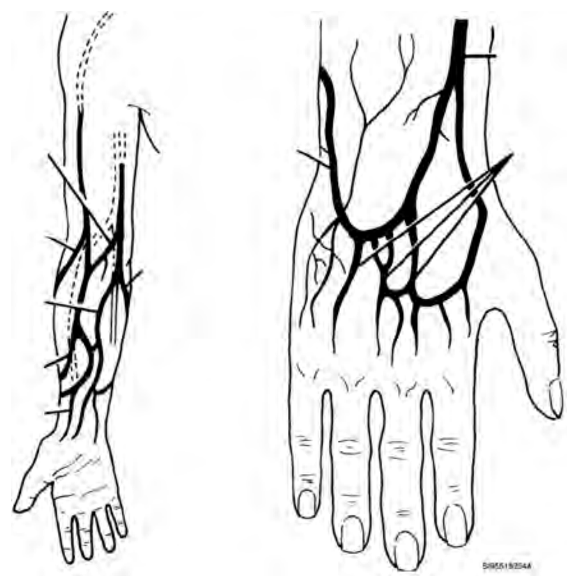


Figure 3–6. Possible intravenous sites on arm and hand.

Insert the intravenous catheter

Before you begin any actual contact procedures, don gloves to protect yourself and your patient. You'll come into direct contact with the patient's body secretions (blood), and you could introduce contaminants into the patient's body. Therefore, gloves will protect both of you. If your patient questions the need for gloves, simply explain that the gloves are meant to protect him or her. Most patients understand and agree with this rationale; in fact, some may request you use gloves.

Figure 3–7. Placement of tourniquet.

Once you decide what part of the body the IV will be inserted in, expose the area and apply a tourniquet to distend the veins. You may use a rubber drain, commercial tourniquet, or even a blood pressure cuff as a tourniquet. Apply the tourniquet about three inches above the site you selected (fig. 3–7). If you haven't selected a site, apply the tourniquet just above the elbow. If you are using a rubber drain, use a slip knot so that you can easily remove it.

When you apply a tourniquet, make it tight enough to obstruct the venous flow, but not the arterial flow. Obstructing arteries deprives the tissues of oxygen and may cause tissue damage. Check for a pulse at a point distal to the tourniquet. If you can feel a radial pulse, the tourniquet is not too tight.

As shown in figure 3–8, palpate the veins to determine their depth and direction. If the tourniquet hasn't dilated the veins sufficiently, place the extremity in a dependent position (lower than the heart. Let gravity help you!) and have the patient open and close his or her hand repeatedly to increase the blood flow. Also, you can massage the arm in the direction of blood flow and tap the vein lightly with your fingertips. If these measures are unsuccessful, remove the tourniquet and apply moist heat to the area for 15 or 20 minutes. Prolonged constriction from the tourniquet is very uncomfortable. If you haven't located a vein within a few minutes, remove the tourniquet and reapply it after a few moments.

When you locate a suitable vein, clean the site (fig. 3–9) with an antiseptic solution or pad (make sure your patient does not have an allergy to Betadine® prior to applying to the skin). Use an alternate antiseptic if the patient is allergic to Betadine®. Use a circular motion, starting at the center of the site and working outward. Allow the site to air dry before proceeding. DO NOT blow on the site to dry it!

Grasp the skin about one inch below the point of entry (fig. 3–10) and gently but firmly pull the skin toward you to stabilize the vein. Hold the needle bevel up at about a 45 degree angle, and insert it through the skin surface about ½ inches below the planned entry site into the vein. Decrease the angle and move the needle slowly in the direction of the vein. You'll feel a sudden "give" when the needle penetrates the vein, and blood should appear in the tubing (wing-tipped) or hub of the needle. Thread the needle carefully into the vein for a short distance to prevent accidental dislodging. If you are using an over-the-needle catheter, hold the hub of the needle in place and carefully thread the entire length of the catheter into the vein. Once the catheter is in place, remove the inner needle and apply gentle pressure on the skin over the top of the catheter. This will keep the blood from running out of the catheter (fig. 3–11).

Figure 3–8. Palpating a vein.

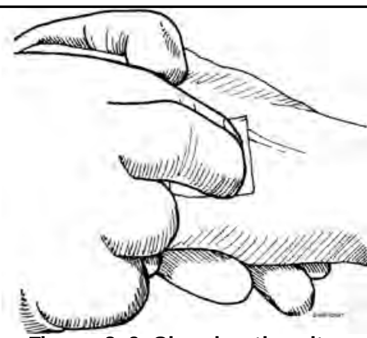


Figure 3–9. Cleaning the site.

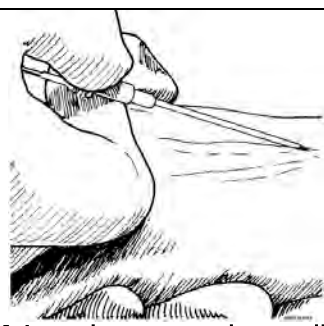


Figure 3–10. Inserting an over-the-needle catheter.

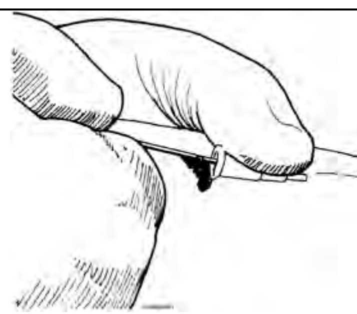


Figure 3–11. Pulling out the needle.

Secure and connect the intravenous catheter

Connect the IV tubing to the adapter (fig. 3–12), release the tourniquet, and open the clamp to allow the solution to flow. Do not open the clamp before you release the tourniquet or you will "blow" the vein. Look at the drip chamber to ensure the IV fluid is flowing freely. Apply dressing materials and secure the catheter with tape strips as shown in figure 3–13. Secure a loop of the IV tubing to the patient's arm near the injection site to prevent accidental dislodging. Do not wrap the tape completely around the arm as it may restrict blood flow if the area swells.

Figure 3–12. Connecting the tubing.

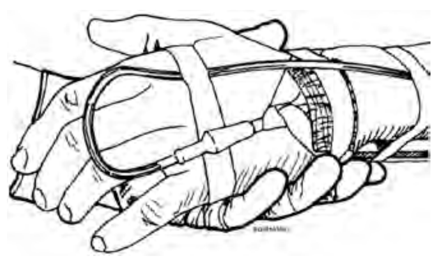


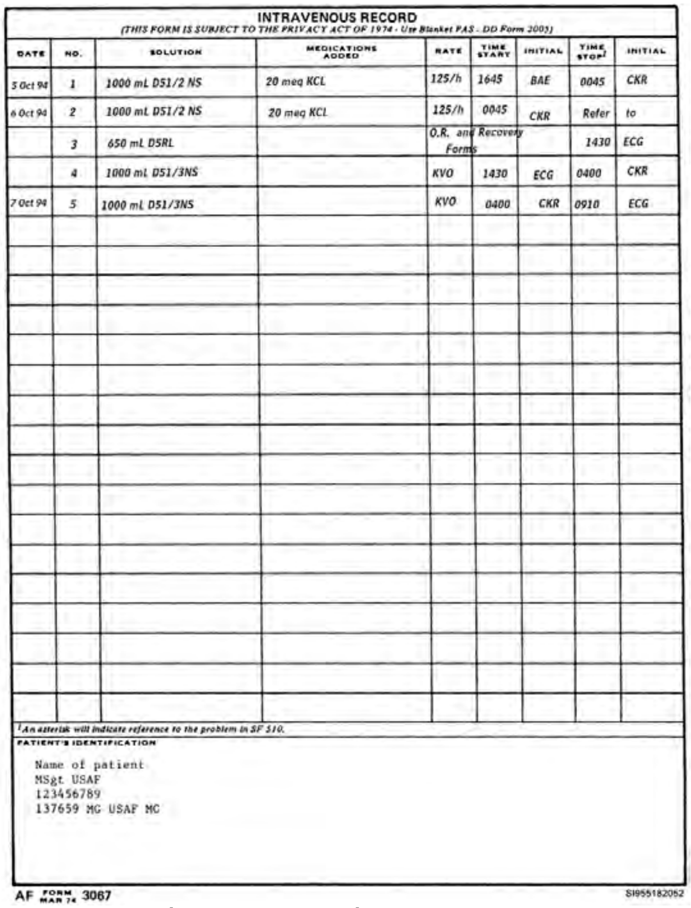
Figure 3–13. Applying tape and dressing.

Mark the date, time, gauge of needle or catheter, and your initials on the tape used to secure the IV. If you wish, tear the identifying information off the needle package and tape it to the site along with your initials and the date and time. As we discussed earlier, mark the start time on the solution container and on the tubing.

Adjust the flow of the solution by tightening or loosening the clamp. Regulate the flow according to the doctor's order by counting the drops for 15 seconds and multiplying by four. Use the equation shown earlier to determine the actual rate in drops per minute. If you are using an EID, follow the manufacturer's guidelines for attaching the tubing and adjusting the flow rate. Remember, these devices do not relieve you of the responsibility for monitoring the IV. Check it at least hourly to observe the patient's condition and rate of infusion.

Immobilize the IV if it is in a precarious position, near a joint, or if the patient is fairly active. If the IV is in a patient's arm or hand, use a commercial arm board or padded board that is about the size and length of the extremity. Place the patient's hand in the position of function with the wrist slightly flexed, fingers cupped, and thumb separated from the other fingers. Attach the board securely, above and below the IV site, but not so tight that you interfere with the patient's circulation or infusion flow. Check the pulse in a distal site, and monitor the flow rate after you attach the arm board. Pediatric scalp infusions can be immobilized by placing a transparent plastic shield or cup over the IV site.

Once you complete the initiation process, make the patient comfortable and assess him or her for adverse reactions. Clean up any mess and document the procedure on AF Form 3067, Intravenous Record (fig. 3–14) progress notes; or DD Form 792, Nursing Service-Twenty-Four Hour Patient Intake and Output Worksheet, as appropriate. Your documentation will include the date and time, location of site, type, size and lot number (found along the side of the individual IV catheter packaging) IV catheter, type of solution, rate of infusion, and any special equipment (EID) or tubing that was used.



INTRAVENOUS RECORD

(THIS FORM IS SUBJECT TO THE PRIVACY ACT OF 1974 - Use Blanket PAS - DD Form 2005)

DATE	NO.	SOLUTION	MEDICATIONS ADDED	RATE	TIME START	INITIAL	TIME STOP[1]	INITIAL
5 Oct 94	1	1000 mL D51/2 NS	20 meq KCL	125/h	1645	BAE	0045	CKR
6 Oct 94	2	1000 mL D51/2 NS	20 meq KCL	125/h	0045	CKR	Refer	to
	3	650 mL D5RL		O.R. and Recovery Forms			1430	ECG
	4	1000 mL D51/3NS		KVO	1430	ECG	0400	CKR
7 Oct 94	5	1000 mL D51/3NS		KVO	0400	CKR	0910	ECG

[1] An asterisk will indicate reference to the problem in SF 510.

PATIENT'S IDENTIFICATION

Name of patient
MSgt USAF
123456789
137659 MG USAF MC

AF FORM MAR 74 3067

SI955182052

Figure 3–14. Sample AF Form 3067.

Monitoring an infusion

After the infusion is in place, check both the patient and IV site at least once every hour. Assess the patient for adverse reactions to the solution or medication and for complications of the therapy. Check the IV to see if the flow rate is on schedule, if the needle is still in the vein, if the container is properly positioned, and to ensure the tubing is not kinked or obstructed.

Adverse reactions

Adverse reactions to the intravenous solution are rare, but may include pyrogenic reactions, allergic reactions, or fluid and electrolyte imbalances (i.e., circulatory overload).

Pyrogenic reactions are characterized by a sudden onset of chills, fever, headache, nausea, and vomiting. If the patient complains of these symptoms, check his or her vital signs, stop the IV, and notify the doctor and nurse immediately. Also, save whatever solution is left for laboratory analysis.

Allergic responses vary from a mild itching and rash to severe anaphylaxis. Again, check the patient's vital signs and general condition. If the patient is experiencing respiratory difficulty and other serious problems, stop the IV immediately and get help! If the symptoms are mild, slow the infusion and notify the nurse so that he or she can assess the patient's condition. If the patient's symptoms are due to another cause, taking out the IV will cause unnecessary stress and suffering, especially when another IV will likely need to be started. Excessive volumes of IV solutions usually cause *circulatory overload* (i.e., fluid and electrolyte imbalances). This condition is characterized by cyanosis, dyspnea, coughing, blood-tinged sputum, edema, distended neck veins, weight gain, decreased urinary output, weak rapid pulse, and rapid shallow respirations. If the patient exhibits some or all of these symptoms, check the infusion rate, slow the flow of the IV, and notify the nurse and doctor immediately. Do not discontinue the IV without the doctor's permission; you may need the open line to administer lifesaving medications. Pediatric and geriatric patients are more susceptible to circulatory overload.

Some patients, like diabetics, may develop hypoglycemia or hyperglycemia from the solution itself or from the medications in the solution. Fatigue, blurred vision, diaphoresis (sweating), irritability, and weakness characterize hypoglycemia. Hyperglycemia is characterized by fruity breath, polyuria (excessive urination), and polydipsia (excessive thirst). If the patient exhibits symptoms of either hyperglycemia or hypoglycemia, check his or her blood sugar, verify the medication order and solution, and notify the doctor.

Patients also may be susceptible to adverse reactions from medications added to the IV. These reactions vary according to the specific medication being administered and can include toxic reactions, allergic reactions, central nervous system (CNS) depression and electrolyte imbalances. As we said, you won't administer these medications, but you should know what the patient is receiving, what the actions and side effects are, and what to do to safeguard the patient if such reactions occur. All these reactions are potentially fatal, and vigorous lifesaving measures may be needed if they occur.

Complications

Most of the complications associated with IV therapy are caused by the therapy itself. Such complications include alterations of the infusion rate, infiltration, phlebitis, infection, and embolism.

Infusion rate

The first thing you should check after you assess the patient's condition is the infusion rate. Check the level of the fluid in the container against the time strip and observe the rate of flow through the drip chamber. If too much fluid has been infused or the solution is flowing too fast, immediately notify the nurse and check the patient for signs of circulatory overload. Do not alter the rate without the nurse's knowledge and approval. Look for possible causes of a change in the infusion rate (e.g., accidental loosening of the clamp by the patient or staff or excessive elevation of the solution container). If necessary, adjust the height of the container and caution the patient not to tamper with the clamp. If the container has emptied or run dry, clamp the tubing to prevent excessive backflow or air entry into the vein and notify the nurse immediately. Be prepared to replace both the tubing and the container.

If you notice that the infusion is behind time or infusing too slowly, check the container to see if it is too low and look for obstructions or kinks in the tubing. If the tubing is kinked or the patient is lying on it, make the necessary adjustments and recheck the flow rate. If the clamp has been inadvertently tightened, adjust it to the proper rate. Check the tubing to ensure it has not fallen below the infusion site and adjust accordingly. Excess tubing should be coiled neatly near the extremity with the IV. If the patient has an arm board or is in restraints, be sure these devices are not interfering with the fluid flow. Sometimes the position of the needle in the vein causes the flow rate to be too slow or too fast. If you haven't found another cause for the slowdown, check the needle position by loosening the dressings and CAREFULLY raising or lowering the angle of the needle slightly. If the flow is restored, adjust the position of the needle with sterile dressings. DO NOT increase the flow rate to catch up to the desired amount. Such an action could cause a circulatory overload. Notify the nurse, who will then check with the physician. If you find the flow rate has slowed to the point that blood has clotted in the needle, DO NOT attempt to relieve the condition by flushing the tubing with fluid. Even if you are successful in relieving the obstruction, you'll only cause the clot to break loose and travel through the vein (thromboembolism). Instead, attempt to relieve the clot by gently aspirating with a syringe and needle. If you are unsuccessful, the IV will have to be restarted in a different location.

Infiltration

Infiltration occurs when the needle becomes dislodged or penetrates the vein wall, and the IV solution flows into the tissues instead of through the vein. When this occurs, the infusion rate slows down dramatically and the tissues around the IV site become reddened or blanched (whitish color), swollen, cold and painful. If you notice that the flow rate has slowed and is unresponsive to clamp adjustments, check for infiltration by briefly lowering the solution container and checking for blood return in the tubing or hub of the needle. Absence of blood return is an indication that the IV has become dislodged; however, it may also indicate the needle is pressed up against the wall of the vein. Confirm this check by applying a tourniquet just above the IV site. If the solution continues to flow at the same rate, infiltration has occurred. Notify the nurse and, with his or her approval, discontinue the IV. If the IV is still needed, start it in a different location and, preferably, in a different extremity. Elevate the affected extremity and apply moist heat per the doctor's orders. The doctor may also order medical antidotes, if the solution contained medications that cause tissue damage (i.e., extravasation).

Phlebitis

Phlebitis is an inflammation of the vein that can be caused by chemical irritation from medications or IV solutions, mechanical irritation from a needle or catheter, or localized allergic responses to the needle or catheter. It is characterized by redness, warmth, swelling, and pain along the course of the vein. In some cases, the vein may feel like a raised hard line. The phlebitis can be complicated by the formation of a clot along the vein (thrombophlebitis). If the patient exhibits these signs, notify the nurse and, with his or her approval, discontinue the IV and restart it with new equipment in a different location. Do not massage the site as you may dislodge the clot.

Infections

Infections are generally caused by the use of poor aseptic techniques in initiating or maintaining the IV. Redness, pain, edema, heat at the site, and a purulent discharge characterize infections. If an infection is severe, the patient also may develop a fever. The treatment is similar to the treatment for phlebitis. Remove and restart the IV (in the other arm if at all possible), apply compresses, and monitor the patient for signs of systemic infection (e.g., fever, elevated leukocyte count, etc.). The most effective treatment is to prevent infection by practicing good aseptic techniques, daily dressing changes, tubing changes every 24–48 hours, and site changes every 48–72 hours (i.e., per local policy).

Embolisms

Embolisms are caused by air bubbles or foreign particles (clots) in the vein. Air embolisms can be introduced by poor techniques used in the preparation of the IV. Normally, a large amount of air is required to cause an embolism, but because of the potentially lethal consequences, make every effort to eliminate all air bubbles. Flush the tubing to eliminate initial bubbles. If bubbles occur in the tubing after the IV is initiated, either aspirate the bubbles with a syringe and needle or tap the tubing until the bubbles rise and are dispersed in the drip chamber. Other embolisms may occur when a clot is dislodged, or when particles are introduced from the medication or solution. Embolisms become a problem when they become lodged in one of the pulmonary arteries. If the obstruction is significant, the patient may experience a pulmonary infarction and could die. Signs of complications include drop in blood pressure, cyanosis, tachycardia, increased venous pressure, and unconsciousness. Treat the patient by turning him or her on his or her left side with the head down and administering oxygen. Check the vital signs and notify the doctor.

As part of monitoring, you'll perform certain maintenance procedures on the IV, including changing dressings, bags, tubing, and IV sites. Local directives (operating instructions) govern the frequency of these procedures, but most facilities follow the recommendations of the Centers for Disease Control and Prevention. As with initiating the IV, wear gloves to protect yourself and the patient when changing the site, tubing, or dressings.

Maintenance of an intravenous

Change IV dressings daily or when they become soiled. Carefully remove the old dressings and examine the site for signs of infection and phlebitis. Clean around the site with an antiseptic solution before applying new sterile dressings. Mark the dressing with the date, time, and your initials, as before, and document your activities and observations. Remove all the discarded dressings from the patient area. Because they are a source of contamination, dispose of them accordingly.

If you are monitoring an IV properly, you'll know when the container is almost empty or when the time is up. Change the bottle or bag as needed, but at least once every 24 hours. When you change the bottle or bag, check the order as before. Obtain a new container and take it to the patient's room. Check the expiration date of the bottle or bag, and inspect the container for contamination or particles. Using a sterile technique, expose the injection port. Clamp the tubing to prevent backflow, and pull the injection spike out of the old container. Quickly insert the injection spike into the injection port of the new bottle or bag, and hang the container from the IV pole. Open the clamp and reset the flow rate. Monitor the tubing for air bubbles until the flow is stabilized.

In some cases, the purpose of the IV is just to maintain access to the patient's venous system rather than to administer fluids or medications. If that's the purpose, the flow rate is set to the slowest possible rate, usually between 10 and 50 cc/hour, with the amount infused at less than 500 cc. At this flow rate, a line is kept open but clotting is prevented. Instead of a time tape, label the solution container "KVO" (for "keep vein open"). KVO bags and bottles are usually changed at the end of each 24-hour period. If there is any fluid remaining in the old container, discard it after the change. Since you normally change the tubing within the same time frame, it is a good idea to consolidate your efforts and change both the tubing and the container when you do the dressing change. This limits the time that the system is open and reduces the possibility of infection.

When you are ready to change the tubing, assemble a new container and tubing as before. Label the new tubing with the date and time. Prime the tubing and eliminate air bubbles. Using gloves and sterile techniques disconnect the old tubing from the needle hub and quickly attach the new tubing. Tape the tubing down as before and set the flow rate. Document the changes on the appropriate forms.

An IV should not limit a patient's activities. He or she should be encouraged and assisted to ambulate, eat, bathe, and perform other activities of daily living. Caution the patient not to kink the tubing during these activities and to keep the solution container 2–3 feet above the IV site. Also, teach the patient the signs of adverse effects and encourage him or her to notify the nurse if problems arise.

Discontinuing an intravenous

Sooner or later, you'll discontinue the IV. You may do so because the patient has a problem or because you want to change the site, but the ideal reason is because the patient no longer needs it. Regardless of the reason, the technique is the same. Verify the doctor's order and check the patient's identification as with any other procedure. Explain what you are doing, and remove the tape and dressing over the site. Stabilize the catheter with one hand as you clamp the tubing and remove the last pieces of tape with the other. Place a sterile gauze pad on the injection site and withdraw the catheter with a quick, smooth motion, following the course of the vein as you do so. Examine the tip of the catheter (or needle if using a butterfly catheter) to be sure it is intact and does not appear frayed (or broken if using a needle). If there appears to be any problem with the catheter or needle, place it in a bag with a label and notify the nurse immediately. It may be necessary for the provider to order x-rays to find the piece that broke off. Ensure you document whether the catheter or needle is intact or if there was damage to it. Maintain pressure over the injection site for 20 or 30 seconds or until the bleeding stops. Apply a small dressing and make the patient comfortable. You may need to hold pressure for a few minutes or have the patient hold pressure. You can also have the patient raise his or her arm up to stop bleeding. On the patient's chart, document the date, time, condition and size of the needle, condition of the patient, and condition of the site. A patient's chart is normally a SF 600, nursing note, computer entry or IV flowsheet. Continue to monitor the patient for bleeding and other adverse effects. Discontinuing a saline or heparin lock is completed the same as an IV.

Equipment and procedures to initiate saline locks

A saline lock, also referred to as a heparin lock, is an intermittent infusion reservoir that permits the administration of IV solutions or medications without the continuous administration of IV fluids. Saline locks are initiated just like normal wing-tipped needles or over-the-needle catheters, except no IV tubing is connected to it. Prior to inserting the saline lock, flush the device and then once the device (shown in figure 3–15) is in place, flush it with a small amount (2 ml) of saline to ensure patency. Flush the needle again every 4–8 hours as long as it is in place. A heparin lock is used for the same purpose but uses a medication called Heparin, which keeps the blood from clotting at or around the IV catheter within the vein. Most facilities now use a saline flush instead of heparin because it is safer to use and while still performing a very similar action, it keeps the blood from clotting in and around the catheter. Since these IV access points (locks) have been called heparin locks for quite some time, many people still refer to them by that term even though saline is being used. The saline used must be IV injectable quality.

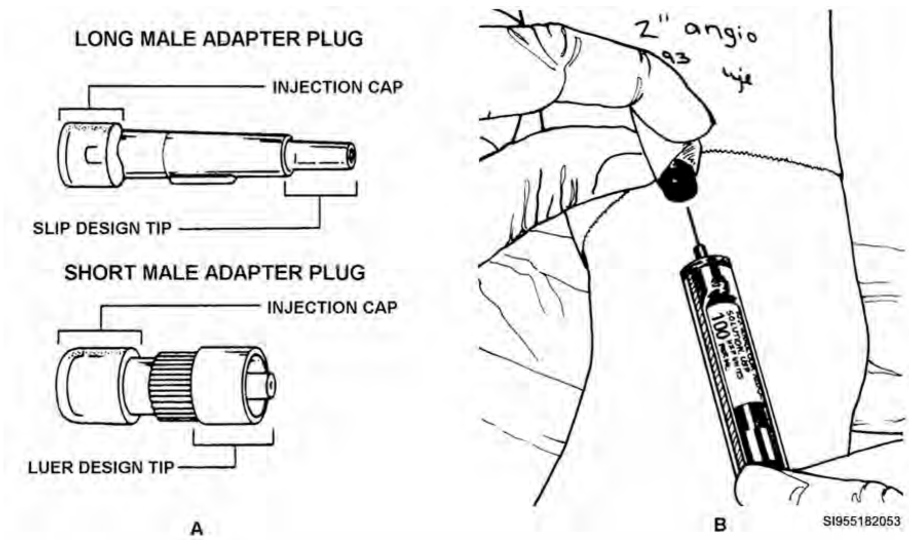


Figure 3–15. (A) Saline lock devices, (B) injection of medication into saline lock.

Initiating a saline lock

Saline locks are very useful for patients who require frequent injections of medications, or intermittent infusions of specific fluids or medications (known as a "piggyback"), but do not need the fluid volume associated with a normal IV. Patients have greater freedom of movement since they do not have to worry about tubing, solution containers, IV poles, and infusion devices. Also, patients are spared the pain of frequent injections. The saline lock can be used for both blood sampling and medication administration.

Other than regular dressing changes and flushing, saline locks require very little maintenance. They can be left in place as long as dictated by local policy and discontinued in the same manner as other wing-tipped needles or over-the-needle catheters.

When you use a saline lock for administering medication (7 or 9-level only), first wipe off the injection port with an alcohol swab. Then, gently aspirate the set to check for patency. If there is a blood return, flush the set with a small amount (2 ml) of normal saline. When the line is clear, inject the medication. Following the injection, flush the line with another 2 ml of saline to clear the medication from the saline lock.

When you use a saline lock for blood specimen collection, first wipe off the injection port with an alcohol swab, and then gently aspirate with a needle and syringe. The first 3–5 mL will be diluted; therefore, discard and take another sample. When finished with blood sample collection, flush the saline lock with 2 cc of normal saline until the line is clear.

Needleless intravenous systems

Needleless intravenous access systems are devices developed to lessen the risk of accidental needle sticks to health care workers. The white ring around the injection port (fig. 3–16) identifies one type of needleless system. These systems can be used as saline locks or on IV administration sets where the administration of piggyback medication is needed. These special rubber ports have a precut slit that self-seals after insertion and removal of a blunt-ended delivery device. Otherwise, the rest of the procedure is the same as using a needle and syringe.

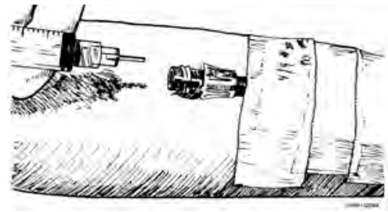


Figure 3–16. Needleless systems.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

017. Fundamentals of intravenous fluid therapy

1. What factors determine the type of intravenous solution used?

2. What is tonicity?

3. What type of patients should receive parenteral hyperalimentation?

4. Why are hyperalimentation solutions administered through central veins?

5. What condition should be treated with blood volume expanders?

018. Intravenous fluid therapy procedures

1. What basic equipment is needed to initiate an IV?

2. How high should the IV container be positioned?

3. What are the basic components of an administration set?

4. What prevents the mixing of primary and secondary infusions when a piggyback setup is used?

5. What are the three basic types of intravenous needles?

6. What type of needle is commonly used to initiate an IV in the scalp of a pediatric patient?

7. What type of needle is most commonly used when the possibility of extravasation is possible?

8. When would a volumetric pump be used?

9. When are variable pressure volumetric pumps used?

10. How do you “prime” the administration set?

11. What information should be included on the medication label placed on the side of the bottle/bag?

12. Where are medications usually added to the IV container?

13. What should you do if there are visitors present when you go to start an IV?

14. What factors should you consider when selecting an IV injection site?

15. Why is it sometimes difficult to initiate an IV on elderly patients?

16. Where should you start an IV if it will be in place for a long time?

17. What three veins are preferred for IV sites in the hand and arm?

18. What should you do before you begin actual contact procedures with the patient?

19. How tight should you make the tourniquet?

20. Where should you insert the needle in relation to the vein you are trying to penetrate?

21. What precaution should you take when applying tape to a dressing?

22. What factors determine whether you should immobilize an IV?

23. What information should be documented after the IV is initiated?

24. What are the indications of a circulatory overload?

25. What complications are associated with the IV therapy itself?

26. Why should you not attempt to catch up if the infusion is behind schedule?

27. What causes infiltrations?

28. What condition may complicate phlebitis?

29. What causes embolisms?

30. What is the normal rate for a KVO IV?

3–3. Specimen Collection

This section covers an important task you will perform as an aerospace medical service journeyman—the collection of specimens. No matter whether you work in an inpatient unit, the emergency room, or an outpatient clinic, accurate performance of this task is a must. You are probably sitting there saying, “Another repeated topic from tech school.” That’s true, but the importance of this task bears repeating. In this unit, you will learn several types of collection and the specifics associated with each one.

019. Special tests and procedures associated with specimen collection

There are many special tests and procedures that are completed to help diagnose and treat medical problems. This unit will deal with only a few that you, as an aerospace medical service journeyman, will be involved in doing.

Requisitions

A requisition is an important aspect of specimen collection. Most of the specimen forms are Standard Forms (check AFI 41–210, *Tricare Operations and Patient Administration Functions*, for form currency). An example would be Standard Form 550, Urinalysis, and Standard Form 551, Serology. These forms are rarely used with the installation of computer systems at nearly every location; however, it is a good idea to know the forms in case you need a back up method. If using the paper method, remember to stamp the requisition with the patient’s nameplate (usually made for inpatients), or write the patient’s information (e.g., name, social security number, physician ordering the test, date, and time) on the form. If entering into the computer system, ensure you accurately enter the patient’s information and pay close attention to similar names or last four of the social security number (SSN). Enter correct providers name so he or she gets the results as soon as possible.

Collecting emesis

A patient’s emesis is collected to determine the presence of blood or in the case of poisoning, to determine what had been swallowed. An emesis basin is usually the easiest container to use. After collecting the specimen, be sure to label it correctly. Information required on the label includes the type of specimen, date and time, patient’s name, sponsor’s social security number, patient registration number (for inpatients) and physician’s name. **(NOTE:** Label all specimens in this manner.)

Sputum collection

Sputum specimens are examined for many different types of microorganisms. In fact, the causative agents for many pulmonary disorders are often discovered in a microscopic examination of the sputum. Tuberculosis is frequently discovered in this manner. For this reason, it is a valuable diagnostic aid to the physician.

No doubt, you will be the one who collects the sputum specimens. Remember, the causative agent for the disorder may be in the specimen; therefore, you must exercise caution when collecting it. Without care, you can spread the disease to other patients, coworkers, and, especially, yourself. Handle the specimen carefully, touch only the outside of the container, and be sure to wash your hands after you have handled it. Close the container tightly to prevent spillage and further contamination. If the laboratory wants to grow the causative organism in a culture, the specimen must be collected in a sterile container and handled with a sterile technique; otherwise, you will contaminate the specimen.

Normally, the specimen is collected in a wide-mouthed bottle or sputum cup. It should be as free of saliva as possible and obtained by a deep cough. For best results, have the patients rinse their mouth with hot water before they attempt to cough up the specimen. This rinse gets rid of excess saliva, which is normally in the mouth. Stay with the patients while they are coughing. Try to get at least a teaspoonful of sputum for the examination. Prepare the appropriate laboratory form indicating the examination requested and take it to the laboratory immediately. If there is any delay, place the specimen in a refrigerator, but not in one used for food.

Gastric washing

When a sputum specimen cannot be coughed up for diagnostic examination, a gastric washing is performed. It is believed that ciliary action may move sputum upward from the lungs to the larynx where it is swallowed. Gastric washings may be helpful in identifying cancer cells. The gastric (stomach) contents are removed by placing a rubber tube (Levin) through the mouth or nose and into the stomach. Once the tube is passed, the patient swallows a few ounces of distilled water, a large syringe is attached to the end of the tube, and by gentle aspiration, a specimen is withdrawn.

The procedure is done in the early morning before the patient has breakfast. This is the most convenient time because most patients swallow sputum while sleeping or when coughing in the early morning. The gastric contents can be examined for blood, pus, acidity, and microorganisms. Here again, the specimen must be handled with care. Like sputum specimens, the gastric contents may contain the causative agents for the disorder. Handle with care and be sure to wash your hands after handling.

Collecting and testing urine

There are several different tests that you may complete on urine samples. One of these tests is a *sugar and acetone test* (S&A). This is done to detect the presence of sugar or acetone bodies in the urine. The method used is determined by each facility. In most cases, you will obtain a urine specimen from the patient using a commode hat, while implementing universal precautions. Place the urine to be sampled in a urine specimen container and take the sample to the utility room. Most facilities use a test strip method; you simply dip the test strip into the urine and wait a specific amount of time for the results. Please check your unit operating instructions for the method used in your facility.

Another test you may complete is a *hematest*. This is a test for occult blood in the urine. Once again, a urine sample is obtained. Then, using a test strip, place it into the urine and wait the amount of time specified in the test strip instructions for the results.

A *specific gravity* test is used to determine the hydration level of a patient. The normal specific gravity of urine is 1.005 to 1.025. High specific gravity suggests dehydration and a low specific gravity suggests that the patient is well hydrated. This test also reflects the diluting and concentrating ability of the kidneys. Therefore, this test is done for patients in renal failure.

For some patients, you may strain the urine for *calculi*. As you learned previously, another term for stones is calculi. These stones may develop anywhere in the urinary tract system. If the physician thinks a patient may have a stone, he or she orders straining of all of the patient's urine. Most facilities have paper funnels with fine mesh gauze in the end, called a strainer. As you strain the urine, look for stones. If you find a stone, save it, place in a sterile urine cup, apply correct labeling, notify the nurse and send it to the laboratory for analysis.

Stool

Stool samples are obtained for many reasons (i.e., occult blood, parasites, fat, and other abnormalities). To obtain a stool sample, give the patient a commode hat to defecate into. Once they have defecated, using gloves and a wooden tongue blade, place two tablespoons of feces into the specimen container. The specimen must be taken to the laboratory while it is warm.

Cytology

This test involves the study of cells. A variety of procedures can be used to obtain tissue for a cytologic examination. Venipuncture, bone marrow aspiration, urine catheters, and lumbar puncture are just a few of the types of procedures used. The samples are viewed under a microscope, normally to confirm a diagnosis. Studies of the tissues are performed to detect carcinogenics, metabolic, vascular, and other changes. Always remember to use standard precautions and aseptic technique to guard against infection or contamination of the specimen. Your involvement will be to assist in the preparation, procedure and post care of the patient.

Collect and label wound drainage

There may be times when an incision becomes infected. If the physician suspects this, he or she will order a *culture and sensitivity* (C&S) of the wound drainage. The culture is to determine the type of organism, and the sensitivity is to determine what type of antibiotic will stop the growth. To perform a C&S, obtain a culturette. Before performing the cleaning of the wound, open the culturette, roll the cotton tipped applicator in the exudate (wound drainage), place the tip back into the holder, then break the medium. Be sure to label the culture with the patient's name and source of culture.

Biopsies

Biopsies are the removal and examination, usually microscopic, of tissue or fluid from the living body to establish a precise diagnosis. There are several different types of biopsies, but let's take a closer look at a few of the more common ones where you may be asked to assist.

Type	Explanation
Cone biopsy	Inverted cone of tissue is excised, as from the uterine cervix.
Excisional biopsy	Tissue is removed by surgical cutting.
Incisional biopsy	A biopsy of a selected portion of a lesion.
Needle biopsy	Tissue is obtained by puncture of a tumor, the tissue within the lumen of the needle being detached by rotation, and the needle withdrawn.
Percutaneous biopsy	Tissue is obtained by simply inserting a needle through the skin.
Punch biopsy	Tissue is obtained by a punch, such as in a bone marrow biopsy.

The physician is responsible for obtaining the tissue sample for the biopsy. Your job is to assist as needed, and you will likely be responsible for ensuring specimen bottles are readily available and properly labeled. Again, these tests are performed as a diagnostic procedure and must be sent to the pathologist in the laboratory for final diagnosis.

Lumbar puncture/spinal tap

The lumbar puncture (LP) is the insertion of a needle into the subarachnoid space, usually between the third and fourth lumbar vertebrae, to aspirate cerebrospinal fluid (CSF). This procedure is also referred to as a spinal tap or spinal puncture. The spinal tap provides important information about intracranial pressure and the composition of the CSF. It is widely used in the diagnosis of bacterial and viral infections, such as spinal meningitis, along with the evaluation of seizure disorders.

Keep in mind, the physician does this procedure. Your responsibility involves room and patient preparation and to assist the provider with collection and labeling of specimen tubes or as otherwise needed. Ensure each collection tube is sealed and labeled with correct information. A spinal tap is normally performed for analysis of CSF or to measure CSF pressure to aid in the evaluation of some underlying condition. If an aircrew or special operational member requires a LP for diagnosis, the flight surgeon will likely ground the individual from flying or operational duty for 24 hours or until a diagnosis is made.

020. Miscellaneous procedures

This lesson devotes its attention to some of the miscellaneous procedures associated with specimen collection. You will learn about venipuncture, skin puncture, glucometer testing, and throat cultures.

Venipuncture

As an aerospace medical service journeyman, there may be many occasions to perform a venipuncture. If you work the evening or night shift, either you or the nurse may be responsible for drawing all admission lab work. To perform venipuncture, gather all equipment you will need, including: a needle (20 gauge or larger), syringe (size depends on amount of blood needed), antiseptic, 2x2 gauze sponges, vacutainer and vacutainer needle (if using vacutainer system), test tubes (with proper color for tests ordered by the physician), tourniquet, and nonsterile gloves. Your unit may have a venipuncture tray that includes the equipment you will need.

As previously discussed in the lesson on IV therapy, determine the site to use by applying the tourniquet above the elbow. The tourniquet will distend the veins and allow you to visualize and palpate the vein. (**NOTE:** The tourniquet should not stop the arterial flow of blood; and the radial pulse should still be palpable.) Remove the tourniquet. Next, cleanse the area with an antiseptic solution and allow the area to dry. Reapply the tourniquet and put on gloves. Insert the needle, bevel up at a 45 degree angle into the vein. Obtain the blood sample, remove the tourniquet, and apply a gauze sponge over the site and withdraw the needle. Have the patient maintain pressure over the site for two to three minutes. Using local policies, transfer the blood into a test tube, ensure proper labeling, and send it to the laboratory.

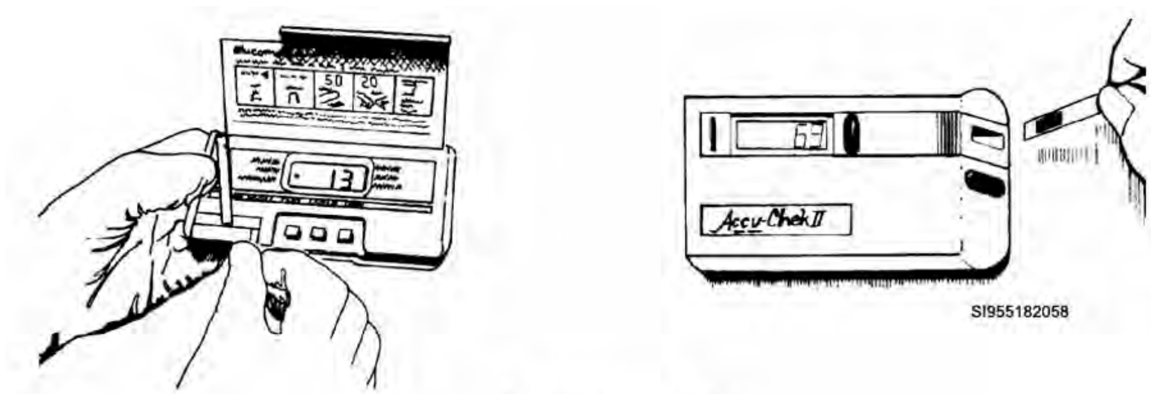
Skin puncture

A skin puncture is performed when only a small amount of blood is needed to perform a test. Different sites can be used to obtain this sample (e.g., fingertips, earlobes, or heels of neonates). To perform a skin puncture, obtain the required equipment—lancet, pipette, slides microhematocrit tube, alcohol, sterile gauze sponges, or any other equipment needed for that particular test. Now you are ready to perform the test.

Identify the patient, cleanse the selected site with alcohol, and then dry the site to prevent any alterations in test results from the alcohol. Apply gloves and press or squeeze above the site to allow the blood to infiltrate the area. To minimize pain, quickly prick the skin with your sterile lancet. Release the pressure and wipe off the first drop of blood. This first drop of blood contains epithelial cells, which can interfere with the test results. Obtain the sample needed, and then apply pressure over the site with a sterile gauze sponge until the bleeding stops.

Glucose meter testing

A glucose meter (fig. 3–17) is an instrument used by diabetics to quickly obtain blood glucose levels. Normal fasting blood glucose levels range from 70 to 115 mg/dl. Many facilities have several different types of glucose monitoring equipment; therefore, each of them will not be discussed in this text. Operating instructions are provided for each unit. Before operating the equipment you will need to read and become familiar with the instructions for the each unit you are required to use. Also, your trainer will give you preoperational training before using the glucose meter on a patient.



Two types of glucose meters

Figure 3–17. Examples of glucose meters.

Throat culture

Collections of throat secretions are taken to determine the presence of disease-producing organisms. If you have ever been to a doctor for a sore throat, you will probably remember one of the first things the technician did was to stick a cotton-tipped applicator into your mouth. You probably did not care much for the procedure, in fact, you most likely gagged. However, it was done for a reason. Since the mouth is the portal of entry for many organisms, the taking of a throat culture may reveal the type of "bug" giving you the sore throat. When physicians know the organism, they can effectively treat the sore throat.

Collect the specimen with a sterile, cotton-tipped applicator from a sterile test tube. The cotton-tipped applicator is placed in the affected area of the mouth or throat. Carry out the procedure using aseptic technique. After the throat is swabbed, replace the cotton-tipped applicator in the test tube, properly identify the specimen with the patient's social security number, and carry it to the laboratory. The results of the culture take two to three days. The *rapid strep test* (there are several different types used) can produce results within minutes to hours. It can only detect the presence of "Group A" strep, the one most likely to cause serious throat infections; it does not detect other kinds of strep or other bacteria.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

019. Special tests and procedures associated with specimen collection

1. What type of pulmonary disorder is frequently discovered through sputum collection?

2. What special test is used to detect occult blood in the urine?

3. What test is used to determine the hydration level of the patient?

4. If you find calculi when straining urine, what should you do?

5. Stool samples are obtained for what reasons?

6. Define "biopsies."

020. Miscellaneous procedures

1. List all equipment needed to perform venipuncture.

2. What is the purpose of a tourniquet when performing venipuncture?

3. When performing venipuncture, how is the needle inserted?

4. How long is pressure maintained over a venipuncture site?

5. When performing a skin puncture, why is the first drop of blood wiped away?

6. What is the purpose of a glucose meter?

Answers to Self-Test Questions

015

1. Hypovolemia.
2. Poor skin turgor, concentrated urine which will result in a high specific gravity, oliguria, dry mucous membranes, weak and rapid pulse, orthostatic hypotension, a low central venous pressure (below four cm of H_20), confusion, and restlessness.
3. (1) Congestive heart failure.
   (2) Renal failure.
   (3) Cirrhosis.
   (4) Cushing's syndrome.
4. A chemical substance (ion), capable of carrying an electrical charge when it is in water.
5. Confusion, weakness, restlessness, hyperthermia (elevated body temperature), tachycardia, muscle twitching, and abdominal cramping. In severe cases, convulsions and coma can be the complications.
6. Signs and symptoms similar to dehydration including: thirst, dry sticky mucus membranes, oliguria (scanty urine output), hyperthermia, dry tongue, and lethargy. If untreated, may lead to coma.
7. Potassium.
8. Calcium.

016

1. Percentage of hydrogen ions (atoms) present in a solution.
2. 7.34 to 7.45.
3. Alkaline.
4. Metabolic acidosis.
5. Metabolic alkalosis.
6. Respiratory acidosis.
7. Respiratory alkalosis.

017

1. The patient's condition, fluid and electrolyte balance, and purpose for the IV.
2. The relative concentration of dissolved substances in a solution as compared to the solution concentration within the red blood cells (RBC).
3. Patients who have a gastrointestinal disorder.
4. To prevent damage and irritation to the small vessels.
5. Hemorrhagic shock and other forms of shock characterized by an excessive plasma loss.

018

1. A solution container, an administration set, and a needle.
2. Normally between 24 and 36 inches above the patient.
3. An insertion spike, drip chamber, plastic tubing, clamp, vent port, medication port, secondary port, and needle adapter.
4. A back-check valve on the primary tubing.
5. Wing-tipped needle, over-the-needle catheters, and inside-the-needle catheters.
6. Wing-tipped needle.
7. Inside-the-needle catheters.
8. For intra-arterial infusions or deep central venous lines (cut-downs), for patients who have multiple IV lines and whose condition is such that they could roll onto or otherwise obstruct the line.
9. When patients require critical volume or critical medication.
10. Insert the spike into the appropriate opening and allow a small amount of solution to flow through the tubing to eliminate air bubbles.
11. The start time, stop time, and hourly intervals.

12. In the pharmacy or nursing unit.
13. Ask them to step out of the room until the IV is in place.
14. The type of solution, rate of infusion, age and condition of the patient, condition of the veins, duration of the therapy, and type of equipment used.
15. They have fragile veins that collapse when punctured with a needle.
16. The most distal vein possible to preserve other sites for future use.
17. The metacarpal, cephalic, and basilic veins.
18. Don gloves.
19. Tight enough to obstruct the venous flow, but not the arterial flow.
20. About ½ inch below the planned entry site into the vein.
21. Do not wrap the tape completely around the arm.
22. If it is in a precarious position, near a joint, or if the patient is fairly active.
23. The date and time, location of site, type and size of needle, type of solution, rate of infusion, and any special equipment (EID) or tubing that was used.
24. Cyanosis, dyspnea, coughing, blood-tinged sputum, edema, distended neck veins, weight gain, decreased urinary output, weak rapid pulse, and rapid shallow respirations.
25. Alterations of the infusion rate, infiltration, phlebitis, infection, and embolism.
26. Such an action could cause a circulatory overload.
27. When the needle becomes dislodged or penetrates the vein wall and the IV solution flows into the tissues instead of through the vein.
28. The formation of a clot along the vein.
29. Air bubbles or foreign particles (clots) in the vein.
30. Between 10 and 50 cc/hour, with the amount infused at less than 500 cc.

019

1. Tuberculosis.
2. Hematest.
3. Specific gravity.
4. Save it and send it to the laboratory for analysis.
5. To check for occult blood, parasites, fat, and other abnormalities.
6. The removal and examination, usually microscopic, of tissue or fluid from the living body to establish a precise diagnosis.

020

1. Needle (20 gauge or larger), syringe (size depends on amount of blood needed), antiseptic, 2x2 gauze sponges, vacutainer and vacutainer needle (if using vacutainer system), test tubes with proper color for tests ordered by the physician, tourniquet, and nonsterile gloves.
2. To distend the veins and allow you to visualize and palpate the vein.
3. Bevel up, at a 45 degree angle into the vein.
4. Two to three minutes.
5. It contains epithelial cells that may interfere with test results.
6. For diabetics to quickly obtain blood glucose levels.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter.

51. (015) Which fluid imbalance is characterized by dry mucous membranes, weak and rapid pulse, orthostatic hypotension, and a low central venous pressure?
    a. Hypervolemia.
    b. Hypovolemia.
    c. Hyperkalemia.
    d. Hypokalemia.

52. (015) What electrolyte deficit or excess can cause dysrythmias, leading to cardiac or respiratory arrest?
    a. Hypercalcemia.
    b. Hypocalcemia.
    c. Hyperkalemia.
    d. Hypernatremia.

53. (016) Which acid-base imbalance is caused by hyperventilating?
    a. Metabolic acidosis.
    b. Metabolic alkalosis.
    c. Respiratory acidosis.
    d. Respiratory alkalosis.

54. (016) Deficiency in respirations such as slow or irregular shallow respirations can lead to an excessive accumulation of carbon dioxide in the blood which results in a condition called
    a. metabolic acidosis.
    b. metabolic alkalosis.
    c. respiratory acidosis.
    d. respiratory alkalosis.

55. (017) The basic purpose of infusion therapy is to
    a. administer fluids into the circulatory system.
    b. increase overall muscular strength.
    c. decrease susceptibility to infection.
    d. control blood loss.

56. (017) What is the best way for a medical technician to ensure the sterility of an intravenous (IV) solution?
    a. Use only the bag the nurse has spiked and ready to hang.
    b. Look for cloudiness or floating particles.
    c. Remove protective devices yourself.
    d. Culture the fluid prior to use.

57. (018) In a piggyback setup, what prevents the mixing of primary and secondary infusions?
    a. Vent port.
    b. In-line filter.
    c. Back-check valve.
    d. Self-sealing rubber cover.

58. (018) To *reduce* the possibility of infection and vessel damage on patients scheduled for long-term therapy, how often should you change a patient's intravenous (IV) site?
    a. Every 24 hours.
    b. Every 24 to 48 hours.
    c. Every 24 to 72 hours.
    d. Every 48 to 72 hours.

59. (018) In cubic centimeters (cc), what is the slowest possible flow rate per hour you may set for an intravenous (IV) solution?
    a. 1 to 5 cc.
    b. 5 to 10 cc.
    c. 10 to 50 cc.
    d. 50 to 100 cc.

60. (019) Which urine test is done to determine the hydration level of the patient?
    a. Hematest.
    b. Specific gravity.
    c. Sugar and acetone.
    d. Clean catch mid stream.

61. (019) What steps should you take if you identify a small object while straining urine?
    a. Call the nurse to come see the patient.
    b. Call the doctor to come see the patient.
    c. Place it in a gauze pad and take it to the lab.
    d. Place it in a sterile urine cup and notify the nurse.

62. (020) After obtaining a blood sample, instruct the patient to maintain pressure over the venipuncture site for
    a. 1 to 2 minutes.
    b. 2 to 3 minutes.
    c. 3 to 4 minutes.
    d. 4 to 5 minutes.

63. (020) What should be done *prior* to operating a glucose meter?
    a. Read the operating instructions.
    b. Confirm the order with a co-worker.
    c. Choose a site to obtain a blood sample.
    d. Ask all family members to leave the room.

Please read the unit menu for unit 4 and continue ➔

Unit 4. Clinical Procedures

THE MAJORITY OF Aerospace Medical Technicians will be working in an outpatient clinic and performing other special clinical procedures. The following lessons provide guidance on many of the examinations and procedures you will likely perform or assist a provider with in different clinical settings.

4–1. Routine Clinical Procedures

021. Outpatient examinations and procedures

This lesson discusses the care, treatment, examinations, and procedures routinely performed in outpatient clinics.

Conducting patient interviews

Interviewing a patient before his or her visitation with the provider, or before performing any treatment, is an essential skill and an extremely important step. One of the most important parts of treating the patient is to obtain an accurate history of the present problem or illness. You should always keep customer service in mind throughout the visit with your patients. A great way to start your visit is to call the patient by the appropriate active duty or retired rank or by Mr., Ms., or Mrs. A friendly greeting with a smile and a handshake will often help put an anxious person at ease. Escort the patient to an area that provides privacy so the patient can talk freely without fear of other staff or patients hearing your conversation. You can verify the reason for the appointment by asking, "How may we help you today?" or "What is the reason for your appointment today?" Comments such as "What do you want?" or "Why are you here?" may be taken as rude or unfriendly. Be aware of the tone of your voice, facial expression and body language at all times, as they may give a negative impression. Have you ever gone to a store where the person at the desk looks completely disinterested or acts like you are bothering them? That kind of treatment normally sends a negative message and may anger the patient or make him or her defensive. The good news is this can be avoided by greeting and listening to your patients with the skills you learned in the first set of 4N051 CDC.

Be sure to document the information you obtain on a standard form (SF) 600, Chronological Record of Medical Care; a SF 600 overprint, often used in Care Extender Clinic (will be covered a little later); SF 507, Medical Record; SF 558, Medical Record-Emergency Care and Treatment; or in the electronic patient record. Use the subjective, objective, assessment, plan and prevention (SOAPP) format and ensure information is accurate and complete. Ask the appropriate SOAPP questions during the patient interview, seeking pertinent medical history and clarification on any information as needed.

SOAPP is a form for problem-oriented medical record documentation, which should be systematic and information must be complete. Each letter of the SOAPP acronym encompasses specific information that should be documented.

- "S"—Subjective data includes symptoms and the patient's own description of the problem. Subjective information is what the patient tells you. An example would be, "I have a sore throat."
- "O"—Objective data based on health care member's observations, physical examination and diagnostic tests. An example would be "Patient is alert and oriented x 3" or "Vital signs: Blood pressure: 140/80, Pulse: 120, Temperature: 104 F (oral)."
- "A"—Assessment or analysis of the meaning of data obtained. This section is generally completed by a provider or nurse. An example would be "Tonsillitis."
- "P"—A plan to resolve the problem. This section is generally completed by a provider or nurse as well. An example would be "Throat culture completed." This is where the provider will list treatment such as medications, referrals or follow up treatment.
- "P"—For preventive measures or teaching the patient on maintaining a healthy lifestyle. An example might be "Stressed good handwashing practice."

You will often be responsible for providing preventative health counseling, especially during Preventive Health Assessment (PHA) appointments. However, any interaction with patients is an optimal time to review healthy lifestyle and behavior counseling. Follow your facility protocols and ensure you use proper counseling techniques while conducting the interview.

Next, you will complete any required documentation and update the DD Form 2766, Adult Preventive and Chronic Care Flowsheet, as applicable. This form is used to provide a complete picture of the patient's current lifestyle and medical status. It should be reviewed and updated every time the patient has a visit to your facility, especially if the visit is with the primary care provider. The DD Form 2766 is maintained in Section 1 of the medical record on top of all documents. Don't forget to ensure immunizations are up-to-date as well. Accuracy in documentation is vital in providing proper care, and routine review of the DD Form 2766 is a key part of ensuring our personnel are medically ready to deploy at a moment's notice. Medical records are official documents so use black or blue ink when documenting forms that will be filed in a record, unless otherwise stated. If you use abbreviations, ensure they are standard abbreviations and your writing is easy to read. Make sure to sign and date all entries. Once these steps are complete, you are ready to prepare the patient for physician as necessary.

Standard form 507, Medical Record

The SF 507 is used as a continuation form to annotate a patient's initial medical history from the SF 93, Report of Medical History, if needed (refer back to your first set of CDCs, volume 3, unit 3). It is used to annotate subsequent medical histories. This information is obtained during PHAs to document any significant changes in medical history, hospitalizations, or illnesses of frequent or chronic nature or illness that precludes flight duties. Do not record routine problems such as: urinary Tract Infections (UTI), viral illnesses, or minor illnesses on the SF 507. When using the SF 507, follow these simple rules:

1. Start your documentation with the word "ADDENDUM" and the date.
2. All entries should be in chronological order as they occurred.
3. Notes can be handwritten in ink.
4. After documenting the patient's history, a denial statement must follow such as "No other significant medical or surgical history to report since last examination," and enter the date of the last examination in parentheses.

If the examinee had no interval medical history, record the above statement, omitting the word "other." Always bring the SF 93 forward in the medical record in section 3 of the medical record and place directly behind the subsequent SF 507s.

Standard form 558, Emergency Care and Treatment Form

The SF 558 is used to obtain and record baseline vital signs, for preventive counseling, to arrange for any follow-ups, and provide complete documentation. It is used primarily in emergency rooms (ER) to document illness, treatment, and follow-up care received during the visit. OF 558s may be ordered through supply or computer-generated products. The SF 558 also identifies any injury or occupational illness and can be forwarded to the member's primary care manager for any AF Form 422, Notification of Air Force Member's Qualification Status, (waiver) action necessary. Care rendered in an ER may also be documented on a SF Form 600. The SF 558 is used to complete and compile patient load information for the 24-hr ER report or log. If a patient is admitted to an inpatient unit through the ER, the original SF 558 is sent to the inpatient unit and filed in the inpatient record. Otherwise, the original is filed in the patient's outpatient record. The second copy is kept in the ER for up to five years and the third copy is given to the patient. Follow local policy to safeguard copies of the SF 558.

Basic physical examination

Routine physical examinations are performed to determine the patient's state of health and detect any physical or mental deficiencies that may impact job performance. This is also an opportunity to educate patients on ways to improve health behaviors and live healthier lifestyles. The goal is to maintain a physically fit force, capable of performing at the highest possible level.

The health care team is charged with providing the highest quality health care possible. Each member of the team (look back to the 4N051A set if you need a refresher) must present impeccable military bearing and professionalism along with a customer service focus.

General tasks performed

Some of the common examinations you will assist with may be: Preventive Health Assessments (PHA), initial flying class physicals, pelvic exams, retirement, or school physicals and so on. Your role will vary based on local policies and procedures but some of the general tasks you will be responsible for are:

1. Stock exam rooms with supplies, equipment, and linens. Be sure to place the needed supplies or equipment out when you escort the patient to the room. This will expedite the exam or procedure for the provider and decrease anxiety for patient.
2. Take and document the patient's vital signs.
3. Assist the patient onto the exam table if needed or give instructions on proper gowning for the exam.
4. If assisting or chaperoning for the provider, hand supplies or equipment to the provider as needed.
5. Assist the patient in sitting up or lying down as required, and adjust the exam table position and leg extension as needed. Assist the patient down from the exam table, using the built-in step.

Commonly used supplies and equipment for exams include but are not limited to: ophthalmoscope, otoscope, percussion hammer, stethoscope, tuning forks, vaginal speculums, proctoscopes, water soluble lubricant, gowns, and sheets.

Positioning patients for exams

- Dorsal recumbent or supine—used for examinations of the abdomen, chest, and breasts.
- Lithotomy—most commonly used for examination of the vagina or childbirth.
- Sims—side-lying with upper leg flexed. Position used for examination of the vagina or rectum. Common position for enema application.

- Side-lying flexed—patient spine is bent to separate the vertebrae; it is used for lumbar punctures

Pelvic examination

Most women are embarrassed about being examined. This can result from the exposure of their body and also from the actions of attending medical personnel. As an aerospace medical service journeyman, make every effort to remove the fright and embarrassment of these patients. Explaining the procedure and ensuring proper and adequate draping helps to relieve some anxiety.

Equipment

Gather the equipment needed for the gynecological (GYN) exam before positioning and draping of the patient. The following is a list of equipment that should be available for use during any gynecological examination:

- Vaginal speculum.
- Glass slides.
- Large cotton-tipped swabs.
- Wooden or plastic spatula.
- Sterile or nonsterile gloves.
- Culturettes.
- Fixative spray.
- Drape.
- Water-soluble lubricant.
- Adequate lighting.

Preparation of the patient

The patient should void (urinate) before going to the exam room. This allows for minimal discomfort for the patient and eliminates difficulty for the physician during the exam. If the bladder is full, it is difficult for the physician to palpate the uterus.

Prepare the patient by informing her of what to expect when the provider comes in and begins the exam. This is especially important if it is the first time the patient is experiencing this exam. Most of the time, the provider will also do a breast exam if the woman is being seen for an annual Papanicolaou (PAP) smear test appointment. After you have explained the procedure, step out of the room and allow the patient to undress in privacy. Check with your provider to ensure you know how he or she prefers to have the patient gowned. The provider will normally want the gown to be put on with the opening in the front and to place a sheet over the lap. This method allows the patient more privacy than having her entire chest exposed at one time. The provider will normally open the side of the gown that he or she is examining and leave the other side covered. If no gowns are available, the patient is normally given a towel to cover her breasts and a sheet to cover the trunk and upper legs. Once the provider comes in and introduces himself/herself and is ready to begin the exam, assist the patient into position on the exam table. Ensure the patient is properly draped to allow maximum privacy while providing a clear field for the provider. The position most commonly used is the *lithotomy* position. Once the patient is in position, adjust the light source to provide adequate lighting and maximum focus. Be ready to assist in handing supplies and equipment, but do not forget you are working with a patient! Always keep an eye on your patient while you assist the provider and keep her informed of what you are doing and where you are in the process of the exam.

The Papanicolaou test

The PAP smear is a test used to detect early cancer of the cervix. To perform the PAP, the physician uses a spatula, swab, or brush to obtain cells from the cervical opening (os). The cells are then placed into a solution or gently smeared on a glass slide, then sprayed with a fixative. Another smear is also taken of the floor of the vagina below the cervix and also placed on a glass slide and sprayed with fixative. The aerospace medical service journeyman ensures proper labeling of the specimen with the patient's name, date of birth, and social security number (SSN).

Follow-up phase

Once the exam is over, ensure the patient has a paper towel or wipe to remove excess secretions and lubricant. Assist the patient, if necessary, in removing her feet from the stirrups and getting off the exam table.

Cervical biopsy

A cervical biopsy is the usual follow-up test after a PAP test is positive. This procedure is usually done on an outpatient basis in the clinic. It is not normally a painful procedure, but the patient may have some discomfort. Once the specimen is obtained, ensure the specimen is properly labeled, placed in the appropriate solution, and then sent to the laboratory. Bleeding may occur after the biopsy is taken and may require vaginal packing. If packing is used, ensure the patient has received instruction concerning the restriction of her activities.

Endoscopy

An endoscopic examination is the inspection of a body cavity or hollow organ by means of a lighted instrument. The stomach, esophagus, colon, and rectum can all be examined by using endoscopic instruments. The ones you most likely will help with are examinations of the colon and rectum.

A *proctoscopy* is an inspection of the rectum with a proctoscope. A *sigmoidoscopy* is an inspection of the sigmoid colon by means of an endoscope called a sigmoidoscope. A *colonoscopy* is an inspection of the entire large intestine. These examinations are performed to identify inflammation, bleeding, ulcerations, polyps (a growth protruding from the intestinal lining mucous membrane), or malignant lesions that can cause mild to severe medical conditions or even death. A fiberoptic scope is used that enables the provider to see the inside of the colon on a display screen by moving the head of the fiberoptic scope around.

Preparation of patients who require a proctoscopy can be performed without a clear liquid prep, although a more thorough exam can be obtained if the patient's lower bowel is clear of feces. You may be responsible for assisting the patient with an enema if the provider needs the lower bowel to be clear for an exam the same day.

Patients undergoing a sigmoidoscopy or colonoscopy must have the bowel clear of fecal material. This is done by providing the patient a cathartic (stool softener), enema, or both the night before the procedure. Patient scheduled for a sigmoidoscopy will normally have a diet restricted to clear liquid the day before the test.

Patients scheduled for a colonoscopy are normally placed on a clear liquid diet for 24 hours before the procedure, along with a laxative tablet for three nights before the test. Patients should be told to avoid red or purple liquids and are normally instructed not to have anything to eat or drink at least eight hours before the procedures. Bowel cleansing with laxatives, cathartics, and enemas should be performed within 24 hours before the test. As you can see, these tests need the intestines to be as clean as possible for the provider to adequately view the mucous membranes.

If you are assisting, you will be responsible for positioning the patient, preparing the equipment, and helping the physician. You should explain the procedure to patients to lessen his or her fear and anxiety. These are uncomfortable and tiring procedures for the patients, and they should be allowed to rest before other tests, examinations, or treatments are performed. It is also important to make sure the patient signs a consent form before the procedure. Sigmoidoscopys and colonoscopys are normally performed in a special lab or in a surgical suite. Proctoscopys can be performed in an exam room.

Proctoscopy

- Have the patient undress from the waist down.
- Place patient in a side-lying or Sims position.
- Ensure all supplies and equipment are ready (gloves, drapes, proctoscope, water soluble lubricant, hand towels, chux and a light source such as the one used for pelvic exams).
- Be prepared to assist the provider with supplies as needed.
- Hand the patient tissue to wipe excess lubricant or don gloves and assist if needed.
- Help the patient to a sitting position after the examination, taking care to ensure the patient has a moment to rest so he or she does not become dizzy and fall.
- Schedule any required follow up.

Sigmoidoscopy

- Encourage the patient to empty his or her bladder just before the test and remove all clothing from the waist down. A signed consent form is required before the examination. Be sure to obtain baseline vital signs.
- Patients are positioned in a side-lying or Sims position. Drape the patient so that only the anus is exposed. (Provide as much privacy as possible.)
- Ensure all equipment to include the fiberoptic light, display, biopsy foreceps, suction, water, and air are working.
- Ensure all required supplies are available (drape, water soluable lubricant, hand towels, gloves).
- Be prepared to assist provider with supplies as needed.
- Remind the patient to breathe slowly and try to relax the lower abdominal and rectal muscles as the fiberoptic scope is inserted into the anus and slowly introduced into the lower intestine. As you can imagine, this can be uncomfortable for the patient. The provider may also inflate the lower bowel with air to provide a better view of the surrounding tissue. Some abdominal cramping will normally be experienced.
- Hand the patient tissue to wipe excess lubricant or don gloves and assist if needed.
- Help the patient to a sitting position after the examination, taking care to ensure the patient has a moment to rest so he or she does not become dizzy and fall.
- Check vital signs before allowing the patient to leave.
- Schedule any required follow up.

Colonoscopy

Patients will be instructed to remove clothing from the waist down and are normally given a gown, open at the back. Once changed, patients will be placed on a gurney or bed with rails up as they will be given sedation to help with relaxation and decrease awareness during the procedure. A long flexible fiberoptic scope will be inserted anally and advanced through the large intestine. The same steps are performed as with the sigmoidoscopy, except the procedure will take anywhere from 30–90 minutes and the scope is inserted much farther. Most patients would not be able to tolerate the discomfort from this procedure without sedation. After you explain the procedure to the patient, ensure he or she signs the required consent form. As before, make sure you obtain baseline vital signs before the procedure.

- Patients are positioned in a side-lying or Sims position.
- Drape the patient so that only the anus is exposed. (Provide as much privacy as possible.)
- Ensure all equipment, to include the fiberoptic light, biopsy foreceps, suction, water, and air are all working.

- Ensure all required supplies are available (drape, water soluable lubricant, hand towels, gloves).
- Be prepared to assist the provider with supplies as needed. The provider may also inflate the lower bowel with air to provide a better view of the surrounding tissue. Some abdominal cramping will normally be experienced during and after the procedure.
- Monitor vital signs every half-hour for two hours, or as directed by the provider or local protocol.
- Monitor for rectal bleeding (there may be a small amount of bleeding if polyps or biopsies were taken).
- Patients will usually be placed on bed rest for six to eight hours after the procedure.
- Ensure the patient has someone to drive him or her home and who will check in on the patient as needed.
- Complete a set of vital signs before the patient's departure and schedule any required follow up.

Bronchoscopy

A bronchoscopy is a diagnostic procedure in which a fiberoptic tube is inserted through the nose or mouth into the lungs. The procedure provides a view of the airways of the lung and allows doctors to collect lung secretions and to biopsy for tissue specimens. If the bronchoscopy is performed through the nose, an anesthetic jelly will first be inserted into one nostril. When it is numb, the scope will be inserted through the nostril until it passes through the throat into the trachea and bronchi.

Usually, a flexible bronchoscope is used. The flexible tube is less than ½-inch wide and about two-feet long. As the bronchoscope is used to examine the airways of the lungs, your doctor can obtain samples of your lung secretions to send for laboratory analysis. Setup for this procedure is essentially the same as the colonoscopy. Ensure you have all the required supplies and equipment, baseline vital signs, and a signed consent form before the procedure. This procedure is usually performed in a specially designated lab or in a surgical suite.

Complete a set of vital signs before the patient's departure and schedule any required follow up.

Care extender protocols

Care extender protocols allow trained individuals to use a SF 600 overprint to document a SOAPP note on a specific illness, injury, or treatment. These are often used in nurse- or technician-run clinics. The examiner's questions are approved, preprinted questions, treatment, and follow up based on the exam or specific chief complaint. Examples of specific clinics or treatment are patient follow-up appointments in wound care, suture removal, wart treatment, throat culture, and pseudofolliculitis barbae (PFB) clinics.

Using an overprint eliminates ambiguous question, guides the examiner/technician through the entire interview, and provides consistent documentation for common illnesses and exams. Additionally, these forms are often created to allow patients to fill out his or her personal information in his or her own words. Documentation must be neat, complete, and accurate to ensure each patient receives the proper care. Care extender protocols are developed and run according to local policy. Ensure you know the guidance in your treatment facility.

Pseudofolliculitis barbae

As an aerospace medical service journeyman, you may have the opportunity to care for patients with PFB or even have the responsibility of managing the "shaving clinic." This text will help you become familiar with the problems associated with shaving and introduce you to the responsibilities that go along with clinic management.

Pseudofolliculitis barbae defined

Pseudofolliculitis barbae (shaving bumps) is an inflammatory condition of facial skin that develops around ingrown hair fragments, which result when curved hair is closely cut. While normally seen in black men, it can be present in any race. Severity ranges from a mild inflammation to severe infection with pitting and scarring. With early detection and treatment, it can normally be managed and the severe form prevented.

The word *pseudofolliculitis barbae* actually means a false infection of the hair follicles in the beard region. It has the deceptive resemblance of infection, but infection is not the cause. The follicle and adjacent skin are not actually infected but are inflamed, either because growing hairs never break the skin surface or more often the sharp and acutely curved hair tip re-enters the skin and grows inward. Figure 4–1 shows how a curved beard hair can lead to trouble. These hairs usually lie close to the skin's surface and are prone to enter the skin after a few days' growth. This growth of the hair into the skin results in an inflammatory reaction called "foreign body reaction." As the inflammatory lesion develops, the hair shaft may eventually be rejected spontaneously. Although the pustule then resolves, the skin surface remains slightly irregular and a small papule remains. By practicing proper facial hygiene, proper shaving methods, and manual release of imbedded hairs, the disfiguring residual can be minimized.

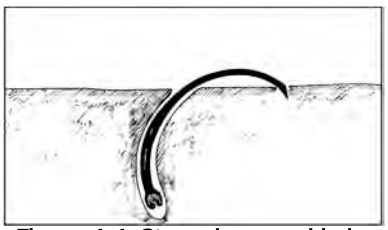


Figure 4–1. Strongly curved hair.

As an aerospace medical service journeyman, you assume the responsibility for patient education. You are responsible for teaching the patient management guidelines for PFB, proper facial hygiene, proper shaving methods, and manual release of imbedded hairs. You also need to know how to admit patients into the PFB program to allow them to conform to Air Force standards and yet prevent recurrence of their disease. Let's now discuss the phases related to the treatment of PFB.

Phase I

Considered the evaluation and treatment period, phase I last 15–30 days. The patient is shown the various shaving methods and hair removing techniques indicated. Embedded facial hairs are manually released (fig. 4–2), hot compresses applied, and topical medications, such as 1 percent hydrocortisone cream, used as needed. The medical provider may recommend to the squadron commander that the patient be permitted to grow facial hair up to $^1/_4$-inch long. This is transmitted using AF Form 422, or AF Form 469, Duty Limiting Conditions Report. Follow the guidance at your location on which form to use. As healing progresses, the shaving waiver may be discontinued at any time.

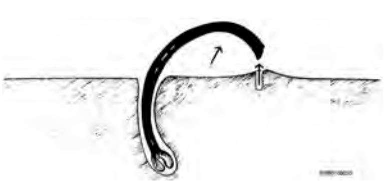


Figure 4–2. Release of ingrown hair.

Phase II

After skin inflammation begins to subside, phase II can begin. In this phase the patient returns to the clinic once or twice a week for monitoring. After proper shaving instructions are given, all shaving is supervised by the aerospace medical service journeyman during phase II. The patient is instructed in the importance of preparing the face, shaving methods, and the finish. Phase II ends when the PFB is controlled and the patient can manage his problem without additional medical assistance.

Phase III

Phase III begins when the patient no longer requires medical assistance. During this time, PFB patients, their supervisors, and commanders have continued responsibilities. Patients must continue to control their PFB with the shaving methods learned, and they must conform to military standards. Commanders and supervisors must know how often individuals must shave. If the physician recommends a patient grow stubble up to $^1/_8$-inch long between shaves, then the individual is considered to be clean-shaven and does not require a waiver. The commander and supervisor are also responsible for not allowing the presence of stubble to adversely affect effectiveness report, promotion, or assignment opportunities.

Refractory cases

True refractory cases are rare, but PFB recurs when the individual does not continue to follow the physician's advice. The treatment sequences may be reinstituted; however, a second recurrence requires meticulous evaluation. The evaluation must determine if the recurrence is primarily due to inadequate adherence to the physician's advice or if it is a true refractory case, which may limit the individual's eligibility for worldwide assignment. Air Force personnel must be able to wear protective equipment for prolonged intervals. The person who cannot be assured of a tight gas mask fit or whose skin becomes irritated so he cannot function at full efficiency is one whose fitness for continued active duty must be seriously questioned.

Shaving techniques

There are several shaving methods from which to choose. Discussed here is the most widely used and recommended technique using an adjustable razor.

When used properly, the adjustable razor allows the patient with PFB to avoid shaving too closely and cutting his face. The razor must be both sharp and clean. Keep in mind the three steps to proper shaving:

1. Preparation of the face.
2. The shave.
3. The finish.

Preparation of the face

Instruct the patient to wash his face with a washcloth, buff puff, soap, and hot water. After washing, have him remove all additional buried hairs with a toothpick or needle before lathering the face. Next, tell him to apply shaving lather thickly to the beard. This helps the curled hairs straighten out by hydrating the hair shaft and also by packing the lather around the hair shafts. Next, instruct him to steam his face by applying a hot towel or washcloth for two minutes while leaving the lather on. This step helps soften the hair further and thereby provides a better, smoother shave. Now, tell him to re-lather his face. At this point, he is ready to shave.

The shave

Instruct the patient to use an adjustable razor, with the razor set at number four or five (medium blade angle). Tell him to hold the razor firm and keep his wrist and arm relaxed, using a wrist motion and making rapid strokes 1½ to 2 inches in length. Instruct him to avoid jerky and choppy strokes. Tell him to start shaving at the sideburns, whether right or left, and then shave downwards with the direction of the beard growth. Instruct him to avoid using slow strokes that may skip beard areas. Instruct the patient not to stretch his facial skin but to hold his skin firmly, since loose skin crawls or rolls in front of the razor. Tell him to hold his skin firmly in the opposite direction of the shaving motion with his thumb and second finger of his free hand. Tell him it is important not to shave too close. Figure 4–3 shows what happens when shaving too closely. After the first shave, tell him to re-lather his face and shave again.

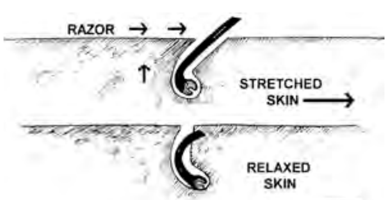


Figure 4–3. Shaving too close.

The finish

Instruct the patient to wash his face with soap and warm water, and then pat dry. He can apply ointments, lotions, or shaving creams as desired.

Clinic management

Management of the PFB clinic requires you to publish the clinic hours. Commanders, first sergeants, and supervisors need to be kept aware of clinic policy by information letters, usually annually. Try to hold briefings on the subject on a regular basis.

In many places, a card file is kept for *each* phase containing the patient's name and rank, SSN, unit, phone number, date of projected PCS, and dates of entry or exit from a particular phase of the program. Arrange cards alphabetically in each file box. When the patient changes phases, his card is moved to the card file box of the next phase. The NCOIC of the clinic needs to maintain a "shaving clinic notebook." As a management tool, this notebook should contain a copy of the current governing AFI, any command regulations, and any locally developed operating instructions.

Develop information packets with information for the patient regarding PFB. This packet should contain an information letter for the first sergeant, AF Form 422, if appropriate, and a followup appointment slip.

Wart clinics

Wart removal may be performed in various clinics, or depending on the size of your facility, there may be a designated "wart clinic." First let's answer the question, "What is a wart?"

Warts are caused by a virus called the *human papillomavirus or (HPV)*. The type of warts seen in the clinic includes *verrucae vulgaris, verrucae plantaris, molloscum contagiosm,* and *condyloma accumata*. There are a number of different ways to treat these warts. As an aerospace medical service journeyman, you will assist the physician with these various therapeutic modalities:

- Liquid nitrogen (cryotherapy).
- Bichloroacetic acid.
- Cantharidin.
- Lactic/salycilic acid combinations.
- Podophyllum with cryotherapy on condyomata accumunata.
- Percent salicylic acid pads.

Clinic procedures

When the patient arrives, escort him or her to the exam room. Depending on the location of the warts, ensure the patient has adequate privacy. Screening procedures include filling out the SF 600 properly to include date, time, and physician.

Wart removal

If you are working in a wart clinic, you will be further trained and certified on the following procedures. This text is to basically familiarize you with some of the procedures that are used. The four methods we will address are paring down verrucae, cryotherapy, curettage, and topical chemotherapy.

Paring down verrucae

Paring down verrucae simply means to scrape off the top. Explain to the patients that warts tend to bleed during this procedure and to let you know when they are uncomfortable. Using a 15 blade or safety razor, gently scrape off the top keratin layer of the wart. This is done until the wart area bleeds or the patient complains of discomfort. When bleeding occurs, control it with pressure, aluminum chloride, and "Monsels" solution (do not use on face because this solution stains the skin).

Cryotherapy

Cryotherapy (freezing) can also be accomplished after paring down of the wart. Cryotherapy is used to rapidly freeze the wart with a jet of mixed gaseous and liquid nitrogen onto the skin surface causing irreversible cell damage to the wart. After paring verrucae, if required, freeze the area until you have a 1-mm rim, then "puff'" liquid nitrogen onto the area for 10–20 seconds. Wait until you see the area thaw (the area sprayed will turn white and gradually fade back to skin color), then liquid nitrogen is applied again. Repeat the process a total of two to three times depending on the provider's instructions. The patient may feel a stinging sensation and the area will develop a blister over the wart. It may take up to a day for the blister to form so do NOT continue applying liquid nitrogen until a blister occurs. You can cause damage to surrounding tissue!

Curettage

Curettage involves the use of local anesthesia and removing (curetting) the wart out, then freezing the base. This is performed by physicians only, with the assistance of the medical technician.

Topical chemotherapy

Topical chemotherpy is performed by applying chemicals to the surface of the wart. The physician will determine which chemical application to use. Keep in mind infection control and sterile technique when applying these chemicals. Never return a used applicator into the bottle. Another method of topical chemotherapy is the use of 40 percent salicylic acid. The salicylic acid is usually on pads, which are cut down to wart size, then stuck to the wart surface, and taped into place.

Tympanometry

Tympanometery is a test used to asses the mobility of the tympanic membrane in a quick and simple method. It can detect disorders of the middle ear such as fluid (serous otitis media or, acute otitis media), perforated ear drum, cerumen (ear wax) impaction, tympanic membrane scarring, improperly functioning bone conduction or a possible tumor. A tympanogram (the graph the results are recorded on) measures the response to sound and different pressures within the ear as the eardrum moves back and forth.

Preparation

First, ensure the ear canal is clean. The test will be inaccurate if the ear canal is full of wax, so check with the provider and get permission to clean the ear before completing the test.

When preparing the patient for the test, ensure you explain the procedure and what the patient can expect to see and hear. Also realize that some of the sounds may be loud or startling, so they should do their best to remain relaxed. You should advise the patient to sit quietly, avoid speaking or swallowing during the test as it can change the pressure of the middle ear and invalidate the results. This can be a challenge with young children. Have the parent assist you in keeping the child quiet and still while the test is being run.

The specific tympanometry machine you use may differ slightly from what is explained here, so ensure you have read about your particular machine, have been trained on it and feel comfortable using it.

Performing the test

You will use a probe that looks similar to many of the tympanic thermometer probes. Attach a clean probe to the earpiece and gently secure it in the ear canal. Push the button and wait for the sign that the test is done. The probe will occlude (stop up) the ear canal while the machine changes pressures and the test is competed. A graphic will be displayed that shows the mobility of the tympanic membranes response to various air pressures. A normal tympanogram will peak at zero on the "Air Pressure," displaying a low level reading with a flat graph or one without a peak; the third type may show a distinct peak, but it will be shifted to a negative pressure, thus signaling an estuation tube dysfunction.

Make sure you show the graph to the provider before you let the patients leave. Ensure the tympanogram is properly labeled and the patient knows when to return for a follow up appointment if required.

022. Visual acuity

One of the basic functions of medical technicians is to measure patients' visual acuity (VA). You must perform this task with a high degree of accuracy and professionalism. Accurate measurements are extremely important for proper patient treatment and medical and legal reasons.You hear some people's vision is 20/20 or 20/40. What does all this mean and why do some people see better than others? Why do people need glasses or contacts? When should visual acuities be checked? These questions and more are answered in the next few lessons.

Principles of visual acuity

Visual acuity (VA) is defined as the eyes' ability to distinguish an object's shape and details. It is assessed by the smallest identifiable object seen at a specified distance (usually 20 feet for distance acuity and 16 inches for near acuity). Think of VA as a measure of the resolving power of the visual system. It is the ability of the visual system to receive light from images and transmit light to the retina where it is converted to an electrochemical message, transmitted through the visual pathway, and then interpreted by the brain as a visual image.

VA is often confused with visual efficiency. Visual efficiency refers not necessarily to how well one sees but rather how comfortably one sees. Individuals actually could have very good VA, even 20/20 vision, but experience difficulty in achieving this level of vision. Many patients may be able to see the 20/20 line of your eye chart but are reluctant to read it because they may not be seeing it with a great deal of visual efficiency. Some even refuse to read the actual line on the eye chart they can see, figuring if they see too well, nothing will be done about their visual complaint. It may be wise to encourage your patients to read the smallest line they can, even if it is not as comfortable and clear as they would like. Reassure them the doctor will still work on helping them achieve better visual efficiency, even if their VA doesn't seem to indicate a problem. There are refractive errors not necessarily diminishing VA but affecting the patient's visual comfort.

Factors influencing visual acuity

Many factors influence VA. Primary factors are the region of the retina stimulated, illumination, spectral quality of light, contrast, pupil size, time of exposure, patient's age, condition of the ocular media, presence of ametropias, and individual variations.

Region of the retina stimulated

The fovea centralis is the area where best vision (under photopic conditions) occurs. The fovea contains only cones, which produce the clearest images. VA progressively decreases the farther an image strikes the retina from the fovea. This is because the concentration of cones is greatest in the fovea and decreases toward the retina's periphery.

Illumination

Good illumination (photopic) conditions allow the visual system to use the cones in the fovea to process light stimuli. Dim light (mesopic) conditions force people to use a mixture of rods and cones to see adequately. This causes a loss of clarity, as rods do not provide images as sharp as cones. When illumination is very poor (scotopic), the visual system becomes almost completely dependent on the rods for any vision. Rods, while very good at picking up visual images under low light conditions, do not produce very sharp and clear vision. Under scotopic conditions, vision is best when images are placed just outside the fovea. This allows a mixture of rods and cones to process what visual images can be seen. (It's interesting to note the greatest number of rods per area of retina exists just outside of the fovea.) For example, a very dim star in the night sky may only be seen when you look slightly away from it. This allows the rods to pick up its image. If you look straight at it, it disappears, as the cones are not sensitive enough to process the minute amount of light coming from the galaxy far, far away.

Spectral quality of the light

The spectral quality of light refers to its color or wavelength. The eye can generally see wavelengths between 400 and 750 nanometers (nm). White light contains all the colors of the rainbow. Some lights are white but have a reddish or bluish tinge to them. Look at the fluorescent lights in your building and you may notice this. Some of the lights will look different from others.

The clarity of vision can change due to variations in the spectral quality of the light being seen. Some light has more blue in it; some has more red and so on. This variation, though subtle, does have an effect on VA and efficiency. Some people are sensitive to fluorescent lighting but do fine under incandescent lighting. This is most probably related to their sensitivity to changes in the spectral quality of the light.

Contrast

A black letter on a white background is easier to see than a black letter on a gray background. Assuming the same intensity of illumination, VA decreases as contrast decreases. Ever try to read an orange sign with yellow letters on it? It's tough because the contrast is poor. The two colors are close to each other on the visible spectrum. Now imagine an orange sign with violet letters. The contrast is much better as they are on opposite ends of the visible spectrum, so reading the sign is much easier.

Pupil size

The eye produces aberrations similar to those found in spectacle lenses. When the pupils are dilated (large), the divergent peripheral light rays previously blocked by the iris are now entering the eye and creating a focusing dilemma for the optics of the eye. Aberrations occur, blurring the image the brain receives and reducing VA. A blurred image triggers the brain to signal the eyes to accommodate (focus). One effect of the accommodative response is for the pupils to constrict. The constricted pupils only allow light rays going relatively straight to enter the eye. This reduces the number of deviant light rays striking the retina, so VA is improved. When you perform the pinhole test, you are using this principle. The pupil's main job is to regulate the amount of light entering the eye. If it allows too much light in, the photoreceptors (rods and cones) are washed out by light and a poor image is sent to the visual cortex of the brain. If the pupil is too small and not enough light gets in, the cones in the fovea are not adequately stimulated, and the visual cortex must rely on stimulus sent by the less precise rods, again reducing VA.

Time of exposure

If a person is given a long time to analyze an object, more details are assessed as more rods and cones are stimulated for a longer period of time. The result is usually good VA. If the time of exposure is short, there is less information being sent to the brain for analysis, so the VA is generally poorer.

Age

When you were born, your vision was at the 20/400 level. Your VA got progressively better as you developed. As you continue to age, time and ultraviolet (UV) light take its toll on the cornea, crystalline lens, and retina, causing the VA to diminish. VA is generally clearest between the ages of 15 and 20.

Condition of the ocular media

Any abnormality of the ocular media (cornea, aqueous humor, crystalline lens, or vitreous humor) tends to reduce VA. Corneal scars, cells, and flares in the aqueous, cataracts, and neo-vascularization in the vitreous are just a few examples of the many conditions degrading one's ocular media.

Presence of ametropias (correctable refractive errors)

Any refractive condition preventing light rays from focusing clearly on the fovea reduces VA. Ametropia is a refractive error (e.g., hyperopia, myopia, and astigmatism). If these refractive errors are not corrected, VA decreases or, at a minimum, visual efficiency suffers.

Individual variations

People are different. Some people just have better vision than others for a variety of reasons (e.g., genetics, visual stimulus experienced as a child, personality type, etc.). Not all people see the same even with all other factors being equal. This is due to individual variations. It is apparent there are many factors involved with the physiology of VA. When you study the measuring of VA in volume 4, you'll learn how the sizes and shapes of the vision chart letters (objects, etc.) determine the levels of VA (e.g., 20/20, 20/400, etc.). For now, it's important to look at one of the biggest factors in the physiology of VA—ametropias, or refractive problems, of the eyes.

Refractive status of the eye

One of the factors affecting VA is the presence of ametropias, which are errors in the eye's ability to focus light on the retina when the eye is at rest. Ametropias result in refractive errors corrected by glasses or contact lenses (CL). If a person's eye is healthy and glasses or CLs still cannot correct the vision, the person is considered to have amblyopia. The major refractive errors are hyperopia, myopia, and astigmatism. A person with good vision and no refractive error is considered to be an emmetrope or have emmetropia. Let's take a look at what it means, physiologically, to be an emmetrope, and then touch on the ametropias.

Emmetropia (normal)

Emmetropia is a refractive condition in which no refractive error is present when the eye is at rest. Distant images are focused sharply on the retina without the need for accommodation or corrective lenses. So, an emmetropic patient could look at a distant object and see it clearly without his or her eyes needing to accommodate. With the eyes at rest, the light rays from distant object focus perfectly on the retina, resulting in a clear image. This is the desired state. The emmetrope still needs to accommodate to see near objects but only a normal amount. This focusing does not cause undue eyestrain. Remember it this way: winning an Emmy is good, so being an Emme- is good. Emmetropes do not generally need glasses or CLs until they get to about 40–45 years of age and they, like everyone else, experience presbyopia.

023. Pulmonary function tests principles and procedures

The pulmonary function tests (PFT) are accomplished when required as part of an occupational physical examination or whenever clinically indicated and requested by a health care provider. It is most useful for evaluating losses in respiratory function and following the course of certain respiratory diseases. Although the PFT cannot provide a specific diagnosis, it can distinguish between obstructive pulmonary disease involving increased airway resistance (such as chronic bronchitis or asthma) and restrictive disorders involving a decrease in total lung capacity due to structural or functional changes in the lungs (such as tuberculosis or polio). To help you understand the calculations of the PFT, you will first study the respiratory volume of the lungs, followed by an explanation of the procedures for calculating the PFT and, finally, the actual testing procedures.

From studying anatomy and physiology in this course, you should already have a fairly good idea of what the respiratory organs are and how they function. In this section you will learn how to identify abnormalities in the respiratory system using the PFT. First, take a look at the principles behind the PFT by studying the volume of air that circulates through the respiratory system. This will help you understand exactly what you should be looking for during the PFT.

Respiratory volumes and capacities

The amount of air that travels in and out of the lungs varies substantially depending on the conditions of inspiration and expiration. Consequently, several different respiratory volumes can be described. Specific combinations of these respiratory volumes, called respiratory capacities, are measured to gain information about a person's respiratory status. The volumes are measured with a device called a spirometer.

Respiratory volumes

The respiratory, or lung, volumes include tidal reserve, inspiratory reserve, expiratory reserve, and residual volumes. During normal quiet breathing, about 500 ml of air moves into and out of the lungs with each breath. This respiratory volume is referred to as the tidal volume (TV). The amount of air that can be inspired forcibly beyond the tidal volume (about 3,100 ml) is called the inspiratory reserve volume (IRV).

The expiratory reserve volume (ERV) is the amount of air, normally 1,200 ml, which can be evacuated from the lungs after a tidal expiration. Even after the most strenuous expiration, about 1,200 ml of air still remains in the lungs; this is the residual volume (RV). Residual volume air helps to maintain alveolar patency and prevent lung collapse.

Respiratory capacities

The respiratory capacities include inspiration capacity, functional residual capacity, vital capacity, and total lung capacity. As noted in the following paragraphs, the respiratory capacities always consist of two or more lung volumes—inspiratory and vital capacities.

Inspiratory capacity

Inspiratory capacity (IC) is the total amount of air that can be inspired after a tidal expiration; thus, it is the sum of the tidal and inspiratory reserve volumes.

Functional residual capacity

Functional residual capacity (FRC) is the combined residual and expiratory reserve volumes and represents the amount of air remaining in the lungs after a tidal expiration.

Vital capacity

Vital capacity (VC) is the total amount of exchangeable air. It represents the sum of the tidal, inspiratory reserve, and the expiratory reserve volumes. In healthy young males, the VC is approximately 4,800 ml.

Total lung capacity

Total lung capacity (TLC) is the sum of all lung volumes and is normally around 6,000 ml in males. Average lung volumes and capacities (with the possible exception of vital volume) tend to be slightly less in women than in men because of their smaller size. A summary of respiratory volumes and capacities for young healthy males is shown in the following table:

	Measurement	Adult male average value	Description
Respiratory Volumes	Tidal volume (TV)	500 ml	Amount of air inhaled or exhaled with each breath under resting conditions
	Inspiratory reserve volume (IRV)	3100 ml	Amount of air that can be forcefully inhaled after a normal tidal volume inhalation
	Expiratory reserve volume (ERV)	1200 ml	Amount of air that can be forcefully exhaled after a normal tidal volume exhalation
	Residual volume (RV)	1200 ml	Amount of air remaining in the lungs after a forced exhalation
Respiratory Capacities	Total lung capacity (TLC)	6000 ml	Maximum amount of air contained in lungs after a maximum inspiratory effort: TLC = TV + IRV + ERV + RV
	Vital capacity (VC)	4800 ml	Maximum amount of air that can be expired after a maximum inspiratory effort: VC = TV + IRV + ERV
	Inspiratory capacity (IC)	3600 ml	Maximum amount of air that can be inspired after a normal expiration: IC = TV + IRV
	Functional residual capacity (FRC)	2400 ml	Volume of air remaining in the lungs after a normal tidal expiration: FRC = ERV + RV

Summary of respiratory volumes and capacities.

Dead space

Some of the inspired air fills the conducting respiratory passageways and never contributes to gas exchange in the alveoli. The volume of these conduits (area in and around the nose, pharynx, larynx, trachea, and bronchial tree), which make up the anatomical dead space, typically amounts to about 150 ml. A general rule of thumb is that the anatomical dead space volume in milliliters in a healthy young adult is equal to the person's weight in pounds. This means for a 150-pound individual with a tidal volume of 500 ml, only 350 ml of this is involved in alveolar ventilation. The remaining 150 ml of the tidal breath is in the anatomical dead space. If some of the alveoli cease to act in gas exchange (due to alveolar collapse or obstruction, for example) the alveolar dead space is added to the anatomical dead space, and the sum of the non-useful volumes is referred to as total dead space.

Calculating the pulmonary function tests

Since a PFT illustrates the various respiratory volumes and capacities, examiners can readily identify potential disease processes. For example, increases in TLC, FRC, and RV could occur as a result of hyperinflation of the lungs in obstructive disease, whereas VC, TLC, FRC, and RV are reduced in restrictive diseases that limit lung expansion. Much more information can be obtained about a patient's ventilation status when the rate of air movement in and out of the lungs is assessed. The two primary tests measured in the physical exam arena are the forced vital capacity (FVC) and forced expiratory volume (FEV). The measured values are then compared against predicted normals based on the individual's sex, height, and age.

FVC measures the amount of air expelled when a patient takes a deep breath and then forcefully exhales maximally and as rapidly as possible. FEV determines the amount of air expelled during specific time intervals of the FVC test; for example, the volume exhaled during the first second is forced expiratory volume at 1 second (FEV_1). Those with healthy lungs can exhale about 80 percent of the FVC within one second. Those with obstructive pulmonary disease have a low FEV_1, while restrictive disease produces a low FVC.

According to AF standards, abnormal functions are present when the FEV_1 or FVC is less than 80 percent of the predicted or the FEV_1/FVC percent is less than 70 percent.

Testing procedures

There are various spirometers available, but each must meet the general guidelines outlined in AFI 48–123, *Medical Examinations and Standards,* to constitute an acceptable spirometer. However, the procedures for accomplishing the test are basically the same.

The procedure must be explained to the examinee in simple terms. A statement that the examinees will be tested on "how hard and how fast they can breathe" may not be physiologically precise, but it may be the only explanation necessary.

Before administering the test, find out if your patient has smoked, eaten, or has recently had a respiratory tract infection. At least one hour must have passed since the examinee has either smoked or administered a bronchodilator and at least two hours since his or her last meal. If the examinee is acutely ill or has experienced an upper or lower respiratory tract infection during the previous three weeks, postpone the test. To properly accomplish this test, instruct the examinee to do the following tasks:

- Remove any constrictive clothing or dentures and to stand in front of the spirometer.
- Place a nose clip on his or her nose, keeping it firmly there (this is very important).
- Take the deepest possible inspiration from a normal breathing pattern to close his or her mouth firmly around the mouthpiece (i.e., maintain an air-tight seal around the mouthpiece) and blow into the apparatus as hard, fast, and completely as possible.

The examinee must make a full inspiration before the forced expiration, put forth a maximal effort, and continue expiration for at least five seconds or until an obvious plateau in the volume-time curve has occurred for the tracing to be acceptable. Have the examinee make two practice attempts before three further tracings are recorded and assessed for acceptability. In assessing for acceptability, reject any attempts marred by coughing, or if the variation between the two largest FVCs of the three satisfactory tracings exceeds 10 percent. Annotate the results on the AF Form 1226, Pulmonary Function Studies.

Predicted values

To determine predicted values, use the formulas in AFI 48–123. There you will notice four spirometric standards: one for caucasion females, one for caucasion males, one for females of other races, and one for males of other races. Make sure you are using the correct one! After ensuring you are about to use the correct nomogram, align a straight edge across the two known factors of height and age. The points where the straight edge crosses FEV_1 and FVC will give you the predicted normals for each category. It must be pointed out that the FVC and FEV_1 of non-caucasians is about 15 percent lower than in whites of the same age and height; differences in the FEV_1/FVC percent are not significant. Make allowances for these ethnic differences during evaluations to avoid serious errors in interpretation. In non-caucasians, multiply the predicted FEV_1 and FVC for any given person by 0.85 to adjust for this 15 percent difference. You do not have to make this adjustment or correction for the FEV_1/FVC calculation. Once you have determined the predicted value, record it on AF Form 1226.

024. Electrocardiogram

You should be familiar with the anatomy of the cardiovascular system from the previous study where you learned how the electrical impulses stimulate the heart. Now you will review the electrophysiology briefly, and learn about the tracing and how to prepare your patient for his or her electrocardiogram.

Electrophysiology of the heart

The crescent-shaped sinoatrial (SA) node, a small cell mass with an enormous job, is also known as the pacemaker. The SA node initiates the stimulation of the heart muscle to contract with electrical stimulation. Located in the right atrial wall, just inferior to the entrance of the superior vena cava, the SA node typically depolarizes spontaneously at the rate of 70–80 times every minute. However, its inherent rate—in the absence of hormonal and neural factors—is around 100 times per minute. Because no other region of the conduction system or the myocardium has a faster depolarization rate, the SA sets the pace for the heart as a whole, determines its characteristic and sinus rhythms, and determines our heart rate.

The cells in the heart are negatively charged, or polarized, in the resting state. When the heart muscle is stimulated electrically by the SA node, both atria contract (depolarization). Think of this depolarization as an advancing wave of positive charges. The stimulating progressive wave continues until it reaches the atrioventricular (AV) node located in the inferior portion of the interatrial septum immediately above the tricuspid valve in approximately 0.04 seconds. The impulse is delayed momentarily (for about 0.1 seconds) at the AV node, allowing the atria to respond and complete their contraction. At this time the cells in the atria regain their negative charge, or repolarize.

The electrical impulse passes from the AV node down the AV bundle (Bundle of His) to the left and right bundle branches, and then to the Purkinje fibers, which complete the pathway through the interventricular septum and penetrate into the heart apex and turn superiorly into the ventricular walls. The cells within will become charged positively (i.e., depolarized) once stimulated, causing simultaneous contraction of the ventricles. Because the left ventricle is much larger than the right, the Purkinje network is more elaborate in that side of the heart.

Electrocardiograph tracing

The electrical currents generated and transmitted through the heart also spread throughout the body and can be monitored with an instrument called an electrocardiograph. The graphic recording of electrical changes during heart activity is called an electrocardiogram, or simply an ECG or EKG. Twelve standard leads are used to record an ECG. Three of these are bipolar leads that measure the voltage difference between the arms, or an arm and a leg, and nine are unipolar leads. Together the 12 leads provide a fairly comprehensive picture of the electrical activity of the heart.

A typical ECG consists of a series of three distinguishable waves called deflection waves (fig. 4–4 B). The first wave, the small P wave, lasting about 0.08 seconds, results from movement of the depolarization wave from the SA node through the atria. Approximately 0.1 seconds after the P wave begins, the atria contract.

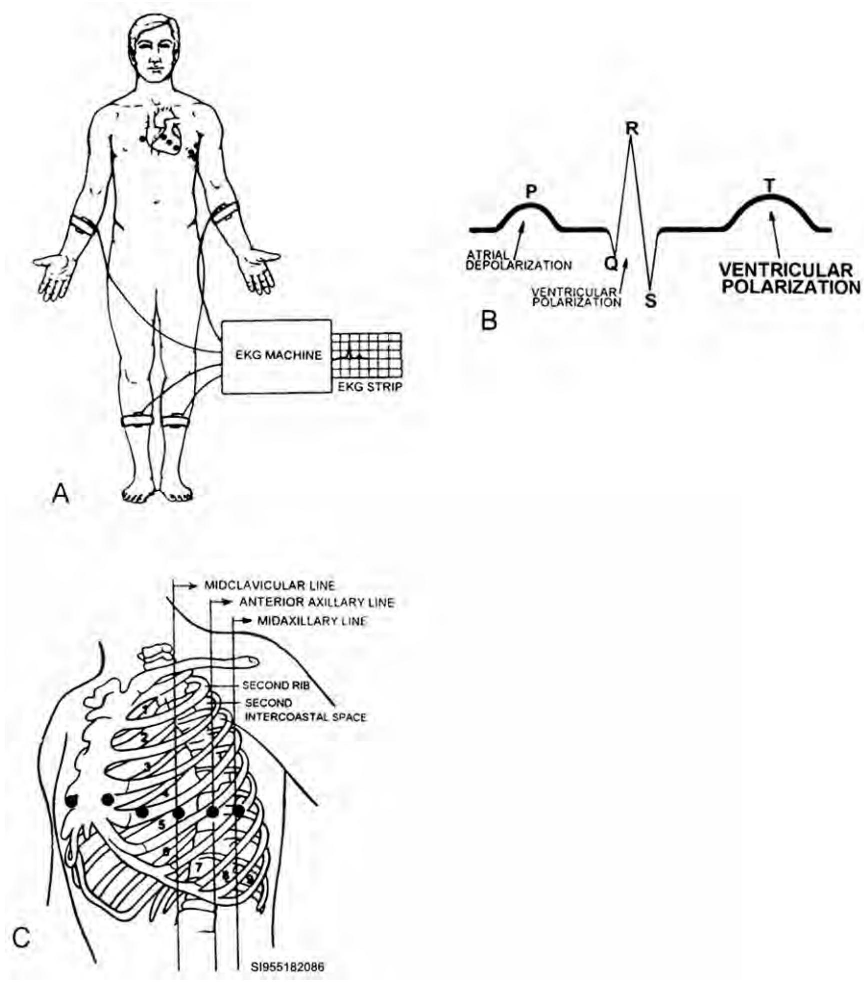


Figure 4–4. (A) EKG limb lead placement, (B) QRS Complex, (C) Chest lead placement.

The large QRS complex results from ventricular depolarization and precedes ventricular contraction. Its complicated shape reveals the different size of the two ventricles and the time required for each to depolarize. The average duration of the QRS complex is 0.08 seconds.

The T wave is caused by ventricular repolarization and typically lasts about 0.16 seconds. Repolarization is slower than depolarization, so the T wave is more spread out and has lower amplitude (height) than the QRS wave. Because atrial repolarization takes place during the period of ventricular excitation, the large QRS complex being recorded at the same time normally obscures its occurrence.

The P-R interval (P to Q) represents the time (about 0.16 seconds) from the beginning of atrial excitation to the beginning of ventricular excitation. It includes atrial depolarization (contraction) as well as the passage of the depolarization wave through the AV node and the rest of the conduction system. The Q-T interval, lasting about 0.36 seconds, is the period from the beginning of ventricular depolarization through their repolarization and includes the time of ventricular contraction.

In a healthy heart, the size, duration, and timing of the deflection waves tend to be consistent. Thus, any changes in the pattern or timing of the ECG may reveal a disease or damaged heart or problems with the heart's conduction system.

The responsibility of interpreting or actually reading the ECG does not lie with the 4N0. A trained physician must interpret all ECGs. However, you must be able to recognize a normal tracing in the sense that it is free from artifacts. Artifacts are any artificial products or features that appear on an ECG tracing and can render the tracing invalid. Artifacts must be corrected once noted; sometimes you can recognize them by a drifting or wandering tracing. Causes of artifacts include the following circumstances:

- Muscle tremors.
- Dirty electrodes.
- Loose or tight electrodes.
- Outside electrical interference.
- Static electricity produced by hair, nylons or sometimes a wristwatch.
- Cycle interference (recognized by fine steady vibration of the ECG stylus).

Other disturbances in an ECG tracing that can show up are arrhythmias. An arrhythmia is any variation from the normal electrical rate and/or sequence of cardiac activities, such as natural body disturbance or underlying pathology within the heart. When you are recording an ECG, you will not be required to interpret or diagnose, but you will be required to notify the physician promptly if in doubt or suspect any abnormality.

Preparation of the equipment and patient

Before obtaining an ECG, as the technician, you must make sure the area is prepared properly and appropriate safety checks have been carried out on the electrocardiograph. Since there are many different commercial brands of electrocardiographs used throughout the Air Force, you will be required to become thoroughly familiar with the instruction booklet before operating the machine used in your particular office.

Preparing the machine

Preparing the machine for use involves six basic steps:

1. Connect the machine to the power source.
2. Turn it on.
3. Check the paper and have extra rolls available.
4. Prepare the electrodes and connecting devices.
5. Have the necessary electropads or conductive pad or paste on hand.
6. Check the machine for the proper sensitivity and paper speed setting.

Preparing the patient

Introduce yourself as you are getting the patient ready and reassure him or her that all electricity flows from the body to the machine, not vice versa. Also, inform them the ECG will be interpreted by a physician once a reading is taken. After introducing yourself, direct the patient to undress from the waist up and have him or her remove all watches and bracelets. Nylon hosiery, if worn, should be removed to avoid potential artifacts. Do not forget to give female patients a gown (open to the front) or properly drape female patients with a towel or sheet.

Applying the limb leads

Place the electode pads (most contain a gel-like substance for conduction) onto the designated locations. Ensure the gel in the pads is soft and not dried out. You will not get a good tracing if there is no conduction gel. Pay close attention to the electode wires, as they will normally have an identifying mark to indicate what location they are to be applied to. An example might be "LL" which would mean Left Leg. Apply an electrode to the inner aspect of each limb (on the fleshy portion). Some local policies will direct you to place the upper limb leads on the upper right and left mid clavicular line just below the clavicle and to place the lower limb leads on the lower right and left quadrants of the abdomen just above the iliac crests. Be sure the electrodes are *not* placed directly on a bone as it will not conduct correctly. If you are using a rubber-retaining strap, apply it snugly (not too tight or too loose) around each extremity. Once all limb leads are in place, attach the ECG lead cable to the electrode. Double check for a proper connection as a misconnection would result in an invalid tracing. In cases where the patient has a great deal of body hair, you may have to shave the lead placement locations to get a good tracing. See figure 4–4 A.

Applying the chest electrodes

To obtain a valid ECG tracing, the proper placement of the six precordial (chest) electrodes is very important. These leads are called V1 through V6 (the V stands for vector). Any variance from the locations shown in figure 4–4 C could result in inconsistent findings or possible false abnormalities. To prevent this, ensure the following:

- The precordial electrodes across the last precordium are not carried along the curvature of the rib but are maintained in a straight line.
- The first and second leads are located in the fourth intercostal space, not the third.
- The electrode paste is not smeared from one precordial space to another, if used.

Electrode material and connection devices may vary from facility to facility, but the placement on the chest is the same in all, as defined in this table:

Lead	Placement
V1	4th intercostal space adjacent to the right sternal border.
V2	4th intercostal space adjacent to the left sternal border.
V3	Halfway between V2 and V4.
V4	Left side 5th intercostal space in the midclavicular line.
V5	Same horizontal level as V4 in the anterior axillary line.
V6	Same horizontal level as V4 in the midaxillary line.

Once the patient has been prepared properly, you are ready to run the ECG. Ask the patient to lie still and breathe normally until the end of the procedure. Ask the patient to withhold speaking or crossing the legs or arms until the test is finished. (Speaking or crossing the legs or arms may cause artifact or an improper reading). Be sure to tell the patient when you are done running the test so he or she will feel free to talk or ask questions. It is normally a good idea to have a provider look at the ECG tracking before you remove all the equipment in possible event it needs to be repeated.

By measuring the various waves, complexes, interval, and electrical voltage, a trained person can determine the rate, rhythm, and axis of the heart, along with any evidence of myocardial hypertrophy or infarction. These determinations, along with other portions of the cardiovascular examinations (blood pressure and auscultation, for example), will give an overall picture of the person's cardiovascular status. However, although the ECG presents an accurate picture of the electrical activity of the heart, it should not be used as a final determining factor as to a person's cardiovascular status. Rather, it is used as a starting point for further evaluation and testing if any abnormalities are discovered.

Whenever you accomplish an ECG on rated personnel, send an original copy to the USAF Central Electrocardiographic Library. (This holds true for any cardiac study done on a rated flyer.)

When sending ECGs to the library, remember to comply with the following rules:

- Complete the patient identification area on the tracing.
- Affix the tracing firmly to a properly completed optional form (OF) 520, Medical Record-Electrocardiograph Record cover sheet.
- Send only original tracings. Duplicated copies are unacceptable, as they cannot be placed on microfilm for future reference.

025. Other tests and procedures

There are a few other tests and procedures you will likely perform in the clinical setting. Some of those covered here are orthostatic vital signs, peak flows, neurological checks, and pulse oximetry. These will be covered briefly here and in greater detail in Volume 2.

Orthostatic vital signs

Blood pressure will fall in relation to the patient's position. It will change from when the patient is lying, sitting, or standing. The normal difference in systolic pressure tends to be no greater than 15 mmHg lower than it was in a reclining position. The diastolic pressure may fall 10 mmHg from the lying position. This change is not noticeable in most individuals. Internal receptors make rapid adjustments to compensate for the changes in blood volume distribution. For some individuals, the pressure may drop more rapidly. This is known as postural hypotension or orthostatic hypotension. This could be a result of several factors such as circulatory problems, dehydration, or medication effects.

When the physician suspects the patient has a low blood volume or possible dehydration, he may ask for orthostatic vital signs to be taken. Orthostatic vital signs are done by taking the blood pressure and pulse with the patient in the lying, sitting, and standing positions (in this order), and waiting three minutes between these changes. If the blood pressure decreases and the pulse increases significantly, postural/orthostatic hypotension needs to be reported to the nurse or physician. Treatment for the patient may include intravenous therapy or blood transfusion therapy.

Pulse oximetry/O_2 saturation machine

There will be times where you will be required to perform a neurologic exam in the field or at a clinic. A noninvasive method commonly used today to rapidly determine pulse and oxygen profusion is the pulse oximetry/O_2 saturation machine. This is another method used to monitor the function of the respiratory system. The oximetry machine measures the amount of arterial blood that is saturated with oxygen in the body by measuring the percentage of hemoglobin (blood) that is bound with oxygen. A sensor or probe is attached to the patient in an area where the red light and infrared on the sensor can reach a capillary bed. Oxyhemaglobin will absorb more infrared than red light, and a microprocessor will use this information to compute an oxygen concentration value. This value can then be read on the monitor screen. The sensor can be placed in areas such as a fingertip, earlobe, toe, or even the bridge of the nose. Depending on the type of Pulse O_x (equipment that measures the pulse oximetry) you are using, you may need to turn the unit on or it may start as soon as you place on the patient. Always make sure that you check the patient when you are taking any reading from a monitor. Some people with chronic lung disease have adapted to pulse oxygen concentrations that would have most of us gasping for breath. Report any readings below 97 or observation of a patient who appears to be in any respiratory or circulatory distress immediately.

Nuerologic checks

There will be times where you will be required to perform a neurologic exam in the field, clinic or at an inpatient unit. Neurological checks are commonly performed on any patient who has had a head injury or a neurological problem such as a seizure or complains of neurological symptoms such as weakness, numbness or tingling in a particular area of the body. The following steps are completed:

1. Identify the patient's mental orientation to person, place, and time. This is generally completed by asking the patient to state his or her full name; the month, day or year; name the current President or a relevant question the patient should be able to answer. Keep the patient's age in mind when doing this. A 3 year old probably won't be able to tell you who the president is but can probably point to or name an appropriate toy or parent.
2. Check the pupils and determine if they are of equal size. This should be done with lights dimmed to allow the pupils to dilate. It is easier to identify difference in pupil size if they are dilated instead of pinpointed.
3. Check pupil response to light by using a pen light and slowly bring the light from the lateral side of the head and shine it in one eye. The room should have the lights dimmed here as well. Quickly remove the light and repeat the action on the other eye. You should see the pupil constrict quickly when the light is shined in the eye, and then it should return to its former size when the light is removed.
4. Using the same procedure as above, shine the light in one eye and watch the other eye. You should see papillary reaction and consensual reflex. This means that both eyes' neurological functions are working together and can be seen when both pupils react and become smaller when light stimulates either eye (one eye at a time). Let the pupil return to its former size and repeat the process with the other eye. It should only take a few seconds for the pupil to return to its former size. Both pupils should react quickly and simultaneously regardless of which eye the light is shined into. Sluggish or unequal responses should be reported to the provider immediately.
5. Check extraocular movements or EOMs, strength of the eye muscles, by having the patient follow an object or your finger as you move your hand from side to side, up and down and diagonally. Watch to see if the patient's eyes move together with smooth movements. Report lack of synchronous movement or nystagmus (jerking or bouncing movement of the eye).
6. Ensure the patient can follow simple commands, such as touching his or her nose with the left index finger or rotating his or her foot counterclockwise.
7. Test upper and lower extremity strength by having the patient squeeze your fingers (index and middle fingers) with both hands (ensure you have your fingers crossed or it may hurt!), push his or her feet against your hands and have them hold his or her arms straight in front and push down on your hands and then resist as you push down on his or her outstretched forearms. Weakness may signal a brain or spinal cord injury.
8. Check for sensation. There are several ways to do this. If the patient is not fully alert, you may need to try a pain stimulus. Otherwise you can have the patient close his or her eyes while you use a blunt object like a paperclip and lightly touch areas on the arms and legs. Have the patient tell you whether he or she feels like you are touching with the "sharp" side (the end of the paperclip) or "dull" (the curved part of the paperclip). This is commonly referred to as the sharp/dull test.
9. Report and document all findings. Appropriate responses and exams are generally documents something like: A & 0 x 3 (alert and orientated times three questions), upper and lower extremity strength equal bilaterally.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

021. Outpatient examinations and procedures

1. What kind of format is used to document an interview with a patient?

2. When conducting a patient interview, how is the “Objective” data determined?

3. What is the purpose of a physical examination?

4. What is the most common position for a patient having a pelvic exam?

5. What procedure should be performed if a PAP test is positive?

6. What is an endoscopic examination?

7. Explain how to prepare a patient for a sigmoidoscopy.

8. Why do patients undergoing a colonoscopy normally require a sedative?

9. List several examples of specific clinics or treatments that may use care extender protocols.

10. What is pseudofolliculitis barbae?

11. What is your responsibility in the pseudofolliculitis barbae clinic?

12. To whom must the medical provider recommend the patient be permitted to grow facial hair up to ¼-inch long?

13. In what phase of the PFB program is medical assistance no longer needed?

14. Why is a clean-shaven face important to continued worldwide duty?

15. What are the three steps to proper shaving technique taught to the PFB patient?

16. What virus is responsible for most warts?

17. What are four methods to treat warts?

18. What should you inform the patient about before performing tympanometry?

022. Visual acuity

1. Define visual acuity.

2. What are the primary factors affecting visual acuity?

3. What area of the retina is responsible for the best vision?

4. Regarding vision, what is the difference between rods and cones?

5. What kind of light rays does a constricted pupil allow to enter the eye?

6. What are ametropias?

023. Pulmonary function tests principles and procedures

1. What are the two most useful purposes of a PFT?

2. Which of the four respiratory capacities represents the total amount of exchangeable air?

3. Define anatomical dead space.

4. Before administering the PFT, what information must you find out from the patient that may have an effect on the test?

5. How long must an examinee blow into the PFT machine before a tracing can be considered acceptable?

6. When using the appropriate nomogram to determine predicted values, what two factors must be known?

7. What must you do to the predicted FEV_1 and FVC values for non-caucasian examinees and why?

024. Electrocardiogram

1. What initiates electrical impulses in the heart?

2. Explain the progression of the electrical impulse through the heart.

3. Where in the heart is the Purkinje fiber network most elaborate?

4. What are the three distinguishable waves of an ECG called?

5. What does the QRS complex result from?

6. Define an artifact.

7. Define arrhythmia.

8. When applying ECG limb leads on the fleshy portion of an extremity, where should the electrodes not lie?

9. By measuring the various waves, complexes, interval, and electrical voltage, what can a trained person determine from an ECG?

025. Other tests and procedures

1. What are two possible treatments for postural/orthostatic hypotension?

2. What does a pulse oximeter measure?

3. When should you report a pulse oximetry reading immediately?

4. A neurologic check is performed at regular intervals on patients who may have what condition(s)?

5. How would you make a neurological assessment of a patient's mental orientation?

6. What is consensual reflex?

7. What are two ways to test upper extremity strength?

4–2. Special Clinical Procedures

Aside from routine outpatient visits, many clinics will perform a multitude of different minor surgeries in the clinic. For most patients, outpatient care for surgical procedures is convenient and less expensive. This unit covers important information on preparation and care of the patient along with your responsibilities as a medical technician. We will also discuss information on technician responsibilities before and postsurgical procedure.

026. Minor surgery

In this lesson, we will cover some common surgical procedures performed on an outpatient basis as well as some common actions you will take while preparing and assisting in procedures.

Surgical procedures

Minor surgery is a surgical procedure for minor problems or injuries that are not considered life-threatening or hazardous. Some common surgical procedures you may assist with are:

- Vasectomy—male sterilization that consists of bilateral removal of a part of the vas deferens.
- Cyst removal—removal of an inflamed closed sac in or under the skin lined with epithelium and containing fluid or semisolid material.
- Laceration repair—surgical repair of jagged or smooth skin tissue by sutures, surgical staples, or medical glue. Lacerations can occur either by surgical means or traumatic injury.

For some patients, minor surgery is a possibility or necessity. To prepare the patient for any type of surgery, there are multitudes of preoperative tasks that must be done. These tasks are taught throughout your five-level upgrade training. As you continue to gain knowledge as a 4N0X1, you will need to comprehend the fundamental reasons why each step is important. Throughout the following lesson, consider how to apply the knowledge you have of the step-by-step procedures to the understanding of how, why or when patient care is to be performed.

As an apprentice, you were taught six basic patient care tasks that are done before performing a procedure: (1) verify the provider order, (2) gather all of your equipment, (3) identify the patient, (4) explain the procedure to the patient, (5) use proper body substance isolation (BSI) precautions with personal protective equipment (PPE), and (6) always provide privacy. Whether the surgery is inpatient (covered in-depth in volume two of your CDCs) or outpatient, there are many variables that must be controlled. For most patients, their basic needs must be met for them to be confident and comfortable to sign consent for surgery.

Pre-procedure

Appropriate surgical consent must be signed by a member not participating in the procedure. This would be a witness. Complete the consent form; escort the patient to the proper procedure room and educate the patient if needed on the procedure. Once the consent is signed, the minor surgery procedure can begin.

Don a gown if it is required; position the patient and prepare the patient's body area affected by the procedure by cleaning and irrigating as required; set up required sterile fields. Make sure you also get the patient's vital signs.

Each provider normally has a specific way and specific equipment that he or she likes to have set up for various procedures. Talk with the provider before the procedure and ask how he or she prefers to perform the procedure and what supplies and equipment you should ensure are available. It is a good idea to become familiar with all clinic providers equipment requirements; it will help ensure the procedures are performed smoothly and timely.

Have all supplies needed in the room. Leaving the room could compromise patient care if an emergency developed. You should generally ensure the following supplies and equipment are available for most procedures: Formalin jars; Lidocaine (Xylocaine) 1 percent with or without

Epinephrine; 1-, 3-, 5-, and 10-cc syringes; 18 and 25 gauge needles; blades; Betadine (check allergies); sterile biopsy procedure kit/suture kit; gauze; alcohol pads; silver nitrate sticks or a disposable cauterizer; sutures or sterile stripes; labels; antibiotic ointment; bandages; and tincture of benzoin.

As a part of your responsibilities, you must maintain a good working knowledge of the principles of aseptic techniques, the instruments used in minor surgery, and the procedures for submitting specimens for pathological testing.

Post-procedure

Be sure to assist the provider during the procedure and in dressing the wound after surgery, if required, and dispose of all sharps into the designated biohazard container. Repeat the patient's vital signs, and then assist the patient in sitting up and getting down from exam/procedure table. Be available to assist the patient in getting dressed as necessary, and then escort the patient to the waiting room if required. Ensure the patient has wound care instructions, and make any follow-up appointment as necessary. Once this is completed, clean and restock the procedure room so it will be ready for the next procedure.

Assisting with surgical instruments

When assisting a health care provider with minor surgical procedures, you will need to know the various instruments used. There are particular instrument sets packaged and sterilized for many different procedures. All instruments used for minor surgery must be of suitable size, shape, strength, and function based on the procedure being performed. Four basic classifications of instruments you will use for a minor surgery are cutting or dissecting, grasping or holding, clamping or occluding, and exposing or retracting instruments. Let's further break down each classification beginning with the cutting or dissecting instruments.

Cutting or dissecting

There are two divisions of these instruments, knives and scissors. The knives further divide into two types: knives with detachable blades and knives with fixed blades (disposable). The knives with detachable blades are most commonly used during minor surgical procedures. This allows the health care provider a wider range of blade types to perform the necessary cut for the procedure. Disposable knives are readily available through supply channels.

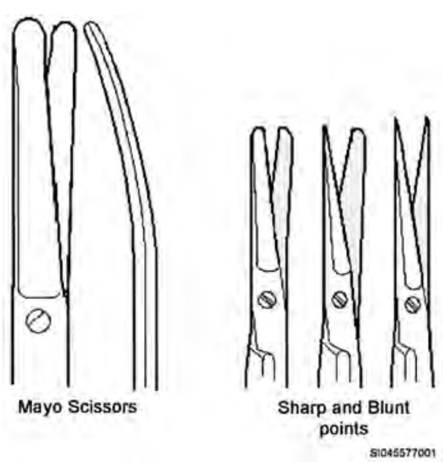


Figure 4–5. Scissors.

There are also different types and sizes of scissors (fig. 4–5). Scissors used for cutting tissue are curved or straight, blunt or sharp, depending on the type of tissue to be cut. This is when a determination will need to be made whether the scissors you are going to use are of suitable size, shape, and strength for the tissue being cut. For example, you would not use a pair of iris scissors to cut thick subcutaneous tissue but may prefer a pair of long curved Mayo scissors.

Grasping or holding

As their name implies, these instruments are used for holding, grasping, or pulling tissue or vessels. Examples of these instruments are tissue forceps, which have teeth for a firm grasp, and dressing forceps, which have serrations instead of teeth to grasp delicate tissue.

Clamping or occluding

Again, the name of the instrument tells its purpose. These instruments clamp blood vessels and certain types of tissue. If necessary, you also may completely stop the flow of blood from a vein or artery with this type of instrument. An excellent example of this category of instrument is the hemostat (fig. 4–6).

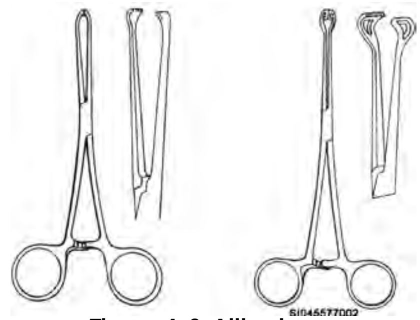


Figure 4–6. Allis clamp.

Exposing or retracting

Exposing or retracting instruments are used to hold back the edges of a wound or cavity to expose an area. Not only do they expose an operative area, but they also hold back superficial tissue to give access and exposure to deeper tissue. The most common examples of these instruments are rake retractors, nasal, and vaginal speculums (fig. 4–7).

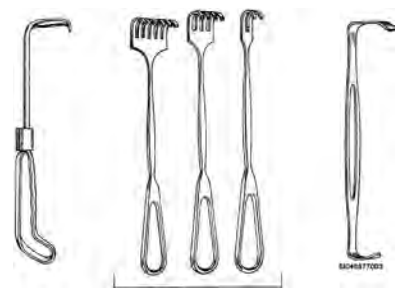


Figure 4–7. Rake retractors.

Even with the nursing challenges of assisting with minor surgery, treatment and release of the patient does not conclude the duties of the medical technician. Many minor surgeries are performed to make a diagnosis of the tissue taken from the patient. This is not something you as the technician can perform, but it is your responsibility to ensure the specimen is labeled appropriately, recorded, transported to the pathology department, and turned over for processing.

Pathology

When biopsies or specimens are taken during a minor surgical procedure, you will need to turn them in to the laboratory or, in larger facilities, the pathology department. These two areas process a large number and type of specimens daily and the only identification to the patient they have is through the label on the container. These departments do not have direct contact with minor surgery patients. As the medical technician assisting with the minor procedure, it is your responsibility to ensure proper labeling of the specimens before the patient is released from your care. On each specimen label, you should have the patient's name, ID number, date of the minor surgery, the type specimen and location from which the tissue was taken, the health care provider's name, and your name. If multiple specimens are taken from the same patient, make sure all tissue specimens are labeled with the correct anatomical location. If you are unsure of the specific location, do not hesitate to ask the health care provider. All pathological specimens are logged into a specimen-tracking log, which may be completed through the Armed Forces Health Longitudinal Technology Application (AHLTA, which is the current MTF computer system), or a hardcopy book or both and then transported and turned to the lab for processing.

The minor surgery process is not complete until the specimen is read and the pathologist gives a diagnosis. Patient follow-up and the results of the pathology report are given to the patient per local protocol.

027. Wound care

The basics of wound care, including cleaning, applying local anesthesia, suturing, applying sterile tape, and removing sutures and sterile tape is covered in this lesson. Other aspects of wound care will be covered in volume two.

Wound debridement and closure

If you are working in an emergency room or surgical clinic, you will also be involved in wound cleaning, debridement, and closure. Cleaning and debridement are done to remove foreign particles and dead or devitalized tissue from the wound. Wound closure is accomplished with adhesive strips, sutures, clips, or staples.

Wound cleaning

Wound cleaning and debridement are done after the wound is examined by a physician. The physician then indicates the extent of the cleaning and debridement and type of closure to be performed. If sutures or clips are to be used, the physician may order the area around the wound shaved to enhance visibility. Do the shave before you do any cleaning or debridement. Use sterile gloves and sterile techniques when performing these procedures. These techniques help prevent contamination for both you and the patient.

Wounds are usually cleansed by irrigation preceded by skin cleansing. Before cleansing, the wound may be anesthetized with a local or topical anesthetic if ordered by the physician. Check the patient for allergies and ensure the request is properly filled out and signed before administering any anesthesia.

Clean the skin around the wound with an antibacterial soap solution. Do *not* allow this solution to enter the wound. Most of the solutions on the market today have some tissue toxicity and interfere with the healing process. Following the cleansing, irrigate the wound with a sterile saline solution.

NOTE: The type of irrigation solution may be prescribed by the physician. Other examples include antibacterial soap, Betadine®, or hydrogen peroxide, all of which can be diluted with sterile saline for irrigation purposes.

Flush out all the foreign material possible, but do *not* attempt to dig out any embedded particles. Such in-depth debridement is done at the direction of the physician.

Debridement is the actual removal of foreign particles and mutilated or dead tissue from the wound and surrounding area. It is necessary to prevent contamination and promote wound healing. Debridement is usually accomplished by the physician or under the direct supervision of the physician. The procedure itself is sterile. The wound is draped, and sterile gloves and sterile techniques are used. Following debridement, the wound is irrigated again to remove any small particles and inspected by the physician in preparation for closure.

Wound closure

The purpose of wound closure is to promote wound healing by approximating or bringing the edges of the wound together. This is accomplished by adhesive-strip skin closures, sutures, or surgical clips and staples. The method depends on the type of tissue involved, potential for infection, wound location, general health of the patient, and cosmetic result desired.

Adhesive skin closures

Adhesive skin closures are used to pull together the wound edge tissue (called approximate) in areas with minimal tension on the wound (e.g., small wounds); to support wounds in which deeper structures are sutured, following suture removal to support wound edges; in tissues with poor circulation; to secure skin grafts; and in areas where cosmetic appearance is important. Anesthesia is not required for skin closures. To apply adhesive skin closure tape, clean and dry the skin at least two inches out from the wound. Using sterile technique, place half of the first strip at the midpoint of the wound margin (fig. 4–8A). Before attaching the other half of the strip to the wound, carefully appose (or position side by side) the wound margins using your other fingers (fig. 4–8B) and press the strip into place. Close the remainder of the wound by alternating strip applications on each side of the center strip (fig. 4–9A and B).

Sutures

Sutures are flexible materials placed through tissues with a needle to approximate the wound edges, decrease dead space in the wound, strengthen the wound until normal tensile strength returns, and minimize scarring.

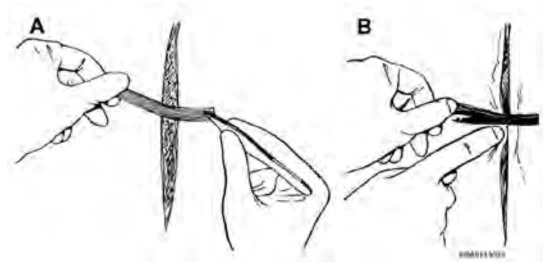


Figure 4–8A and B. Tape closures.

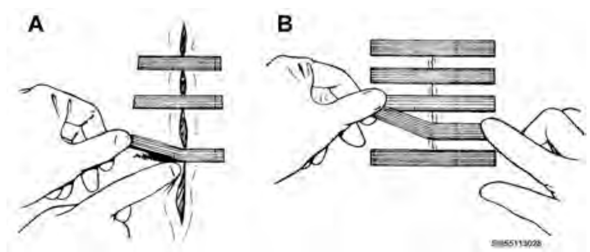


Figure 4–9A and B. Tape closures.

Suture material is either natural or synthetic and absorbable or nonabsorbable. Absorbable sutures are used in areas that cannot be reached for suture removal. They are also used on children's skin to prevent the trauma of suture removal, and on adults in areas of low cosmetic concern. Animal absorbable sutures are generally more reactive than synthetic absorbable sutures and are gradually being replaced by the synthetic materials. Synthetic, nonabsorbable sutures are also replacing their natural counterparts because they are stronger and cause less tissue reaction. Nonabsorbable sutures are generally used on the skin.

Sutures are sized, and the smaller the number, the larger the suture's diameter. The suture size selected depends on the characteristics of the tissue it supports. For example, 2–0 suture is normally used on areas such as the sole of the foot, while 7–0 suture is used on areas such as the eye or other facial plastic surgery.

There are a variety of techniques used to apply sutures. The following material gives you some procedural knowledge on how to suture**.** (**NOTE:** To perform suturing in your facility, you must be properly trained and that training documented in your Specialty Training Standard.) Follow your facility's local policy and use the techniques you are most comfortable with. Before suturing, a local anesthetic is applied or injected into the area to be sutured to minimize the patient's pain.

Local anesthesia

There are several anesthetic agents that can be used to anesthetize the skin or parts of the body. The most common agent you will probably use will be a form of Lidocaine (also known as Xylocaine). The three types of anesthetic agents we will cover include topical, local infiltration, and digital blocks. Common steps for all three methods include:

1. Verify physician orders.
2. Identify patient and explain the procedure and obtain written consent.

3. Gather supplies/equipment, wash hands, and don gloves.
4. Place the patient in a comfortable position with the affected area exposed.
5. Verify the order using the five rights (covered in greater detail in volume 3).
6. Ensure the patient is not allergic to cleaning agent or anesthetic agent.
7. Clean the site with an antimicrobial soap and water (or provider's preference) and allow to air dry.
8. Assess the patient's sensory awareness at the site before administering the anesthetic.

Now let's look at each method:

Topical—Lidocaine cream or spray may be applied as a *topical* anesthetic.

After completion steps 1–8 above, apply the prescribed topical agent and wait 5–10 minutes. Reassess the sensory awareness at the site and complete the required action. When you are finished, clean the area around the wound, apply dressing as necessary, and dispose of used supplies. Finish by washing your hands and documenting the procedure.

Local infiltration—Lidocaine is also available in an injectable with or without epinephrine.

Xylocaine with Epinephrine is used to decrease bleeding in the area by the vasoconstricting properties the epinephrine provides. Epinephrine also increases the duration of the anesthetic effect from approximately 20 minutes to 60 minutes. There are some areas of the body that Epinephrine must NOT be used because it may compromise the blood flow to a confined space. The areas you should not use an anesthetic containing Epinephrine are: digits (fingers and toes), the nose, ear or penis and most flaps of skin. Ensure you check with the provider before using any anesthetic agent. Most minor surgeries or laceration repairs will use a local anesthetic by using a needle and syringe to inject directly into the tissue immediately around the site to be sutured. This is called *local infiltration*. It provides comfort for the patient while being sutured. When the anesthetic agent is injected into the skin and subcutaneous tissues, the nerve impulses from the area to the brain are blocked. When injecting the anesthesia, care must be taken so the xylocaine is not injected into a vein. Injecting a local anesthetic intravenously can cause cardiovascular collapse or convulsions.

After completion steps 1–8 above, draw the prescribed amount of anesthetic into a syringe, change the needle (normally a 25–27 gauge needle is used), and inject the agent into the superficial tissue around the site. Wait 2–3 minutes and reassess sensory awareness. It may be necessary to administer additional anesthetic if the area is not numb. If this happens, check with the provider. Once the area is numb, complete the procedure, clean the area around the wound, suture and/or apply dressing as required, and clean up. Do not forget to wash your hands, document and give the patient follow-up instructions and educate the patient on signs or symptoms to watch for such as increased pain, fever/chills, pus-like drainage, bleeding, or red streaks. Have the patient follow up immediately if any of these signs or symptoms occur.

Digital Block—a *digital block* is a nerve block used to anesthetize digit such as a finger by affecting the bundle of nerves that serve that particular area.

A digital block is performed by injecting the anesthetic along the nerve path, *not* into the nerve. Once the agent is injected it takes longer to take affect, but the area stays anesthetized longer. Do not use epinephrine for this procedure. Again follow steps 1–8, draw the prescribed amount of anesthetic into a syringe (approximately 3ml), change the needle (normally a 25–27 gauge needle is used), and inject the agent along the nerve pathway on each side of the digit. You may lightly massage the site to ensure equal distribution of the anesthetic. Wait 2–3 minutes and reassess sensory awareness. Again, it may be necessary to administer additional anesthetic if the area is not numb. If this happens, check with the provider. Once the area is numb, complete the procedure, clean the area around the wound, apply dressing as required, and clean up. Follow the same steps above and ensure you give the patient the follow-up instructions including signs and symptoms to watch for.

NOTE: Due to the possibility of complications with healing, many facilities require suturing of the palm to be completed by a physician. Technicians do not suture areas such as the eye, the vermilian border of the lips, wounds requiring subcutaneous suturing, and some other specific areas. You should be familiar with your local policy.

Suturing procedure

Refer to the following pictorials for making a square knot using the instrument-tie technique:

- Step one (fig. 4–10)—hold the instrument in your dominant hand, perpendicular to and above the point you want to pass the needle through. Pass the suture material through the epidermal and dermal layers of the skin. Keep in mind the visible layer of skin varies in thickness from one part of the body to the next. The palms of the hand and soles of the feet are the thickest of the epidermis.
- Step two (fig. 4–11)—hold the instrument in your dominant hand and perpendicular to and above the suture end that is being held by your nondominant hand.
- Step three (fig. 4–12)—the suture held by the nondominant hand is wrapped over and around the instrument.
- Step four (fig. 4–13)—with the instrument surrounded by the looped suture, grasp the free end of the suture and pull it through the loop.
  - Step five (fig. 4–14)—cross hands while applying tension in a lateral direction.
- Step six (fig. 4–15)—release the suture material held by the instrument, wrap the suture material held by the nondominant hand around the instrument forming a loop as in step three.
  - Step seven (fig. 4–16)—with a loop around the instrument, grasp the free end of the suture.
  - Step eight (fig. 4–17)—pull the free end of the suture through the loop.
  - Step nine (fig. 4–18)—apply lateral tension to the suture ends and cut off.

STEP-BY-STEP SUTURING TECHNIQUES

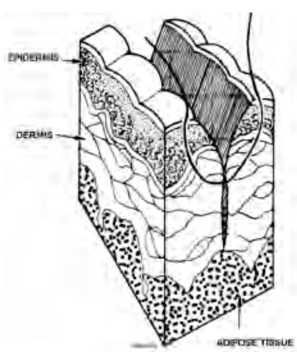


Figure 4–10. Step one suturing.

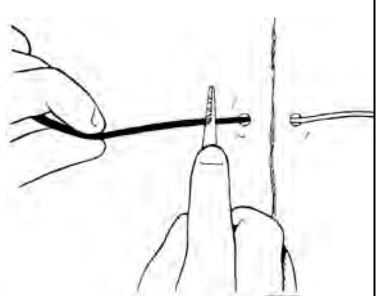


Figure 4–11. Step two suturing.

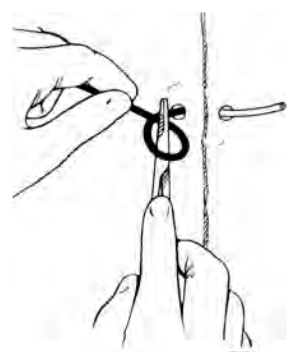


Figure 4–12. Step three suturing.

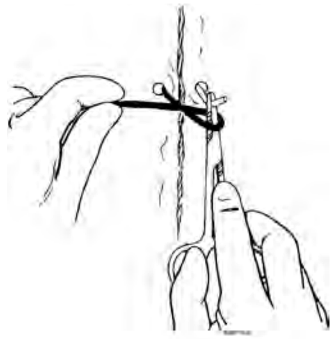


Figure 4–13. Step four suturing.

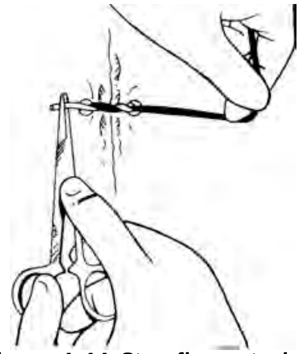


Figure 4–14. Step five suturing.

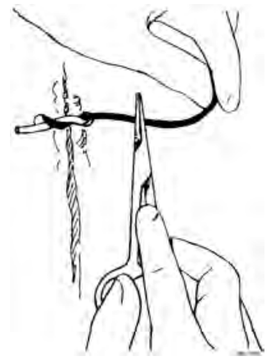


Figure 4–15. Step six suturing.

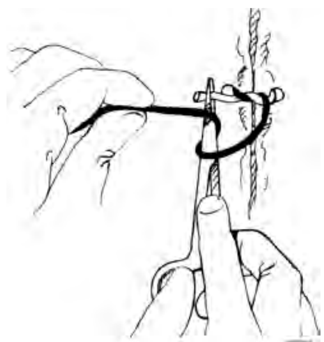


Figure 4–16. Step seven suturing.

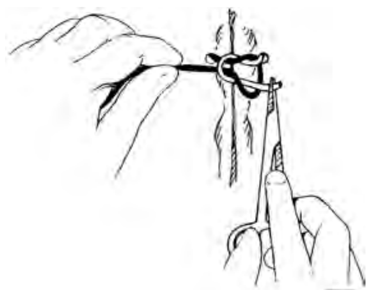


Figure 4–17. Step eight suturing.

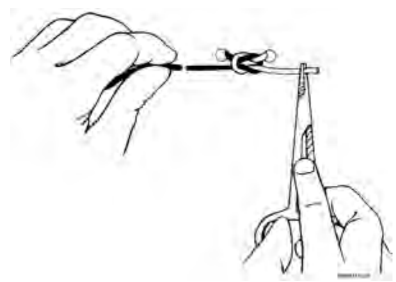


Figure 4–18. Step nine suturing.

Use a sufficient number of sutures to approximate the wound edges completely. Monitor the patient for healing and signs of infection around the wound, such as warmth, redness, pain, and swelling.

Staples are metal devices used to hold wound edges together. They are inserted and removed with special instruments. These devices are used like sutures, often in tissues under great tension. Staples may be used on deep tissues and then the overlaying skin sutured. Or, they may be used on the skin alone.

Care of sutures or staples in wound management

The object in caring for the patient's sutures or staples is to maintain dryness of the wound (wet, dark areas are the perfect medium for bacterial growth). If there is an unusual amount of drainage, change the dressing frequently. Be alert for signs of redness, swelling, and warmth to the area.

Removal of sutures or staples

Nonabsorbable sutures should be removed when the wound edges are fairly well healed. Leaving sutures in place for an excessive period of time will cause scarring and infection. Generally speaking, the more distal the wound, the longer the suture is left in place. Facial sutures are usually removed after three to five days, but sutures on the soles of the feet are left in place for 10 to 14 days. If the wound is not fully healed when the sutures are removed, adhesive strips can be used to maintain the wound until healing is complete.

To remove sutures, clean the wound with an antimicrobial solution. Open the suture removal kit. Using sterile technique, grasp the suture by the knot with forceps. Using the special suture removal scissors, place the scissors under the suture material opposite the knot. Cut the suture, and pull up on the knot side. Clean the incision again. Apply sterile tape strips if there is apparent gapping of the incision. The technique for removal of sutures is illustrated in figure 4–19 and removal of staples is illustrated in figure 4–20.

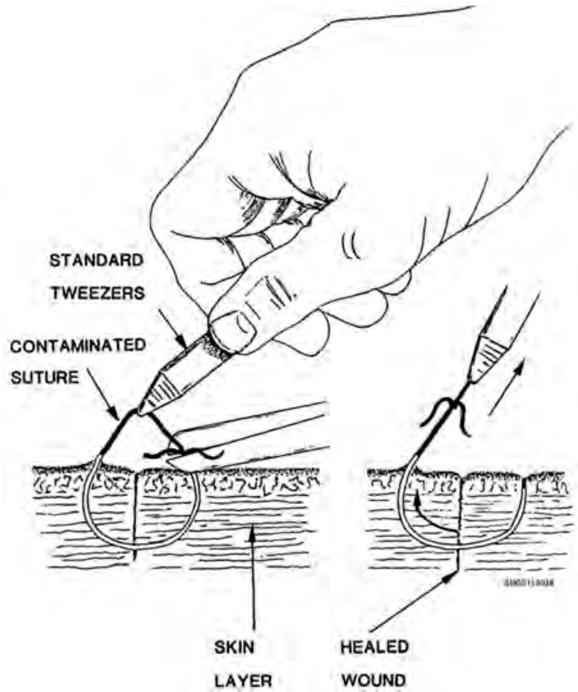


Figure 4–19. Suture removal.

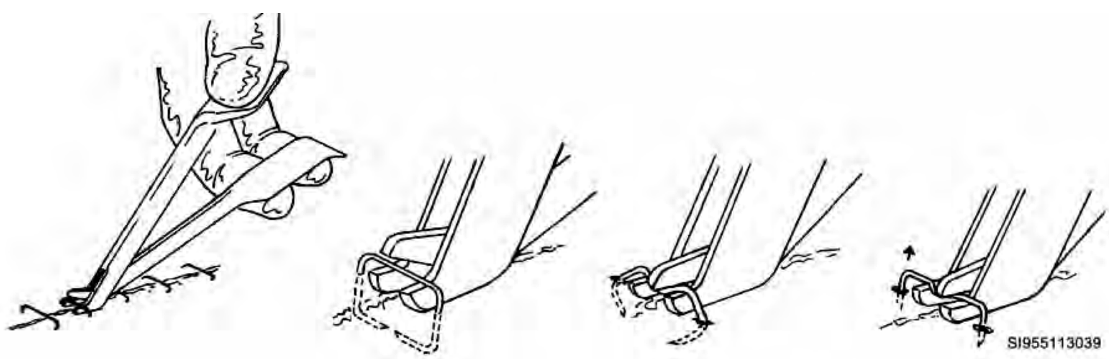


Figure 4–20. Staple removal.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

026. Minor surgery

1. List the six basic tasks you must accomplish before performing a procedure?

2. List at least four responsibilities of the medical technician when in pre- and post-procedures.

3. What is the most common type of knife used during minor surgeries?

4. Describe the function of a hemostat and rake retractors.

5. What are the technician's duties when a tissue sample is taken and must be processed by pathology?

027. Wound care

1. What action should you take if there are foreign material in a wound you are cleaning?

2. Explain debridement.

3. What term is used to describe the pulling together of tissue before suturing?

4. When and why are adhesive skin closures used?

5. What are the general categories of suture material?

6. How is suture size determined?

7. What are the three types of anesthetic agents?

8. On what areas of the body would you refrain from using an anesthetic with Epinephrine?

9. How do you start the first suture?

10. What can happen if staples or sutures are left in place too long?

Answers to Self-Test Questions

021

1. SOAPP.
2. "O"—Objective data is based on health care member's observations, physical examination and diagnostic tests.
3. To determine the patient's state of health and detect any physical or mental deficiencies that may impact job performance. It is also a good opportunity to educate patients on ways to improve health behaviors and live healthier lifestyles to maintain a physically fit force, capable of performing at the highest possible level.
4. The position most commonly used is the *lithotomy* position.
5. A cervical biopsy.
6. Endoscopic examination is the inspection of a body cavity or hollow organ by means of a lighted instrument.
7. The bowel must be empty, so the patient is given a cathartic, enema, or both the night before the procedure.
8. The fiberoptic scope is inserted into the large intestine and most patients would not be able to tolerate the discomfort without sedation.
9. Patient follow up appointments in wound care, suture removal, wart treatment, throat culture and pseudofolliculitis barbae (PFB) clinics.
10. Pseudofolliculitis barbae (shaving bumps) is an inflammatory condition of facial skin that develops around ingrown hair fragments resulting when curved hair is closely cut.
11. Patient education; convince them that their previous shaving program is a failure, and that you can help them.
12. The patient's commander.
13. Phase III.
14. Air Force personnel must be able to wear protective equipment for prolonged intervals. The individual who cannot be assured of a tight gas mask fit, or whose skin will become irritated that he cannot function at full efficiency.
15. Preparation of the face, the shave, and the finish.
16. Human papillomavirus or (HPV).
17. Paring down verrucae, cryotherapy, curettage, and topical chemotherapy.
18. Explain the procedure and what the patient can expect to see and hear. Also realize some of the sounds may be loud or startling, so they should do their best to remain relaxed. Advise the patient to sit quietly, avoid speaking or swallowing during the test as it can change the pressure of the middle ear and invalidate the results. Since this can be a challenge with young children, ask the parent to assist you in keeping the child quiet and still while the test is being run.

022

1. The eye's ability to distinguish an object's shape and details.
2. The region of the retina stimulated, illumination, spectral quality of light, contrast, pupil size, time of exposure, patient's age, condition of the ocular media, presence of ametropias, and individual variations.
3. The fovea centralis.
4. Rods do not provide images as sharp as cones.
5. Light rays going relatively straight to the eye.
6. Errors in the eye's ability to focus light on the retina when the eye is at rest.

023

1. Evaluating losses in respiratory function and following the course of certain respiratory diseases.
2. Vital capacity (VC).

3. The volume of the conducting respiratory passageways (area in and around the nose, pharynx, larynx, trachea, and bronchial tree) which fills with inspired air, but never contributes to gas exchange in the alveoli.
4. If the patient has smoked or administered a bronchodilator within the past hour, eaten a meal within the past two hours, or is acutely ill or has experienced an upper or lower respiratory tract infection during the past three weeks.
5. For at least five seconds, or until an obvious plateau in the volume-time curve has occurred.
6. Height and age.
7. Multiply them by 0.85; to adjust for the lower (15 percent difference) predicted normals.

024

1. The sinoatrial (SA) node.
2. Initiating in the SA node, the electrical impulse passes through the AV node down the Bundle of His to the left and right bundle branches, and then through the Purkinje fibers which terminate in the ventricular walls.
3. The left ventricle.
4. Deflection waves.
5. Ventricular depolarization.
6. Any artificial product or features that appear on an ECG tracing.
7. Any variation from the normal electrical rate and/or sequence of cardiac activity.
8. Directly on a bone.
9. The rate, rhythm, and axis of the heart, along with any evidence of myocardial hypertrophy or infarction.

025

1. Intravenous therapy, or blood transfusion therapy.
2. Arterial hemoglobin oxygen saturation.
3. When the reading is below 97 or the patient appears to be in any respiratory or circulatory distress.
4. A head injury or neurological problem such as a seizure or complains of a neurological symptoms such as weakness, numbness or tingling in a particular area of the body.
5. This is generally completed by asking the patient to state his or her full name; the month, day or year; name the current President or a relevant question the patient should be able to answer. Keep the patient’s age in mind when doing this. A 3 year old probably won’t be able to tell you who the president is, but can probably point to or name an appropriate toy or parent.
6. Both eyes’ neurological functions are working together and can be seen when both pupils react and become smaller when light stimulates either eye (one eye at a time).
7. Have the patient squeeze your fingers (index and middle fingers) with both hands (ensure you have your fingers crossed or it may hurt!), push his or her feet against your hands and have them hold his or her arms straight in front and push down on your hands and then resist as you push down on his or her outstretched forearms.

026

1. Verify the provider order, gather all of your equipment, identify the patient, explain the procedure to the patient, use proper body substance isolation (BSI) precautions with personal protective equipment (PPE), and always provide privacy.
2. Don a gown if it is required; position the patient and prepare the patient’s body area affected by the procedure by cleaning and irrigating as required; set up required sterile fields. Make sure you also get the patient’s vital signs. Assist the provider during the procedure and in dressing the wound after surgery, if required, and dispose of all sharps into the designated biohazard container. Repeat the patient’s vital signs, and then assist the patient in sitting up and getting down from exam/procedure table. Be available to assist the patient in getting dressed as necessary, and then escort the patient to the waiting room if required. Ensure the patient has wound care instructions, and make any follow-up appointment as necessary. Once this is completed, clean and restockthe procedure room so it will be ready for the next procedure.
3. The type with detachable blades.

4. Hemostat—used for clamping or occluding. Rake retractors—used for exposing or retracting.
5. Label specimen, log it into AHLTA and or log into a hardcopy book, and transport the specimen to pathology.

027

1. Flush out all the foreign material possible, but do *not* attempt to dig out any embedded particles.
2. Debridement is the actual removal of foreign particles and mutilated or dead tissue from the wound and surrounding area. It is necessary to prevent contamination and promote wound healing. Debridement is usually accomplished by the physician or under the direct supervision of the physician. The procedure itself is sterile. The wound is draped, and sterile gloves and sterile techniques are used. Following debridement, the wound is irrigated again to remove any small particles and inspected by the physician in preparation for closure.
3. Approximating.
4. Adhesive skin closures are used to approximate wound edges in areas with minimal tension on the wound (e.g., small wounds), to support wounds in which deeper structures are sutured, following suture removal to support wound edges, in tissues with poor circulation, to secure skin grafts, and in areas where cosmetic appearance is important.
5. Natural or synthetic and absorbable or nonabsorbable.
6. The smaller the number; the larger the suture's diameter.
7. Topical, local infiltration, and digital blocks.
8. Digits (fingers and toes), the nose, ear or penis and most flaps of skin.
9. Hold the instrument in your dominant hand, perpendicular to and above the point you want to pass the needle through. Pass the suture material through the epidermal and dermal layers of the skin.
10. Scarring and infection.

Complete the unit review questions before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter.

64. (021) In the *objective information section* of the paperwork, it is important to identify the patient's
    a. statement that he or she feels dizzy.
    b. plan to resolve a health issue.
    c. complaint of headache.
    d. pulse rate.

65. (021) A proctoscopy is an inspection of the
    a. rectum.
    b. sigmoid colon.
    c. ascending colon.
    d. transverse colon.

66. (021) When educating the patient with psuedofolliculitis barbae (PFB) on proper shaving methods, you should instruct the patient *to avoid all* of the following *except* shaving
    a. in the opposite direction of hair growth.
    b. in the direction of hair growth.
    c. with facial skin stretched.
    d. with slow strokes.

67. (022) The eye can generally see wavelengths between
    a. 200 and 800 nanometers (nm).
    b. 300 and 650 nm.
    c. 400 and 750 nm.
    d. 500 and 850 nm.

68. (022) At what ages is visual acuity at its best?
    a. 20 to 30.
    b. 10 to 25.
    c. 5 to 15 .
    d. 15 to 20.

69. (023) When performing a pulmonary function test on a patient, according to Air Force standards, abnormal functions are present if the predicted forced expiratory volume at one second (FEV1) or forced vital capacity (FVC) percentage is less than?
    a. 65.
    b. 75.
    c. 80.
    d. 90.

70. (023) During pulmonary function testing, the minimum number of practice attempts and acceptable tracings an examinee must perform are
    a. 1; 1.
    b. 1; 2.
    c. 2; 2.
    d. 2; 3.

71. (024) Any artificial products or features which appear on an electrocardiogram tracing are called
    a. artifacts.
    b. disturbances.
    c. random waves.
    d. deflection waves.

72. (024) What term is used to describe any variance in the normal electrical rate or sequence of cardiac activities discovered on electrocardiogram tracings?
    a. Arrythmia.
    b. Cardiac arrest.
    c. Depolarization.
    d. Atrial excitation.

73. (024) If you are performing an electrocardiogram on someone who is rated, a copy of that electrocardiogram must be sent to the
    a. major command (MAJCOM).
    b. local medical examination board (MEB).
    c. command level Electrocardiographic Library.
    d. US Air Force Central Electrocardiographic Library.

74. (025) What is another term for orthostatic hypotension?
    a. Postural hypotension.
    b. Positional hypotension.
    c. Situational hypotension.
    d. Environmental hypotension.

75. (025) Notify the nurse or physician immediately if the patient's oxygen saturation (SaO2) falls below
    a. 88 percent.
    b. 90 percent.
    c. 97 percent.
    d. 100 percent.

76. (026) When can the minor surgery procedure *begin*?
    a. When the provider says its time.
    b. After the consent form is signed.
    c. Once a set of vital signs are repeated.
    d. Only after housekeeping has cleaned the room.

77. (026) When cutting through thick muscular skin of the back, a provider would most likely use a
    a. retractor.
    b. allis clamp.
    c. iris scissors.
    d. mayo scissors.

78. (027) When cleaning a two inch laceration on a healthy active duty male's right forearm, you notice some foreign material in the wound, what would be the next step?
    a. Begin suturing.
    b. Flush the wound.
    c. Clean out the debris with an allis clamp.
    d. Soak the wound in an antibiotic solution.

79. (027) After you have applied a topical anesthetic to a wound that requires treatment, what should you do next?
    a. Apply a sterile dressing.
    b. Assess sensory awareness.
    c. Begin suturing the wound.
    d. Soak the wound in cold water.

Please read the unit menu for unit 5 and continue ➔

Unit 5. Emergency Room and Ambulance Operations

"EMERGENCY, emergency, we have an aircraft down!" Would you know what to do next? This unit is designed to provide you with the information needed when emergency operations are activated. Whether it is a simple base exercise or a real natural disaster, your actions could mean the life or death of a human being. Take your job seriously. Know what you are doing; you never know when it could be your loved one needing emergency care.

5–1. Ambulance operations

You must be able to respond quickly and safely to the scene of an aircraft or missile mishap. This section covers some ambulance duties and responsibilities that will make your response a success. Although the information may seem generic, you should also be prepared to handle any situation that may be unique to your local environment (i.e., cold weather rescue, water rescue, or heat-related incidents in arid climates).

028. Response preparation

One of the more thrilling jobs you may have is to work in an emergency room or on an ambulance response unit. Depending on where you are stationed, you respond to emergency calls from an emergency room, fire department or from a flight medicine clinic. The information here will help prepare you for your responsibilities ensuring supplies and equipment are ready for emergencies. Additionally, there are daily requirements for supply and equipment checks in just about every area of a medical facility. This unit will introduce you to some of the tasks you may be required to perform.

Crash vehicle

One of the most important elements in preparing for "the call" is the availability and readiness of equipment and supplies. Perhaps the most important piece of equipment is the ambulance itself. You or a fellow member of your staff must check the crash ambulance on a daily basis. Points of interest should include fuel level, tire pressure, horns, lights and sirens, along with a radio check. Do not forget to do a radio check with both the fire department and the hospital or medical control center. In the event of a response, the ambulance crew will be in contact with both of these sections. The list can go on and on, but as you can see, all of these items impact the response capability of your vehicle. Your office should have a checklist for daily, weekly, and monthly ambulance checks or maintenance. Following a checklist will ensure the vehicle is in top condition at all times.

Supplies and pieces of equipment can be classified as medical or nonmedical and the following information will address both.

Medical supplies and equipment

As a Nationally Registered Emergency Medical Technician (NREMT) you may participate as an ambulance crewmember. However, like all jobs, there are duties and responsibilities inherent to ambulance crew duties you will need specific training on. Aside from emergency medical technicians (EMT), you will likely encounter other personnel that will accompany you on ambulance runs or transfers such as paramedics, doctors and nurses. As EMTs, you will have access to a large variety of equipment and supplies to aid in your rescue effort. The list is far too large to describe in detail here. The following table groups some of the most common supplies and equipment to which you will have access. Your local requirements may dictate a broader scope than those listed. But again, this is a very generic inventory.

Supplies and Equipment	Description
Basic items	Linens such as pillows, sheets, blankets, and towels should always be kept in your vehicle. Thermometers and blood pressure cuffs, along with a stethoscope, should also be included in your basic supplies. Intravenous (IV) tubing and sterile irrigation fluids must be readily available during treatment or transportation. Many locations store these two items in the office area until needed due to the environmental extremes within the parked ambulance. A pre-response checklist may help to remind you to take along items that are normally stored outside of the crash ambulance. Additional supplies would include disposable gloves, plastic waste bags, sharps containers, and trauma shears. Supplies for dealing with specific problems or conditions such as cold or heat injuries should also be available.
Items for airway management	Oropharyngeal airways for adults, children, and infants must be on hand. Although your patients are typically adults, the vehicle may be used by other sections of the hospital or clinic, which require these “nontraditional” sizes. Suctioning equipment should include both a portable and onboard device. These units must be powerful enough to provide an air flow of 30 liters per minute at the end of the tube and a vacuum of 300 millimeters of mercury (mm Hg) when the tube is clamped. The equipment should be easily accessible to you when you are sitting at the head of the litter or stretcher. Obviously, the tubing must reach the patient’s airway, regardless of the patient’s position in the vehicle.
Devices for ventilation	The pocket mask and bag-valve mask (BVM) are two common portable artificial ventilation devices that are carried on the vehicle. These masks should be transparent to help you monitor respirations and to notice any vomiting easily and quickly.
Oxygen equipment	Your vehicle should be equipped with at least two oxygen supply units—one portable and one installed on board. The portable unit should have a capacity of 300 liters of oxygen and be equipped with a yoke, pressure gauge, flow meter, oxygen supply tubing, nonrebreathing mask, and nasal cannula. This unit must deliver oxygen at a rate between 2 and 15 liters per minute. It’s a good rule to keep at least one extra portable cylinder on the ambulance in cases of multiple patients or extended treatment away from your vehicle. The onboard unit should have a capacity of 3,000 liters of oxygen and must be able to deliver oxygen at a rate of between 2 and 15 liter per minute.
CPR equipment	A cardio pulmonary resuscitation (CPR) board is required to provide a firm surface under the patient’s torso during chest compression. Without a firm surface, effective compressions will not be achieved.
Automated external defibrillator (AED)	If permitted by your local medical director, this piece of equipment should be carried on your ambulance.
Basic wound care supplies	These items include sterile dressings, bandages, and gauze. Adhesive tape and roller bandages, and safety pins should be on hand while providing basic wound care.

Supplies and Equipment	Description
Splinting supplies	Supplies for splinting fractures and dislocations include traction, wire-ladder, or padded board splints. A short and long spine board along with a variety of triangular bandages and different sizes of cervical collars aid in immobilizing a patient. If your local protocol permits, pneumatic antishock garments (PASG) can be carried in your unit.
Transportation devices	In addition to the primary wheeled stretcher, your unit should have a number of folding or collapsible litters on board. The additional litters must be easy to move, store, clean, and disinfect.

Nonmedical supplies and equipment

Personal safety equipment such as face shields and masks, gowns, or helmets must be available. Maps and preplanned directions to various locations on or off base should be maintained in the driver's compartment of the ambulance. Here again, your local environmental conditions will guide you in developing a comprehensive list of supplies that will benefit you in the response.

Don't forget; be prepared for the unexpected! To ensure you and your crew are able to provide the best possible care at the scene or while en route, check all medical equipment and supplies at least daily. This includes all of the oxygen supplies, response kits, splints, dressings and bandages, backboards and other immobilization equipment, and all other supplies. Equipment should be checked for proper function, while supplies are assessed for adequate quantity, cleanliness, and expiration date. All battery-operated equipment should be checked daily as well.

Daily Duties

When working in a hospital or clinic, it is essential to complete specific activities to ensure all required supplies and equipment are available and that correct documentation and follow up are provided for our patients. You may be assigned the duty to perform daily inventories and equipment checks on such things as the ambulance (discussed previously), IV trays, crash carts, and so on. The goal is to have all supplies and equipment available and in working order in an emergency situation. Since we do not know when those emergencies are going to occur, we need to be ready ahead of time. If you have ever reached for a piece of equipment in an emergency and it was not available or was not working, you know what a terrible feeling that is. We will talk specifically about a few areas, however, take it upon yourself to always replace supplies or equipment that are removed and report any problems to your supervisor or shift leader immediately. Most facilities have a committee that determines what items should be kept on crash carts and will have a designated time (usually once a month or once a quarter) to check for specific items that need to be changed out. An example would be replacing outdated medication. These items still need to be checked daily to ensure equipment is operating and that none of the seals have been broken or supplies used without being replaced.

Completing checklists

Just about anywhere you may work in a medical facility will have some kind of daily checklists of duties, and supply or equipment items that need to be checked. You may use a formal checklist such as a crash cart or ambulance checklist or it may be an informal check of inpatient or outpatient exam rooms. Both are very important to the success of your daily mission. The greatest difference between the checklists is that some have life and death consequences and some may be an inconvenience for the health care staff or patient. However, both are important to ensuring the mission is completed as smoothly as possible. A few things that must be remembered are:

1. If you are assigned the duty of completing daily, weekly or monthly checks, you must ensure you complete them. Integrity is a must! Do NOT "pencil whip" checks. Beware of the "Those things never happen here" mentality. Emergency events can happen anywhere at anytime! If someone yells down the hall for you to bring the crash cart, you certainly do not want to be

wondering if someone did the job correctly or wish you had ACTUALLY checked the oxygen instead of copying the same psi as the day before!

2. When you complete the checks, make sure you document the date, time and sign or put your initials next to the date. Just like everything else in medicine, if it was not documented, it was not done!
3. If you find a problem such as missing items or a piece of equipment that is not working properly, take care of it immediately. Problems with critical items such as oxygen, and cardiac monitors, among others, should be upchanneled through your supervisor immediately. That way an alternate means of preparing for a potential emergency can be addressed and communicated to others BEFORE it is a problem.

Your trainer or supervisor will teach you the specific way to conduct daily checks in your facility. However, here is a brief list of common tasks for inpatient and outpatient rooms, crash carts, IV trays and treatment rooms:

Inpatient

1. Patient rooms and carts/trays should be checked at the beginning and end of each shift.
2. Check each shelf and/or bedside table and drawer in the patient room for items such as tissues, basins and personnal items.
3. Check wall units for oxygen flow, masks, cannulas, tubing and tubing connectors, working suction, suction canisters and suction tubing.

Outpatient (examination rooms)

1. Check all carts/trays, exam table and supply drawers and cabinets for high usage supplies (this may depend on the clinic you are working in). Examples are gowns, linen, table paper, gloves, water soluable lubricant, ear speculums, and so on.
2. Ensure rooms are clean and wiped down at the end of each day (exam tables should be cleaned between patients as well, especially in areas where body fluids may contaminate the tables).

Crash cart

1. Check items on the top and sides of the crash cart. Ensure monitors are plugged in to an electric source or batteries are charged (be sure to unplug it before pulling it away from the wall in an emergency!). Check oxygen supply (follow local policy to determine when to exchange the old tank for a new tank. Normally, however, the tank on a crash cart should be three-fourths full). Also, ensure required paperwork for documentation in an emergency is present. There should also be a backboard (for CPR) and an assortment of sizes of respiratory resuscitative equipment (BVM, airways etc). Check defibrillator or cardiac monitor by running a rhythm strip and annotating the date and time on the strip.
2. Ensure the cart is locked. Most facilities use a plastic lock with an identification number on it. The plastic lock can be twisted and easily pulled off in an emergency. Check to see that the correct lock number is annotated on the checklist. If it is incorrect, notify your supervisor and check to see that everything is there and in working order. (Pharmacy or a committee representative will likely want to complete a thorough check on all medication to ensure no tampering took place).
3. Check lights on all laryngoscope blades and ensure all blades are present.
4. Check expiration dates on IV fluids and medications.
5. Check expiration dates on emergency trays (e.g. chest tube, cut down trays etc.).
6. Make a list of required supplies and re-stock.

7. When you are finished, lock the cart and annotate the new lock number. Locks are controlled in many facilities by a crash cart committee member or the pharmacy. Know what your local policy is and where to get a new lock.

IV cart or tray:

1. Stock after each use and at the end of each shift with all required items and fluids.
2. Check expiration dates on IV fluids, IV needles, blood tubes and anticeptic wipes, bandages, etc.
3. Report any items you do not have on hand to your supervisor or supply custodian. If it is a critical item, you may need to talk with someone in another area of the facility and ask if he or she can give you the required item.

Treatment Room

1. Ensure the cabinet is stocked with required items.
2. Many facilites have a medication cabinet that must be kept locked. Check expiration dates on all medication and rotate those due to expire the soonest to the front. Relock when finished.
3. Check sterile packages for sterility dates and look for any outdated or damaged packages. Sterile supplies should be on the top shelf(s). Rotate those steriled most recently to the back or place the packages with the earliest expiration date to the front.
4. Check date, condition, and stock levels of fluids. Fluids should always be stored on the bottom shelf(s). If they leak, they will not contaminate other supplies below them.
5. Ensure the room has all required supplies and equipment and is cleaned like the inpatient and outpatient room.

029. Ambulance response

This section demonstrates the parts of an emergency call and the responsibilities the 4N0X1 may be required to execute.

Preparing for the call

Equipment and supplies should be stored in your vehicle, according to their relative importance and frequency of use. These items should be durable and as standardized as possible, and some examples of these were discussed in the previous section. Storage cabinets and kits should open easily but must be securely fastened to keep them from opening during transport.

Notification

An inflight emergency call will generally be reported by the “crash phone” from the air traffic control tower. Information such as type of aircraft involved, number of personnel on board, amount of fuel, hazardous cargo or munitions, and the like are relayed to you. Also given are estimated time of arrival, location, and current wind conditions.

Dispatching

Emergency room personnel are normally responsible for dispatching emergency vehicles. However, some areas are now notified through a local 911 operator. The person answering the emergency phone is considered the “dispatcher.” The dispatcher is responsible for receiving and processing calls. Other responsibilities may include providing medical instructions to patients (must have written protocols and/or physician oversight), dispatching and coordinating emergency personnel, and possibly coordinating with other on base/off base agencies.

When answering an emergency call for help, the dispatcher must obtain as much information as possible. If you are the dispatcher, obtain the following information:

- Location of the accident or injured person.

- The caller's telephone number.
- Nature of the problem.
- Age and sex of the patient.
- If the patient is conscious or unconscious.
- If the patient is breathing.

These questions assist the dispatcher in determining what type of emergency response is needed. For example, an ambulance running COLD is a response at normal speed, also referred to as a Code 1; Code 3 HOT refers to an emergency, responding with lights and sirens on**.** If the patient is not breathing, the dispatcher may need to provide CPR instruction. Keep in mind that the person calling is often hysterical, and you will need to stay calm and assist the person on the other end of the phone in calming down and giving the best description of the event, number of victims, and location possible. A good way to do this is to tell him or her you have emergency personnel on the way as soon as he or she gives you a location (assuming you have notified the ambulance crew). This will ease their anxiety and let them know help is coming. Next, ask the person to stay on the line with you so you can get additional information that will speed up assistance when the crew arrives on scene. You can then get detailed information and you might even be able to direct the individual through life-saving steps. The key here is that YOU must remain calm and let the caller know that help is on the way.

Transmitting information

All transmissions made over the ambulance radio are heard by numerous people including the command post, ER, and Security Police. Do *not* compromise the patient's privacy or the integrity of the hospital or clinic by transmitting inappropriate information over the radio. If it is necessary to mention the patient's name or any sensitive information concerning the patient, use the telephone.

When you do transmit information about a patient, limit it to the following:

- Patient's age and sex.
- Chief complaint (or your observations about the problem).
- Brief history about the patient's illness including medications, allergies, and systemic problems such as diabetes, and so forth.
- Brief report of physical findings to include vital signs, level of consciousness, general appearance, and degree of distress.
- Brief summary of treatment provided and patient response.
- Estimated time of arrival at the hospital.

If there are multiple patients at the accident or disaster, use numbers or another locally-developed system to identify each patient. Do *not* broadcast names over the radio.

Radio Communications

Professionalism is paramount when operating the radio. The following guidelines and procedures are in place to assist you while performing your duties.

Radio procedures

Practice improves message transmission and reception. Medics must ensure they understand local radio transmission procedures. Proper use of these procedures will ensure the radio net works well under both normal and emergency conditions.

Call signs

Each medic with a radio is assigned a combination of words and phonetics (letters and/or numbers) used to identify his or her identity. These call signs simplify, clarify, and make communications more protected (preclude disclosing individual's name).

When contacting another post:

1. The calling station first identifies the station being called.
2. Followed by their call sign; for example, "Medic One, this is control."

In this example, the Medical control center (Control) is calling Medic One.

Procedure words (Pro-words)

We use pro-words in radio/telephone communications to shorten transmissions and facilitate message reception. The following (fig. 5–1) are a just few examples of the pro-words you will use during a radio conversation:

Pro-Word	Meaning
BREAK	The separation of the text from other portions of the message
(I) SAY AGAIN	I am repeating transmission or portion indicated
I SPELL	I spell the next word phonetically
OUT	End of my transmission to you and no answer is required or expected. (Since OVER and OUT have opposite meanings, they are never used together)
OVER	End of my transmission to you and a response is necessary. Go ahead; transmit
SAY AGAIN	Repeat all of your last transmission.

Figure 5–1. Pro-word.

Clear speech

Use clear speech procedures when using the radio. Keep the message short and use as few words as possible. Example: Medical Control: "Medic One, this is Medical Control." Medic One: "Medical Control, Medic One, on scene at 111 Doe street, 1251." Medical Control: "Medic One, contact Fire Chief on scene for patient location, acknowledge." Medic One: "Medical Control, I copy contact Fire Chief on scene for patient location, Medic One, out."

Phonetic alphabet

Use the phonetic alphabet when accurate communication is critical. Speech-transmitting techniques used in radio/telephone communications are extremely important. Transmit words that are normally difficult to understand in radio/telephone communication, abbreviations, and groups of letters using the phonetic alphabet. Duress signals or words, often referred to as codes, are designed for transmission in a manner that is not noticed by an untrained person but alerts an SF member receiving the signal. Use locally developed duress codes for emergency or distress situations.

Prohibited radio practices

When using the radio, users should know Federal Communications Commission (FCC) prohibited practices:

- Use of profane or obscene language.
- Transmission of unnecessary, extravagant, false, or deceptive signals.
- Transmissions not in accordance with the limitations of a station license or by an unlicensed station. For example, the license granted to Medical Control limits range to 150 miles and does not allow for transmitting music or commercial radio signals.

Grid maps/flight-line response

A critical location used for radio communications is the flight line. Ambulances provide flight-line response whenever an aircraft declares an in-flight emergency. After you have been notified, you must be sure of where it is you need to go. Every flight/missile medicine (FMM) office and ambulance should have a grid map of the base and local area on hand.

A grid map is simply used to identify location. By dividing a map into squares, you can quickly and accurately find an area by locating the square it is in. If all base agencies use the same grid map, all will have the same references to identify areas.

Reading a grid map

The grid coordinate system uses vertical coordinates labeled with numbers at the top and bottom of the map and horizontal coordinates labeled with letters on the sides. The coordinates of a location are obtained by reading across the map from left to right for the number and reading from the bottom to the top for the letter. The number and the letter combined are the grid coordinates. The figure on the next page shows a small portion of a grid map.

Use the grid map in figure 5–2 to find coordinates “3R.” The third column across the map is “3” and the fourth row down the map is “R.” The block grid where column 3 and row R intersect is grid coordinate “3R.”

Grid maps can be subdivided into smaller grids to better identify a location. A widely recognized aid to plotting on a grid map is the grid-map overlay. The purpose of a map overlay is to increase your accuracy and save time when plotting locations. A grid-map overlay is normally constructed of clear plastic sheeting and is made to the scale of the map used and divides the block into 10-line increments.

Driver licensing

To be an ambulance driver, you must be both qualified and properly licensed. First of all, every person who is assigned duties involving the driving or operation of an ambulance must be trained and licensed in accordance with applicable military rules and regulations. Having a civilian license and several years’ experience as a driver does not entitle you to operate an Air Force vehicle. You will be trained and evaluated on ambulance operations at your base. The requirement for a government driver’s license will depend on the requirements of your local facility. Once you have a requirement to drive on the flightline, you will be trained, tested and then receive documentation that you are qualified for flightline driving.

Driver responsibilities

As an ambulance driver, you have great responsibilities and a big job to do. The Air Force depends on you and your vehicle for transporting the sick and injured. Your success depends greatly on how well you know your job and how well you accept your responsibility. As a driver, you are responsible for the safe operation of your vehicle, the safety and comfort of your patient, and the proper care and cleaning of your vehicle and its equipment. Remember, the proper functioning of the ambulance and its emergency equipment may be a life-and-death matter several times a day. Inspect the function of the ambulance each time you begin a shift. Check the warning devices, communication system, fluid levels, and medical supplies. Each time you use the ambulance, replace the supplies and fuel you use so the ambulance is ready for the next trip. Also, clean and decontaminate the ambulance as needed after each trip. In addition to the daily checks, the ambulance must undergo periodic maintenance inspections to determine serviceability of different components.

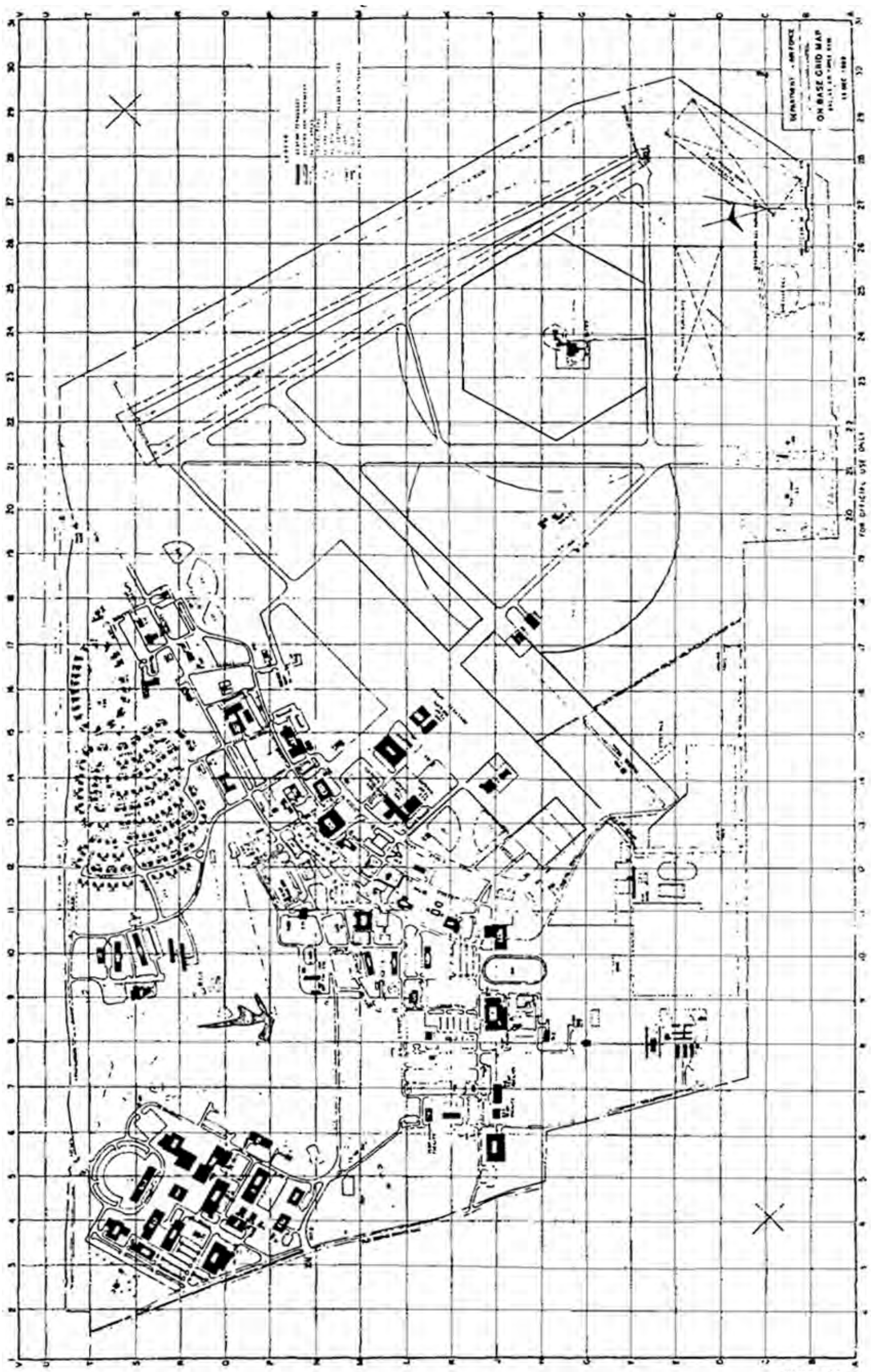

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Figure 5–2. Grid map.

Operation rules

Rules governing the operation of emergency vehicles are determined by Air Force regulations and instructions, state laws, and local policy. The fact that an ambulance is an emergency vehicle with a red light and a siren does not necessarily give it the right-of-way. Also, these signals do not give you clearance to operate the vehicle without due regard for life, property, and traffic laws. Many states do not permit an ambulance to exceed the legal speed limits. However, when you are responding to an emergency call, some states permit you to proceed through a stoplight or stop sign but only after slowing down or stopping to ensure safe passage. Each medical facility publishes rules and regulations governing the safe operation of an emergency vehicle. Be sure you know the requirements of Air Force regulations and state laws. It is your responsibility to gain as much knowledge as possible in the operation of emergency vehicles and to be fully familiar with local operating procedures. Remember that emergency vehicle accidents are possible and are, in fact, quite frequent and serious.

Flight-line Response

At this time you should communicate to the fire chief that your ambulance is en route to the flight-line area if responding to an in-flight emergency (IFE) or to the actual site for ground emergencies. If responding to an on-base crash, you must let the fire chief know the direction of your arrival to avoid any hazard such as smoke or fumes. The driver of the vehicle must exercise safe driving practices. You must obey all the traffic laws on your base and of those in your local community. Speed does not save lives. Responding to an ambulance call does not instantly qualify you to become a speed racer. If driving on wet roads, speeds of 30 mph or above may cause hydroplaning. This gives you little or no control over the vehicle. If hydroplaning occurs, you should gradually slow down without jamming on the brakes. While driving on the flight line, you must not exceed 15 miles per hour. As you approach, pass, or otherwise come near an aircraft, the maximum speed of any vehicle must not exceed 5 miles per hour. The information provided here is only an introduction to responding to a flight-line incident. You must have specific training to drive on or around the flight line! Flight-line driving courses are normally held at bases with an active runway and flying mission, and training is conducted for both day and night response to the flightline. As you can imagine, the flight line looks completely diferrent at night when all the runway lights are on, flashing and different colors!

Use of lights and sirens for responses to emergencies depends on local protocol. Before you jump into the driver’s seat, make sure you are totally familiar with the guidelines set at your base. Right-of-way privileges granted to an ambulance may vary from base to base as well. Here again, check with your local safety office to find out what is expected of you as a driver of an emergency vehicle. Regardless of location, intersection accidents are the most common and usually the most serious type of collision in which ambulances are involved. Be careful!

Arrival

Once you reach the scene or “stand-by” area, let the fire chief know that you have arrived. The fire chief will tell the driver where to safely park the vehicle. If applicable, you can do an initial scene sizeup and request additional help from the medical facility if there are multiple casualties. You should begin the triage process to identify and then treat the most seriously sick or injured patients.

Transfer to the ambulance

Only after lifesaving care (clear an airway, use of an AED, apply bandage to a hemorrhage, etc.) has been given should a patient be moved to the ambulance. An exception would be a multiple trauma patient with suspected internal bleeding or a severe head injury that is a “load and go.” Less critical care can be given en route to the medical treatment facility (MTF). Be sure the patient is secured to the stretcher or litter with at least two straps across the body before lifting and loading into the vehicle.

Transport to the treatment facility

At this point you must report the number and severity of the patients you are moving to the receiving facility. Ongoing care, assessments, and reassurance can be provided to the patients while en route.

Delivery and postrun

The driver of the ambulance will be in contact with the treatment facility periodically during transport. He or she will relay an estimated time of arrival along with the current status of the patient, or patients, on board. Once the patient is transferred to the hospital or clinic and the patient is no longer in your care, your duties are not over. You and the other ambulance crewmembers must clean and disinfect the unit and any equipment used as soon as possible. You must restock the vehicle with any needed supplies and, if necessary, refuel the vehicle.

The satisfaction associated with a successful ambulance run is hard to match. The personal growth and team cohesiveness derived from helping people in need is truly a highlight in a 4N0X1's career. Unfortunately, not all calls result in a life saved. When you return from an accident site, especially when fatalities are involved, emotions are often still running at full throttle. Some members of your team may experience extreme emotional upset. It is a good idea, and common practice, to have group discussions of personal feelings and lessons learned from the field. Many offices hold what is called a critical incident stress debriefing (CISD) to "air out" or "vent" feelings that may hinder a person's further growth or well being. The CISD should be conducted as soon as possible following the incident, and representatives from Mental Health or the base Chapel Service are routinely involved in the process. If you or someone you know ever feels overwhelming depression following an ambulance call—or at any time for that matter—let your supervisor know about it. To do nothing would be a great disservice.

Ambulance log/run sheet

At the end of each run, the ambulance driver is responsible for ensuring completion of the necessary information in the log. The information should include:

- Run number based on the current month.
- Date.
- Name of ambulance driver.
- Name of person requesting the ambulance.
- Telephone number of requester.
- Name of the patient to be transported.
- Last four of the SSN of individual or sponsor.
- State the patient's chief complaint or problems.
- Location from which the call was received.
- Time out.
- Time of arrival at destination.
- Returning time.
- Time of arrival back at the hospital.
- Total time taken for the run.
- Code priority assigned to scene.
- Code priority utilized returning to the hospital.
- Destination of ambulance.

The log is maintained on a clipboard in the ER. At the end of the month, the logs are compiled and given to the superintendent of the flight for filing.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

028. Response Preparation

1. As a *minimum*, how often should the crash ambulance be checked?

2. How much vacuum must suction units provide when the tube is clamped?

3. Why should ventilation masks be transparent?

4. What types of litters should be carried in an ambulance?

5. Why should equipment and supplies be checked daily?

6. What equipment or areas commonly have a daily checklist?

7. What items in an IV tray or cart require expiration date checks?

8. Where should fluids be stored in a treatment room? Why?

029. Ambulance response

1. How should equipment and supplies be stored in the ambulance?

2. What is the responsibility of a dispatcher?

3. What is a code 3 response?

4. What type of information is considered inappropriate for transmission over the radio?

5. If you are driving your ambulance and you notice that it is hydroplaning, what should you do?

6. When not near aircraft, what is the *maximum* speed limit on the flight line?

7. What is the *maximum* speed limit while driving near an aircraft?

8. During what phase of an ambulance call do you accomplish an initial scene sizeup?

9. What are the *minimum* number of straps used to secure a patient to a litter or stretcher?

10. When should the CISD occur?

11. Who is responsible for completing the information in the ambulance log?

5–2. Patient Assessment

As previously mentioned, you will encounter a variety of patients for which you must learn to make quick and accurate assessments and provide quality care. Understanding how to quickly assess a patient, beginning with the scene size-up through the history and physical will help you identify life threatening problems and enable you to act swiftly. To help you attain a balance of care and speed, we will take a look at the initial trauma and medical patient assessments and the detailed physical exam. Keep in mind these techniques can be used whether in the field, the emergency room, or any clinic you may be assigned to. This system does away with time-consuming, comprehensive assessments and focuses on what is important for the patient at that time.

030. Scene sizeup

Considered the first part of patient assessment, the scene sizeup is basically a survey performed by you at the emergency scene to provide valuable information. You must quickly determine threats to yourself, patients, and bystanders. It is also the time you determine the need for additional help.

Scene sizeup

Sizing up the scene takes into consideration the following five important aspects:

1. The need for body substance isolation (standard precautions).
2. Scene safety.
3. Need for additional resources.
4. Mechanism of injury.
5. Determining the number of patients.

Standard precautions

First, determine the necessity for body substance isolation (standard precautions). At this point, you need to put on your disposable gloves and protective eyewear or a mask to protect you against contacting a bloodborne pathogen.

Scene safety

Second, and most important, determine scene safety. Scan the area for dangers, infection control concerns, and hazardous materials. As you near the accident scene, look and listen for other emergency service vehicles. Be observant; look around to see if the power is out in any buildings close to the accident. Look for downed wires. Be aware of the flow of traffic. If there is any smoke coming from the scene, this could mean the possibility of fire. Look for vehicle hazardous materials placards on trucks; be alert to any suspicious looking vapor clouds. If there is a possibility of a HAZMAT, stop—do *not* enter the *danger zone*. As you get closer to the scene, look for victims that were thrown from the vehicle or who walked away and collapsed. Continue to use your sense of smell to determine the possibility of spilled gasoline or diesel fuel.

Danger zone

The danger zone is established to define an area in which special safety precautions must be taken. Establishing the danger zone is imperative when there are downed wires, a vehicle fire, or a hazardous material spill. Even when there are not any signs of hazards, this zone is considered 50 feet in all directions of the accident scene. Never park the ambulance within this zone. This is important to avoid glass, debris, and not to get in the way of other emergency vehicles.

Downed lines

When downed wires are involved, the danger zone extends beyond each intact pole for a full span and to the sides for the distance that the severed wires can reach. Stay out of the danger zone until the power company deactivates them.

Vehicle fires

When there is an apparent fire, park the ambulance no closer than 100 feet from the burning vehicle.

Hazardous materials

Park upwind from the scene, and if possible, stay 2,000 feet away. The distance from the scene depends on the hazardous material and the threat of fire or detonation of explosives. There is more information related to hazardous materials in unit 5.

Crime scenes and acts of violence

In these times, violence and crime headlines are most of the news we hear. As an emergency medical technician (EMT), you must be aware of dangers from many sources. Protecting yourself from the dangers of weapons and domestic violence is as important as protecting yourself from hazardous materials. As medics in the armed forces, depending on where you work, a crime scene can be as dangerous as retrieving a casualty from the battlefield. As you get close to the scene, be alert for fighting or loud voices, visible weapons, signs of drug or alcohol use, and unusual silence. If the situation seems risky, retreat to an area of safety and call for help from the Security Forces.

Mechanism of injury or nature of illness

For trauma patients, what caused the injury? Commonly, the mechanism of injury is the only ingredient you have to go on when determining the possible injuries of the unconscious patient. Knowing what caused the injury helps you determine what care to provide. This is especially true when caring for the motor vehicle accident victim. Take into consideration whether it was a head-on collision, rollover, or rear-end collision. All of these determinations help you in your care. For medical patients, information of the nature of the illness can be gathered from the patient, family members, bystanders, and the scene itself.

Number of patients

The number of patients helps you determine if you need more help. Sometimes family members may be so upset with the situation you end up with two patients rather than one. The number of patients could also lead you into a triage situation. As we mentioned in CDC 4N051A, volume 3, the triage process begins as soon as the first person with medical training arrives at the site of the mass casualty. In the civilian community, this may be anybody from a policeman or firefighter with first aid training to a doctor. Most commonly, the triage process is initiated by an EMT or paramedic. If there are several EMTs at the scene, the senior or most experienced one is responsible for conducting the triage. When a more experienced or more qualified person arrives on the scene, he or she takes over the duties as triage officer.

031. Administer initial assessment

The initial assessment is designed to identify and treat life-threatening conditions and to set your priorities for continued assessment, treatment, and immediate transport. Following are the six parts to the initial assessment:

1. General impression.
2. Mental status assessment.
3. Airway assessment.
4. Breathing assessment.
5. Circulation assessment.
6. Determination of priority.

General impression

Look, listen, and smell! Forming a general impression helps determine the seriousness of the patient’s condition and sets priorities for care and transportation. When forming your general impression, look at the scene for clues as to the mechanism of injury. Look at the patient’s position. Look at the patient to determine sex and possible age. What is the chief complaint? Listen for sounds of crying, moaning, snoring, or gurgling respirations. Smell to determine hazardous materials, urine, feces, vomitus, alcohol, or decay.

Mental status assessment

Mental status assessment is also referred to as level of responsiveness. The patient’s neurological status or level of consciousness can generally be described by using one of the terms on the *AVPU scale*. As described below, this scale is an evaluation of the patient’s ability to move and level of consciousness.

A—alert

The patient’s eyes open spontaneously and he or she answers questions in a clear manner. If the patient knows his or her name, the date, and the location, the patient is said to be *oriented*.

V—responsive to verbal stimulus

The patient's eyes do not open spontaneously and he or she may not be oriented to time, date, and person, but the patient responds in a meaningful manner when spoken to.

P—responsive to painful stimulus

The patient does not respond to verbal stimuli but he or she moves or cries out in response to pain. The response to a painful stimulus is tested by *gently* but firmly pinching the patient's skin. (Do **NOT** attempt to press on the supraorbital space or other areas that may cause permanent harm.) An appropriate response is withdrawal from the stimulus. If the patient is paralyzed in an extremity, the examination is not valid for that extremity. Extremely painful stimuli should *never* be applied to the patient.

U—Unresponsive

The patient does not respond to painful stimuli. Be very alert for any indication that the patient has a head or neck injury. As we mentioned, the car windshield may be cracked or the patient may complain of head or neck pain, numbness or tingling in an extremity, or have difficulty moving an extremity. If there is any indication of such an injury, stabilize the patient's neck with a cervical collar or a rolled blanket before continuing with the examination. If you are working with another person, have him or her guard the cervical spine to prevent any movement. Rough or careless handling of a patient with cervical spine injuries can cause immediate paralysis or even death.

As you are conducting your neurological or disability examination, note exactly what the patient does rather than trying to interpret his or her movements. The words "pulls away from painful stimuli" is much more meaningful than the terms "lethargic" or "stuporous", which are also open to individual interpretation.

Airway assessment

An open airway is necessary for any kind of oxygen and carbon dioxide exchange. Checking the airway is usually quick and easy. If the patient is talking clearly or crying, you know the airway is open. Factors that can obstruct the airway and prevent that exchange include the following:

- Positioning.
- The tongue.
- Dentures or teeth.
- Food particles.
- Blood or secretions.

If the patient is unconscious, the jaw muscles relax, which allows the tongue to fall back and obstruct the airway. To correct this, simply open the airway using one of the techniques learned in EMT training. If you are sure the patient does not have a spinal injury, use the head-tilt, chin-lift maneuver to open the airway. If there is even a remote possibility the patient has a spinal injury or if the patient is unconscious, use the jaw-thrust method instead. Do finger sweeps to remove debris and suction if necessary (do not perform blind finger sweeps on infants). Consider putting oral or nasal airways in place to ensure the airway remains open.

Breathing assessment

Once you open the airway, check for patency by placing your ear over the patient's mouth, *listening* for breathing, *feeling* for air against your cheek, and *looking* for the rise and fall of the patient's chest. If there are still no breath sounds, begin rescue breathing. If the patient is breathing but the airway is partially obstructed by dentures, secretions, or other substances, clear the airway by using a finger sweep. If the patient is not alert (V, P, or U on the AVPU scale) and his or her breathing is slower than eight breaths per minute, provide ventilations with a bag-valve-mask (BVM) and high-flow (100 percent) oxygen. If the patient is alert and his or her breathing rate is faster than 24 breaths per minute, give high concentration oxygen by a non-rebreather mask.

The most common cause of airway obstruction in the conscious patient is large, poorly chewed food particles. If the patient is showing signs of airway obstruction (cyanosis, inability to speak, and hands grasping at the throat), begin the Heimlich maneuvers.

If the patient is breathing, note the characteristics of the breath sounds. Does the patient appear to have difficulty breathing; is the breathing rapid and shallow or deep and gasping; or is there some sort of abnormal breathing pattern (Cheyne-Stokes, Biot's, etc.)? Observe the skin coloration. Is the patient's skin *cyanotic*, indicating poor oxygen exchange, or is it *cherry-red*, indicating carbon monoxide poisoning?

Circulation assessment

Once you establish an airway, the next step is to assess pulse, observe for external bleeding, and assess the characteristics of the skin. Determine if there is a pulse present (this step can often be accomplished simultaneously with the airway checks). If the patient is conscious, check the radial pulse. You might not be able to find a radial pulse if the patient is in a state of shock or if the radial artery is obstructed by a fracture or laceration. If so, palpate the carotid pulse instead. The carotid pulse is much stronger and persists even when the patient is in shock. If you are unable to locate the carotid pulse, begin resuscitation immediately. If the patient is unconscious, check the carotid pulse as you learned in Basic Life Support (BLS). As you palpate the pulse, check for abnormalities in rate, rhythm, or volume. Then, check and control bleeding. Quick control of severe external bleeding can be life saving. Look at the patient's skin—is it warm and dry or pale and clammy (cool and moist)? These signs are indications of poor circulation. Such abnormalities may indicate shock, heart attack, or other cardiovascular problems.

Determination of priority

When the process of assessing and caring for life-threatening problems is complete, decide on the patient's priority for immediate transport to the hospital. Some situations that need immediate transport are:

- Poor general impression, unresponsiveness, responsive but not following commands.
- Difficulty breathing.
- Shock.
- Complicated childbirth.
- Chest pain with a systolic blood pressure less than 100.
- Uncontrolled bleeding.
- Severe pain anywhere.

At this point, your initial assessment may take a different avenue for intervention depending on the answers to the following questions:

- Does the patient have a medical problem or a trauma problem (injury)?
- Is the patient responsive or unresponsive?
- Is your patient an adult, child, or infant?

032. Trauma patient history and physical

Once you complete your initial assessment and determine there are no immediate life-threatening injuries, you have more time to assess the patient at the scene. Your first step is to *reconsider the mechanism of injury*. Depending on whether the mechanism of injury is significant or not significant determines your next steps. Look at figure 5–3 as we study the history and physical for the trauma patient. First, your actions are discussed about when the mechanism of injury is not significant.

No significant mechanism of injury

In your reconsideration of the mechanism of injury, look around again to determine other clues that will assist you in treating your patient.

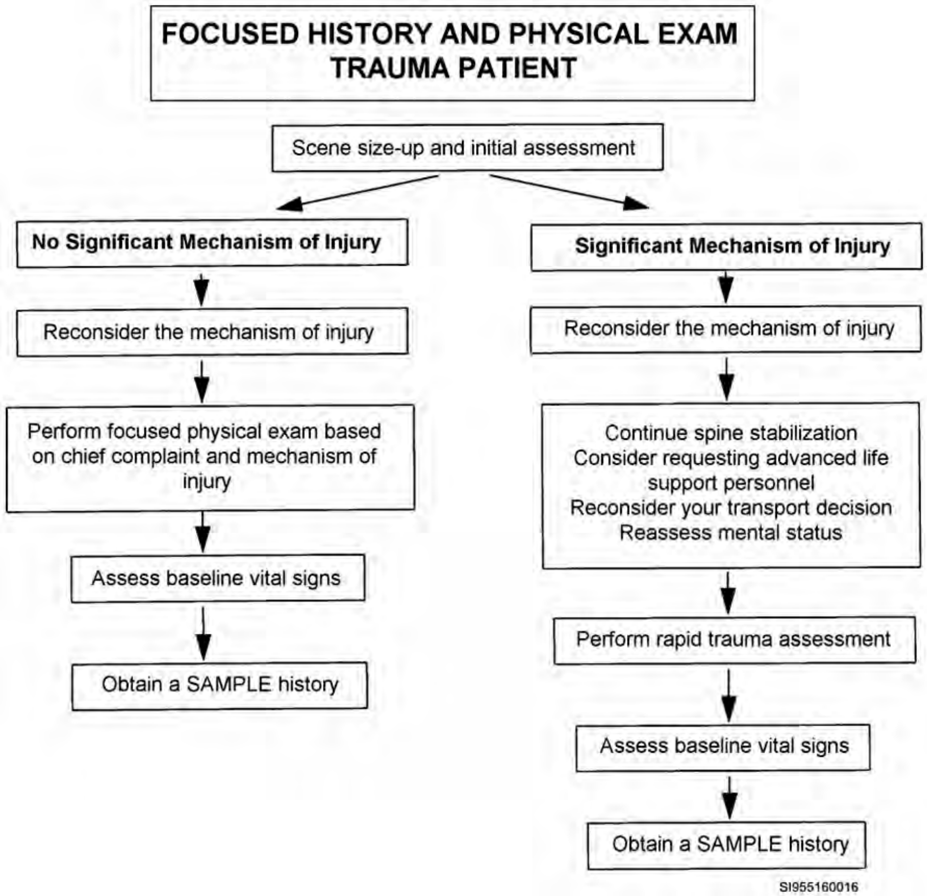


Figure 5–3. Focused history and physical exam trauma patient.

Focused physical exam

To perform the focused physical exam, you must take into consideration the patient's complaint and the mechanism of injury. Focusing on the chief complaint, assess only those areas that the patient is complaining about. For example, if the patient's chief complaint is pain in the head and knee, you examine the head, neck, and knee. While your partner holds the neck still, you inspect and palpate those areas of concern. Since you suspect a spinal cord injury, apply the cervical collar now. During your inspection, look for contusions, abrasions, punctures, penetrations, burns, and lacerations. Palpate for deformities, tenderness, and swelling. *Brady* suggests the use of an acronym called DCAP-BTLS, pronounced "Dee-cap, B-T-L-S":

1. D—Deformities: body shapes that no longer appear normal.
2. C—Contusions, bruises.
3. A—Abrasions, scrapes.
4. P—Punctures or penetrations—holes in the body.
5. B—Burns, reddened, blistered, or charred skin.
6. T—Tenderness—areas of pain identified by the patient during palpation.
7. L—Lacerations, cuts, open wounds.
8. S—Swelling, enlarged edematous areas.

Any patient with a suspected spinal cord injury needs the application of a cervical collar. Keep in mind one rule to determine if a cervical collar is needed. Brady states, "If the mechanism of injury exerts great force on the upper body or if there is any soft tissue damage to the head, face, or neck from trauma, you may then assume that there is a possible cervical spine injury." Also "any blow above the clavicles, or if there is a depressed level of consciousness, apply a cervical collar."

Since you learned the procedure for applying a cervical collar in technical school, a step-by-step procedure is not discussed again here, but keep the rules in mind. Assessment of the neck is important prior to applying the collar. Provide reassurance to the patient; explain what you are doing. Make sure you have the right size. Remove necklaces and earrings prior to application. Keep the patient's hair out of the way. Lastly, keeping the head in the correct anatomical position is most important.

Vital signs

Take the patient's vital signs. If your patient is stable, take vitals at least every 15 minutes. For unstable patients, take vitals every 5 minutes.

Sample history

Important information gained from your patient is information about the present problem plus his or her past medical history. The present problem includes signs and symptoms. The past history includes allergies, medications, disease, conditions, etc., and all have an effect on the outcome of the patient's problem and treatment that he or she receives. You should also find out what the patient last had to eat as well as any events that led up to the current problem. A good way to remember all these questions is through the use of the word "SAMPLE":

- **S**—Signs or symptoms.
- **A**—Allergies.
- **M**—Medications.
- **P**—Pertinent past history.
- **L**—Last oral intake.
- **E**—Events leading to the illness or injury.

As you can see, there is some overlap between this approach and our previous discussion of the chief complaint. Because your time is already fairly tight, avoid duplication of effort whenever possible. To avoid this duplication, follow local protocol and your own inclinations regarding specific questions for the chief complaint and current medical problems.

Transport

Transporting the patient is the last step in this process, which is discussed later in this unit.

Significant mechanism of injury

In your reconsideration of the mechanism of injury, once again look around to determine other clues that will assist you in treating your patient. Was the patient thrown from a vehicle or did he or she fall more than 15 feet? Did the vehicle roll over or how fast was the vehicle going? Was anyone hit by a car? Look at all these factors because they indicate to you the types of injuries you can expect your patient to have.

NOTE: If you determined during your initial assessment that there was a possibility of a spinal cord injury, someone should stabilize the head.

During this part of the assessment, determine the need for advanced help. Once again, ask yourself, "Does this patient need to be transported now?" Last, reassess the patient's mental status using AVPU, as mentioned in the previous lesson: alert, verbal, pain, unresponsive.

Rapid trauma assessment

Using your senses and considering the mechanism of injury, perform assessment or evaluation of the areas of the body that are the greatest threat to the patient. After assessment of the head and neck using DCAP-BTLS, size and apply a cervical collar. Now move on with your rapid trauma assessment to the chest. Check for DCAP-BTLS, crepitus, breath sounds, and paradoxical motion. Remember, paradoxical motion is movement of part of the chest in the opposite direction from the rest of the chest. This is a sign of a "flail chest."

Moving on to the abdomen, check for DCAP-BTLS, firmness, softness, and distention. Distention and firmness of the abdomen can be an indicator of internal bleeding. Next, assess the pelvis for DCAP-BTLS. Check for bleeding and priapism. A priapism is a persistent erection of the penis, which suggests a possible spinal cord injury or other medical problems. Quickly assess the extremities for DCAP-BTLS, distal pulses, sensation, and the patient's ability to move. Ask the patient to squeeze your fingers and to move his or her feet against your hands. As you now log-roll the patient and check his or her back using DCAP-BTLS, a backboard is placed under the patient. This is done to prevent rolling the patient twice—once for inspection and another time for placement of the backboard.

Vital signs

Quickly obtain the patient's baseline vital signs.

Sample history

As discussed with the "no significant mechanism of injury," obtain a SAMPLE history. One exception is, since the patient cannot give you his or her signs and symptoms, use the S to mean "story."

Interventions and transport

Transporting the patient is the last step in this process.

033. Medical patient history and physical

After completing the initial assessment, you may determine you have a medical patient. Using the patient's chief complaint, move on to the history and physical. Follow figure 5–4 as we discuss the focused history and physical exam for a medical patient. When considering which route to take, first determine if the patient is responsive or unresponsive.

Responsive medical patient

Using the AVPU scale, perhaps you have determined your patient is responsive. He or she is alert and oriented, and does not have any life-threatening problems. There are four parts to the focused physical exam to be accomplished:

1. Gather history of the present illness.
2. Gather SAMPLE history and physical.
3. Conduct focused physical exam only on the areas patient complains about.
4. Obtain baseline vital signs.

Gather history of the present illness

Use simple conversation with the patient to gather the history of the present illness. You must determine the chief complaint. If the patient complains of pain, Brady defines an excellent acronym to help you remember all the information you need to gather regarding the pain. It is called the OPQRST (in alphabetical order) memory jog:

- O-Onset—What was the patient doing when the pain started?
- P-Provoke—What is the cause of the pain? What affects it or makes it feel better or worse?

- Q-Quality—What does the pain feel like? Describe it as sharp, dull, burning, stabbing or crushing.
- R-Radiation—Does the pain spread from one part of the body to another? Cardiac pain, for example, is commonly characterized by radiating to other areas such as the jaw or shoulder.
- S-Severity—Is the pain moderate, mild, or severe? Again, this is strictly a matter of individual interpretation.
- T-Time—Is the pain constant or intermittent? Has the pain occurred before? When did it start, how does the intensity change, and how long does the pain last?

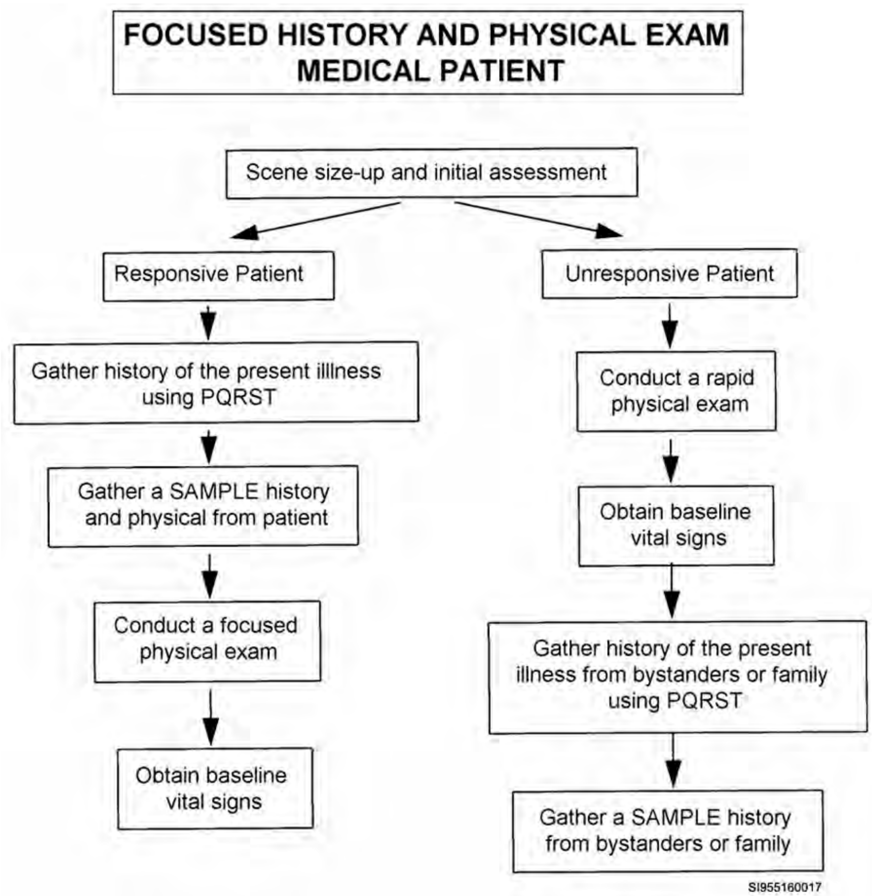


Figure 5–4. Focused history and physical exam medical patient.

Gather a sample history and physical

Now you can gather the SAMPLE history—signs or symptoms, allergies, medications, pertinent past history, last oral intake, and any events leading to this illness. In some cases, you may have a patient with medical problems and *no* known prior history. In other cases, the patient may have a history of the same problem. If so, he or she may possess prescribed medications that you can administer for intervention.

Conduct focused physical exam only on the areas patient complains about

For the responsive medical patient, focus your exam on the areas of the patient's complaints. For example, if the patient complains of abdominal pain, examine his or her abdomen.

Obtain baseline vital signs

Perform vital sign assessment and record your findings. Now, administer interventions and transport the patient.

Unresponsive medical patient

Obviously, the patient cannot talk to you, so for the unresponsive patient, first conduct a rapid physical exam and obtain the patient's vital signs, look for a medic alert device or Vial of Life identification, and ask family or bystanders for information.

Conduct rapid physical exam

Rapidly conduct a physical exam starting with the head and moving on to the neck, chest, abdomen, pelvis, extremities, and posterior. Use DCAP-BTLS while performing your assessment. Other considerations for the medical patient include distended neck veins; presence and quality of breath sounds; distention of the abdomen, patient incontinence of urine or feces; and extremity pulses, sensation, and motor functioning. With the unresponsive medical patient it is imperative for you to be alert for medical identification devices.

Medical identification devices

Many people have chronic medical conditions that could be adversely affected by certain medical procedures (i.e., allergies to penicillin). Anaphylactic shock and death could result from inadvertent administration of penicillin. Because of this and other equally serious reactions, a nonprofit organization has devised a system called "Medic Alert" to alert health care providers to these hidden conditions. Patients are given a Medic Alert card, tag, necklace, or bracelet, such as those illustrated in figure 5–5. The device has the Medic Alert emblem on one side and information about the patient's condition and the toll-free number of the organization on the other. Look for these devices when you are doing the primary survey and other assessment procedures. Be especially alert if you are caring for the unconscious medical patient or one who is otherwise unable to communicate.

The *Vial of Life* program is very similar to the Medic Alert system. Patients fill out a form (fig. 5–6) containing pertinent medical information. This form is then placed in a small prescription-type bottle or vial and stored in the home refrigerator or similar location. Stickers are placed on the entrance to the home and on the storage location to inform medical personnel that the vial is present.

Figure 5–5. Medical identification device.

Figure 5–6. "Vial of Life" sticker, information, and medication.

Obtain baseline vital signs

Now obtain the baseline vital signs.

Gather history of the present illness

Use the OPQRST acronym to gather information from family members or bystanders. Remember, these letters represent onset, provokes, quality, radiation, severity, and time.

Gather a SAMPLE history

As previously explained, use SAMPLE to gather information regarding the patient's history. Once you complete these steps, provide appropriate interventions and transport the patient.

034. Gaining access

The previous units prepared you for assessing the patient in an emergency, but what happens if your patient is trapped in a vehicle or building? This unit is geared to assist you in safely gaining access to your victims and safely transporting them to a facility.

Scene preparation

Extrication is the process by which entrapped patients are rescued from vehicles, buildings, tunnels, or other places. Below is a recommended 10-phase process that should be understood by all emergency medical technicians:

1. Prepare for the rescue.
2. Size up the situation.
3. Recognize and manage hazards.
4. Stabilization of the vehicle.
5. Gain access to the patient.
6. Provide initial patient assessment and a rapid trauma exam.
7. Disentangle the patient.
8. Immobilization and extrication of the patient.
9. Provide a detailed physical exam, ongoing assessment, treatment, and transport.
10. Termination of the rescue.

Size up the situation

As discussed earlier, the scene sizeup involves the need for additional personnel, police, fire or specialty rescue response teams, or services such as the power company.

Recognize and manage hazards

Hazards can range from broken glass and debris, slippery roads, inclement weather, darkness, to severe threats to safety such as downed wires to hazardous material spills and fires. Wear the proper clothing to safeguard against hazards. Most emergency room personnel are dressed in the airman battle uniform (ABU). This is considered a uniform for situations where hazards are minimal. Most fire departments wear full protective gear that prevents injuries from fire and glass. Other protective gear worn by emergency personnel includes helmets, face shields or goggles, hand protection such as latex gloves under leather gloves, to full body protective gear.

Protection of the patient

You may have to shield the patient from further injury at the accident scene, especially during extrication. Rescue blankets are designed to protect the patient from flying debris and weather. Short and long backboards help protect the patient from contact with tools. Protective gear, as discussed above, can also be used to provide protection for the patient.

Traffic hazards

Most traffic control is done by the police or firefighters. Read your local operating instructions for the use or nonuse of flares.

Electrical hazards

Downed power lines are extremely dangerous. Keep yourself and any spectators in a safe zone until a power company representative assures you the power is off and the rescue scene is safe.

Vehicle fires

Extinguishing a vehicle fire is the responsibility of firefighters. Small fires can be contained by using a 15 or 20 pound class A:B:C dry chemical fire extinguisher. Make sure you have on full protective gear before attempting to put out a fire.

Hazardous material

According to the US Department of Transportation (DOT), a hazardous material (HAZMAT) is "any substance or material in a form which poses an unreasonable risk to health, safety, and property when transported in commerce." Do *not* attempt a rescue when an accident involves hazardous materials unless you have been trained to do so, have the proper equipment, and have the personnel necessary to ensure a safe scene. Special training is needed to understand hazardous materials, work at the scene of incidents involving hazardous materials, and render the scene safe. Should you arrive first at the scene of a hazardous materials accident, establish a "danger zone" and a "safe zone." Keep all people out of the danger zone. Stay in the safe zone until an expert arrives to make a scene determination. The safe zone is at the same level as, and upwind from, the hazardous materials accident site. You may be thinking, "How do I know if the accident scene involves hazardous material?" There is usually a colored placard (fig. 5–7) on the vehicle, tank, or railroad car. This placard has a four-digit identification number used to identify the hazardous material being carried. The emergency room or local dispatcher may have access to the name of the material through this identification number. Do not get close to the scene; use binoculars to read the numbers, then call the emergency room.

Figure 5–7. Hazardous materials placard.

Another placard system used to determine types of hazardous materials is the National Fire Protection Association (NFPA) 704 System (fig. 5–8). As an EMT at the scene of a HAZMAT incident, you have two responsibilities—take care of the injured and monitor and rehabilitate the HAZMAT team members.

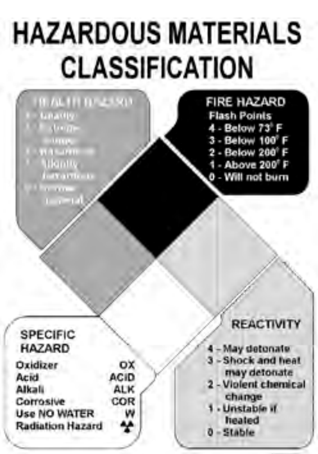


Figure 5–8. National Fire Protection Association.

Stabilization of the vehicle

Consider all collision vehicles as unstable, or rather capable of moving or falling over during extrication. Fire department personnel are trained in vehicle stabilization. This means they know when and where to place wheel chocks, cribbing, or jacks to prevent the vehicle from shifting during the rescue.

Gaining access to the patient

Access to the patient can be as simple as opening the car door, or it can be a highly complex access which needs power tools to break windows. Once the window is broken, a properly dressed EMT can crawl into the vehicle and assess the patient. As an emergency medical person, your primary responsibility is patient care.

Disentangling the patient

Disentanglement is a three-part plan performed by trained rescue personnel, usually firefighters. This means that, whenever possible, specialists such as fire rescue personnel do the cutting, prying, and lifting necessary to extricate the patient from the wrecked car, crashed plane, collapsed building, and so forth. While they do this, you stabilize the patient and prepare him or her for removal and transportation to the hospital. The three-part plan you should be familiar with includes the following:

1. Gain access by disposing of the roof.
2. Create exitways by displacing doors and roof posts.
3. Disentangle occupants by displacing the front end of the vehicle.

This is the usual order for attempting access to the patient; all three steps may not have to be taken.

Immobilization and extrication of the patient

Sometimes you will have to extricate a patient rapidly from a threatening situation without full consideration of his or her injuries or without proper immobilization. Even under extreme circumstances, try to ensure you have enough help available to manually stabilize all the patient's injuries and the efforts of the other rescuers are coordinated under your direction. Whenever possible, take time to stabilize the patient with appropriate immobilization techniques.

Immobilization techniques

Manual in-line stabilization for the head and neck is performed by the EMT first gaining access to the patient. If necessary, this stabilization is done during assessment of the airway, breathing, and circulation. Remember, the jaw-thrust is used for suspected spinal injury. After the focused trauma exam, apply a rigid cervical collar. For the seated patient, use a short backboard or Kendrick Extrication Device (KED) (fig. 5–9) for extrication purposes. It is usually somewhat difficult to totally immobilize the patient's head with the short backboard. You may want to consider using a device such as the KED to extricate a patient from the sitting position. The device actually wraps around the patient to provide much more support than is available from a short backboard. A particular sequence must be followed in all applications, whether you are using a short spine board (fig. 5–10) or a flexible extrication device. First, position the device behind the patient; secure the torso first and the head last. This approach offers greater stability throughout the strapping process and may help prevent compression of the cervical spine. Next, evaluate torso fixation and pad the area behind the neck as necessary (to keep the head and neck in line). If the patient has suffered abdominal injuries or displays diaphragmatic breathing that prevents adequate securing of the torso, the torso straps are still needed but care must be taken not to interfere with breathing.

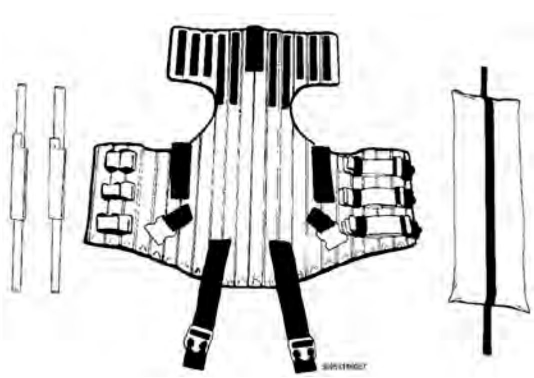


Figure 5–9. Kendrick Extrication Device

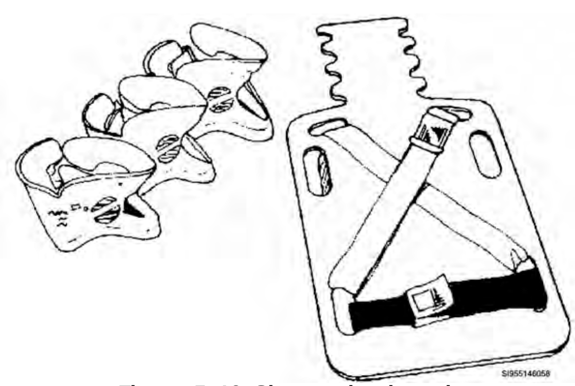


Figure 5–10. Short spine board.

Packaging, or preparing the patient for transfer as a unit (keeping full body alignment) is best handled by using a long backboard (spineboard) (fig. 5–11) or similar device. Such packaging converts difficult situations into easier ones. The boards are essential in moving patients with potential or actual spine injuries; they are helpful in other cases as well. When applying the long backboard, log-roll the patient onto the board. Immobilize the patient's torso to the board by securing the torso straps and then secure the legs and across the chest. Always secure the head to the backboard last just like the short board.

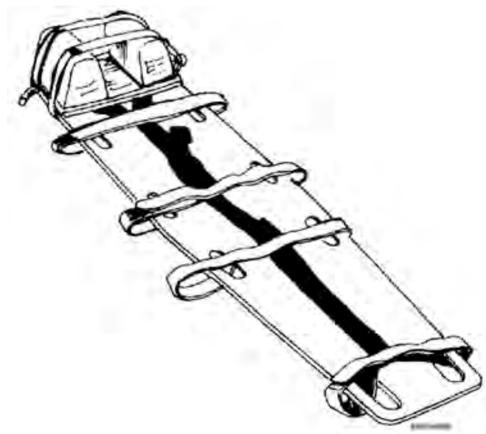


Figure 5–11. Long spine board.

Provide emergency medical care

Initial priority for emergency care is the ABCs (airway, breathing, and circulation), followed by definitive care as needed. If the patient needs CPR, he or she must be positioned supine on a hard, flat surface. CPR is not effective if the patient is in the sitting or prone position. If the patient is in an automobile (or anyplace where there is a possibility of cervical spine injury), apply the cervical collar and backboard before moving him or her. Technicians must be careful to maintain traction on the patient's neck as they apply the immobilization devices. Only when the patient is properly secured do they move him or her out to the longboard.

Patient-handling techniques

Let's move on to moving and transferring patients in emergency situations. Techniques include one-rescuer carries, two-rescuer carries, and three- or multiple-rescuer carries. The selection of techniques depends on the patient's problems or injuries, environmental risks, and limitations that could compromise technician and patient safety, availability of assistive equipment and manpower, and your own physical strength and technical capabilities and limitations. Whenever possible, assistive devices and equipment, such as stretchers, blankets, straps, splints, and so forth, should be used.

The most ideal situation is one in which you have plenty of skilled help when you are trying to move a patient. Even without specialized equipment, you can properly immobilize and protect the patient if you have enough help. In fact, the only way you can move patients with suspected spinal injuries is if you have plenty of help. One- and two-rescuer carries and drags do not provide the needed support and should only be used if the situation is desperate (these techniques are learned in the Self-Aid and Buddy Care course). The types of patient transfer techniques listed here are limited to medical and rescue personnel as training is provided on the other lifts and carries in another course. In-hospital transferring devices and techniques are covered in volume 2.

Carrying devices

There are numerous devices that can be used to help lift and carry patients. The army field litter (fig. 5–12) remains the standby in wartime and disaster situations. Other devices that can be used include the scoop stretcher, Stoke's basket, KED, stair chair, and standard ambulance stretcher. Each of these has advantages and disadvantages. For example, the scoop stretcher tends to pinch patients as the sides are brought together, and patients tend to become wedged into the Stoke's basket if you do not line it with a blanket before you load the patient. The choice depends entirely on the situation and availability of equipment. The SKED device may also be used. No matter what transfer device you are using, ensure you know how to use it properly and always ensure the safety of the patient and rescue personnel.

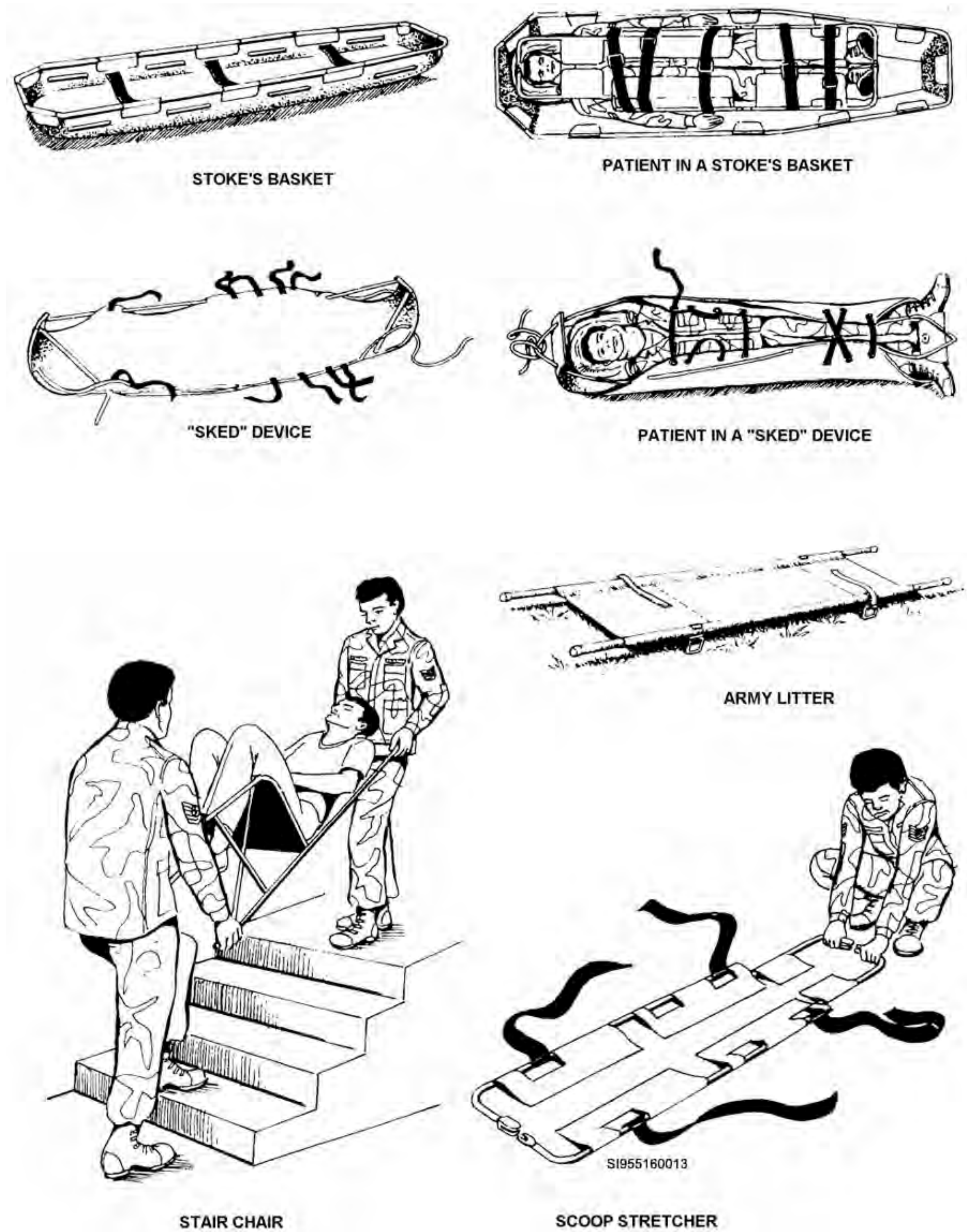


Figure 5–12. Carrying devices

Securing patients

Earlier we mentioned "packaging" the patient. Regardless of the type of device used, the patient must be properly secured. This usually involves the use of safety straps around the chest, waist, and knees. It also includes the use of blankets, pillows, and so forth. Occasionally, you have to use special techniques for patients that are very large, very small, or have special injuries. Figure 5–13 illustrates a packaged patient as well as carrying devices and techniques for moving a patient upstairs and loading him or her into an ambulance.

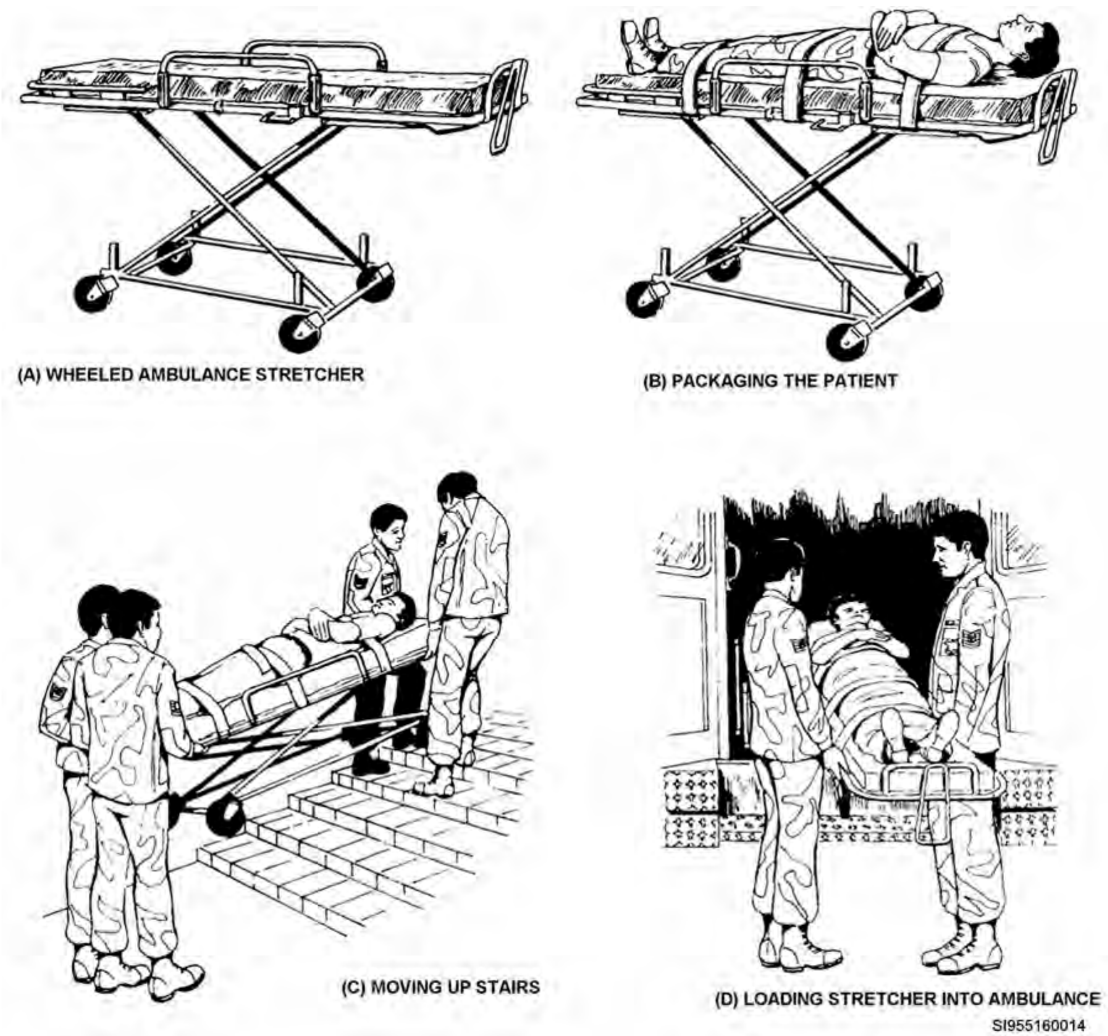


Figure 5–13. Litter techniques.

Moving patients

Before moving a patient, regardless of the setting (pre-hospital or inpatient), requires preparing the patient for transfer and maintaining continued control of all life-threatening problems, dressing all wounds, splinting all suspected spinal injuries, and immobilizing all suspected fractures. In some cases, there is not enough room to apply standard splints and other devices. If not, immobilize arms and legs until you can apply the proper splints by securing the patient to a backboard. Transfer of the patient from the injury site to the ambulance is usually accomplished with a long backboard or similar device and placed on a stretcher. In a military environment, the standard army litter is most commonly used for patient transfers.

Transfer of the patient

When moving a conscious patient, make sure you explain what you are doing and what obstacles you are moving around. This provides comfort for the patient and lets other rescuers know your direction of travel so they can assist or move out of the way. Once the patient is loaded on a stretcher and secured, raise the stretcher to full extension. A minimum of two persons is required to do this safely. Use both hands on the stretcher and roll at a constant speed. This method helps the stretcher roll smoothly at a safe constant speed and provides a safety measure in case the stretcher were to start to tip. Turn corners slowly to minimize patient discomfort and lift the stretcher over floorboards in doorways or uneven ground. Never leave a patient unattended on a wheeled stretcher, especially in a raised position because it will topple over very easily.

Ambulance loading

Once the patient has been packaged and wheeled to the ambulance, you should prepare to load the patient into the ambulance. Follow these easy steps to properly load a patient into the ambulance:

1. Clear any bags or equipment from the floor of the back of the ambulance.
2. Lift the rear step (most will lift up).
3. EMTs will normally position themselves across from each other on opposite sides of the stretcher and perform one of the following techniques:
    - Lower the stretcher to the lowest position, bend at the knee, and grab the lower bar of the stretcher then give the command and lift together with their backs straight.
    - Place the wheels at the head of the stretcher along the floor of the ambulance. Pull the lever to collapse the legs of the stretcher and slide the stretcher into the ambulance.
    - Some stretchers have the lever at the foot of the stretcher. If this is the case, use extra care to ensure you do not strain your back or tip the patient over. One EMT will be positioned at the feet and control the lever for the stretcher legs. Ask for assistance from rescue personnel and place a person on either side of the head for safety purposes. On command, pull the lever. One rescuer at the head should reach down and ensure the legs of the stretcher fold up and the third helps provide stability and guides the stretcher into the ambulance.

Alternatively, the method below places less strain on the EMT and is safer for the patient. EMTs are encouraged to use the assistance of other rescue personnel to lift the stretcher to provide greater stabilization of the stretcher and decrease the strain on the EMT. EMTs must use proper lifting techniques to minimize the risk of dropping a patient or incurring a back injury to themselves and other rescue personnel.

- EMTs will move in unison towards the ambulance and roll the stretcher into the ambulance.
- Secure the stretcher into the latching devices, and ensure the forward and rear catches are engaged to hold the stretcher.
- The EMT should be securely in the seat with a seatbelt on.

Ambulance unloading

1. Make sure all straps are secured on the patient.
2. EMTs should be opposite from one another (as in loading) or at least one at the head (preferably one on each side at the head) and one at the feet.
3. Release the stretcher-catch mechanism.
4. Slowly start rolling the stretcher towards the rear of the ambulance and engage the “leg” release.
5. “Legs” should come down and lock in place. Move footrests out of the way.

6. Roll the patient completely out of the ambulance while making sure the stretcher is secured in full extension. It is terribly embarrassing and potentially harmful if the legs of the stretcher do not engage and lock, causing the stretcher to come down with a crash!
7. Use the same techniques to take the patient into the facility as you used to wheel him or her to the ambulance.

Assisting a patient to and from a car

At some point you will probably be asked to help bring a patient in from a car. It is a good idea to ask what is wrong with the patient so you can determine whether a wheelchair is appropriate or if you will need to place the patient on a stretcher.

Preparing to assist patient into a wheelchair

If the patient is not feeling well but is conscious, a wheelchair will normally work well. It is a good idea to take a wheelchair with a security strap in case you do need to secure a patient to keep him or her from falling forward or to the side.

1. Move the wheelchair to the patient side of the car, open the door, and introduce yourself. It is best to ask if you can help the patient move into the wheelchair.
2. Lock the wheels of the wheelchair (this will keep it from sliding away from the patient as he or she attempts to sit down) close to you and the patient, but leave yourself enough room to support the patient and allow for proper body mechanics as you turn with the patient.
3. Ask the patient if it is okay if you place your hands under his or her arm or around the waist once he or she stands to keep him or her from swaying, falling over, or collapsing down.

Physically assisting patient into a wheelchair

1. Coordinate movements with the patient and try to make steady, smooth movements.
2. Assist the patient into the wheelchair, move footrests into place, and assist with foot placement.
3. Secure the patient with a strap if needed.
4. Release wheel locks and ensure the patient’s hands are on his or her lap or out of the way of the wheels and move the patient inside.

Alternate method

An alternate method uses two people. The process is the same except the second person will keep the wheels unlocked and move the wheelchair forward so the patient can turn and immediately sit down. As with most patient movements, it’s usually better to have more than one person to assist whenever possible.

Assisting patient from wheelchair into car

If you are assisting a patient from the facility to their car, the technique is essentially the same but in reverse order:

1. Wheel patient to the vehicle, leaving enough room to open the car door.
2. Lock the wheelchair and open the door.
3. Unlock the wheelchair and move it closer to the car and relock the wheels.
4. Position yourself next to the patient and coordinate your next move and ensure you can put your hands under the patient’s arms or on the waist for stabilization.
5. Move the footrest out of the way and use smooth, steady movement.
6. Assist the patient to the standing position and have the patient rotate his or her body to prepare to sit down into the car.

7. Remind the patient to watch his or her head prior to sitting down and assist him or her into the car.
8. Help situate the patient in the car and assist with the seatbelt if needed.
9. Make sure hands and feet are out of the way and close the door.
10. Give a warm goodbye and good luck!

Other patient movement devices and practices are covered in volume 2.

035. The detailed physical exam

The detailed physical exam is performed en route to the hospital. It is only done after the initial assessment, the focused physical exam, and any necessary critical interventions needed to stabilize the patient. The purpose of the detailed exam is to gather additional information to help in further interventions you may need to do and provide more information for the emergency room staff. In most cases, you only need to perform a detailed exam on a trauma patient with a significant mechanism of injury and less often on the trauma patient with no significant mechanism of injury. The detailed physical exam is seldom done on a medical patient.

Trauma patient with a significant mechanism of injury

After performing any critical interventions for the trauma patient, repeat your initial assessment of the patient. Keep in mind; life-threatening problems always take priority over the detailed exam. In many cases, you may be busy attending to the airway, breathing, and circulation and not have time for this exam. Now that the patient is in the ambulance, you can expose body parts to perform the detailed exam. The exam includes the following areas:

- Head.
- Neck.
- Chest.
- Abdomen.
- Pelvis.
- Extremities.
- Posterior.

Head

Examination of the head includes scalp or cranium, face, ears, eyes, nose and mouth.

Scalp or cranium

Palpate and examine the skull for deformities, contusions, abrasions, punctures, burns, tenderness, lacerations, and swelling (DCAP-BTLS). Also look for bleeding, tender areas, and crepitation. Palpate gently to avoid complicating any injuries, and check the back of the skull by sliding your fingers beneath the head and feeling for deformities or blood.

Face

The face should be symmetrical and the teeth should align when the mouth is closed. Asymmetry is an indication of a facial fracture. Palpate the facial structures, including cheekbones, forehead, and lower jaw, for any deformities or bleeding. Examine the eyes for discoloration, bruises, or swelling. Discoloration, or *raccoon's eyes,* is an indication of a skull fracture.

Ears

There should not be any fluids coming out of the ears. Blood draining from the ears is an indication of a skull fracture, as is cerebrospinal (clear) fluid draining from the ears. (Do not block any fluid that is draining. Doing so increases the intracranial pressure and increases the chances of brain damage.)

Examine the area behind the ears (mastoid process) for a bluish discoloration. Such a discoloration is called *Battle's sign* (fig. 5–14) and is an indication of a basal skull fracture.

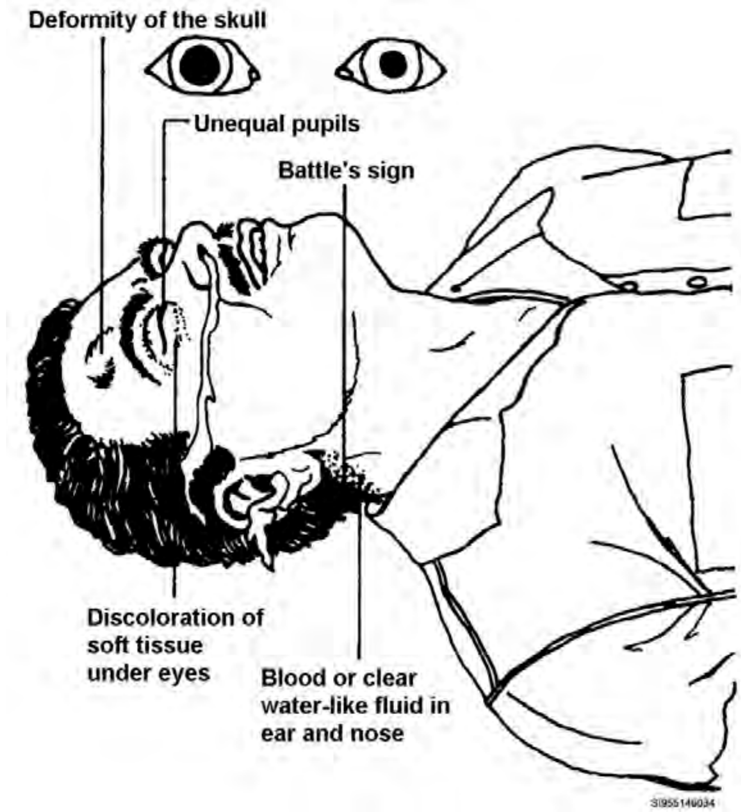


Figure 5–14. Battle's sign and other signs of skull injury.

Eyes

Yellow discoloration of the whites of the eyes is an indication of liver disease. Red discoloration (bloodshot eyes) is a sign of eye irritation or eye injury. Check the size and shape of the pupils. They should be round, regular in outline, equal, and reactive to light. Use a small flashlight to check the pupils. They should dilate in darkness and constrict when you expose them to light. If they are constricted before you shine the light, the patient may have central nervous system (CNS) damage or have recently taken narcotic medications. If the pupils are dilated when you expose them to light, the patient may be severely frightened, unconscious, in pain, hypoxic, or have suffered brain injury, a stroke, or took drugs such as atropine. Unequal pupils are usually an indication of a head injury or stroke. Do not discount the possibility of contact lenses or prostheses when you are examining the eyes. Either causes abnormal reactions to light or movement. The following information demonstrates the correct procedure for checking pupillary response. This procedure can be done in the MTF or in the field and is used in conjunction with other tests to measure neurological function, illness, or injury.

Purpose of pupil reflex testing

Pupillary reflex testing checks the visual afferent (sensory) pathway and the brain's efferent (motor) response to visual and light stimulus. Pupillary reflex tests are a simple but effective way to detect and diagnose the presence of cranial lesions in or near the visual pathway. Pupil testing can also help in detecting nerve palsy, nerve damage, systemic diseases, visual abnormalities, and more.

You can help detect the conditions just described and narrow down their causes by performing three simple pupillary tests:

1. The *direct* pupillary response.
2. The *consensual* pupillary response.
3. The *accommodative* pupil test.

Performing pupillary reflex testing

Perform pupillary reflex testing in a dimly illuminated exam room, with light distributed evenly throughout. The patient *always* looks at a distant target during pupil testing, with the sole exception being when you ask the patient to look at a near target to accomplish the accommodative test. Do not occlude the patient's eyes while testing.

When performing the pupil reflex tests, the rate and symmetry of pupil constriction should be the same in each eye. A difference in the rate and symmetry of pupil constriction between the two eyes indicates a problem.

A simple way to remember what you are looking for during pupil testing is to think of the acronym **PERRLA:**

- **PER** stands for "**p**upils **e**qual and **r**ound." This assessment begins even before you shine the penlight into the patient's eyes. You have the patient look at a distant target and you evaluate whether the pupils are equal and round, or is one larger than the other; maybe one is distorted or misshapen (i.e., oval).
    - When the pupils are different in size by 1 mm or more, the term used to describe the condition is *anisocoria*. Roughly, 10 percent of the adult population has anisocoria and is normal. This means it is not caused by any systemic disease or ocular condition. It could be something such as a corneal abrasion causing the difference, headache, or something as serious as a massive brain tumor. The point is, if you evaluate a patient and find the pupils are not equal, test and observe the patient very carefully. There may be a more complex reason for the unequal pupils.
- **RL** stands for "**r**eacts to **l**ight." You confirmed this after performing both the direct and consensual pupil tests.
- **A** stands for "**a**ccommodation", meaning the pupils responded when the eyes accommodated on a near target.

Direct pupillary reflex testing

In this test, you shine the transilluminator into an eye and observe the eye's reaction. Test the right eye first, and then switch to the left eye. The patient should be looking at a distant target while you do this test (fig. 5–15).

Position the transilluminator about 3–4 inches away from the eye to be tested. You need the light to be close so a good concentration of light enters the patient's eye and avoid getting stray light into the opposite eye. Keep the light contained or restricted to just the eye being tested. Now shine the light into the eye and note the rate and symmetry of constriction of that pupil. Now shut off the light and note the rate and symmetry of re-dilation.

If you shine the light in an eye and the pupil in that eye gets smaller and then re-dilates when shutting off or removing the light, the patient has a normal direct response. Be sure to test both eyes before moving on to the next test. If you do notice a difference in the rate and symmetry of pupil reaction between the two eyes, note which eye reacted slower or to a lesser degree. You need to let the doctor know.

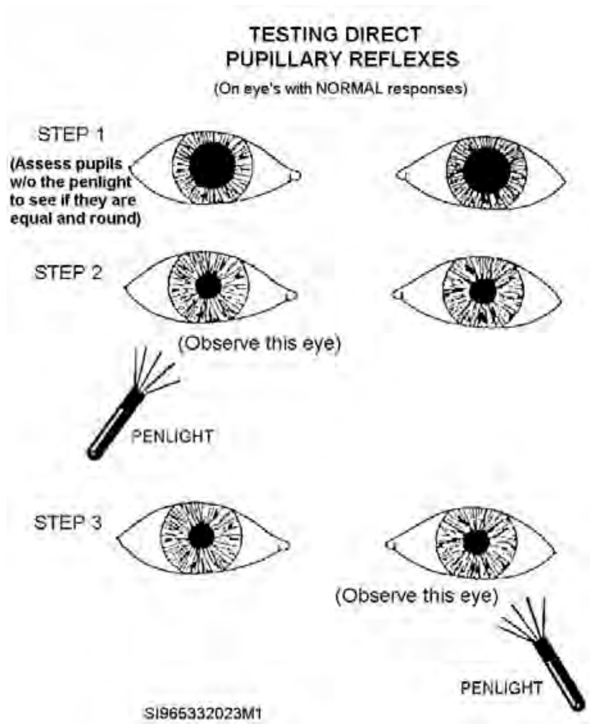


Figure 5–15. Direct papillary response.

Note whether the pupil of the eye constricts and how brisk the reaction is. Rate the briskness on a scale of 0 to 4.

- **0**—Nonreactive
- **1+**—Very sluggish
- **2+**—Sluggish
- **3+**—Brisk
- **4+**—Very brisk

If the pupil is nonresponsive, absence of a direct response is indicative of damage along the pupillary pathway. The most likely areas with a problem or damaged area indicated by the absence of pupillary response include the optic nerve of that eye, the pretectal area, cranial nerve (CN) III on that side, or the iris constrictor muscle.

Consensual pupillary reflex testing

The consensual testing is where you shine the light into one eye but actually observe the *opposite* eye for a reaction, which should be constricting of the pupil. For example, you shine the light in the right eye; you watch the left eye for a consensual response and vice versa (fig. 5–16).

Again, you want to note the rate and symmetry of constriction and re-dilation. If both eyes responded consensually, then they are normal. If one eye or the other fails to respond consensually to the light, note which eye did not have a consensual response. If the rate and symmetry of the reactions of the two eyes were not the same, note which eye responded slower or to a lesser degree. For the consensual reflex test, there is no need to grade the briskness.

Absence of a consensual response may be due to damage to the optic nerve of the opposite eye, damage to the pretectal area, CN III damage, or damage to the iris constrictor muscle.

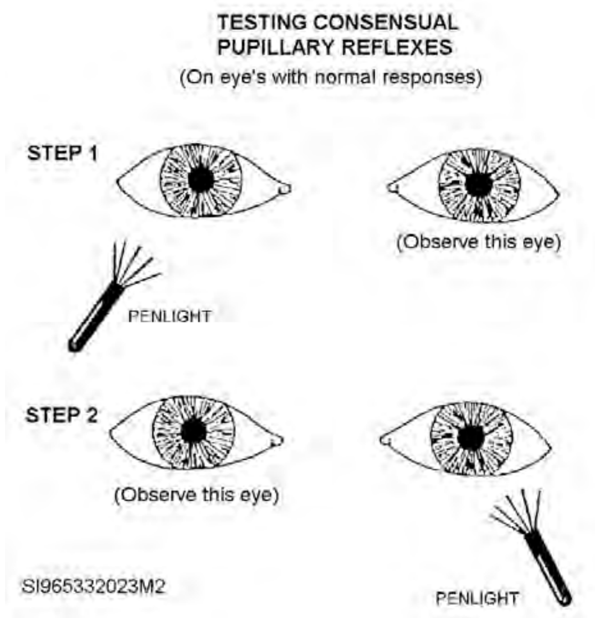


Figure 5–16. Consensual pupillary reflex test.

Accommodative pupillary reflex testing

You do not need a transilluminator (pen light) for this test. What you need is a fine-tipped object or other small target for the patient to look at instead. Begin the test with the patient once again looking at a distant target. Hold the near target about six inches in front of the patient's face, level with the eyes, and ask him or her to look at it. Observe both eyes to see if they constrict when looking at the near target (fig. 5–17). Then have the patient look back at the distant target again, and watch to see both eyes re-dilate. Do this test two or three times to give you plenty of opportunity to observe both eyes to see if they constrict/re-dilate and whether their rate and symmetry of constriction and re-dilation is equal. If one or both eyes failed to constrict, note which eye had problems. If the rate and symmetry of the constriction and re-dilation are not equal, again note which eye was slower or responded to a lesser degree. This test is judging the whether the eye reacts appropriately instead of using a ruler to measure the distance that accommodation occurs.

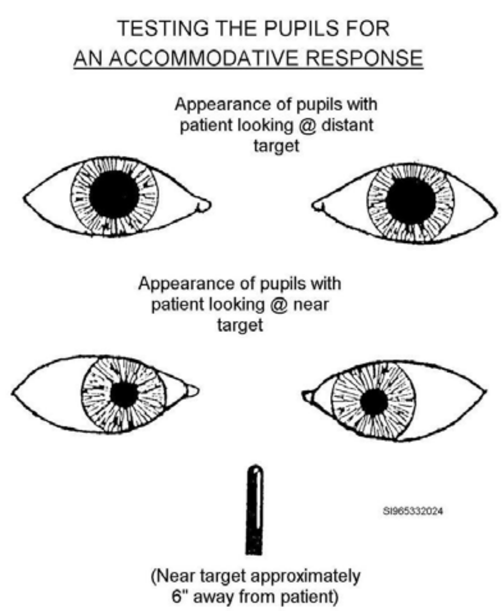


Figure 5–17. Accommodative pupillary reflex test.

Nose

Inspect and palpate for injuries or signs of injury. Use DCAP-BTLS and observe for drainage or bleeding. Do not pack the nose! You can pinch the bridge of the nose and/or apply ice to stop bleeding. Packing the nose could further the patient's injuries if the patient has cerebral spinal fluid leaking into the nasal cavity.

Mouth

Examine the mouth for lacerations or obstructions such as dentures, blood, vomitus, lacerations of the tongue, unusual breath odors, and discoloration. Clear any obstructions you find. If the patient is actively bleeding or vomiting, clean the mouth out and position him or her to facilitate drainage.

Neck

If the cervical collar is in place, you are limited as to your assessment here. Through the opening in the collar, you can assess for jugular vein distention and crepitation.

Chest

Begin your examination by visually checking the breathing pattern, breathing characteristics, and movements of the chest wall. Asymmetrical breathing may be caused by a hemothorax, pneumothorax, flail chest, or sucking chest wound. Of these, a sucking chest wound is a life-threatening emergency demanding immediate action. Listen to the breathing on each side of the chest to determine if the patient does have a hemothorax or a pneumothorax. Observe the shape of the chest and the muscles used for respiration. If the patient is conscious, listen to the way he or she speaks. A patient with a spinal injury or respiratory difficulty can only speak in short phrases. A stroke victim has difficulty enunciating words or putting sentences together. Victims of severe strokes may not be able to speak at all.

Palpate the ribs gently to confirm your visual observations and find any other problems. (Do not press on areas where you noted deformities in your visual examination.) Feel for the presence of air beneath the skin (subcutaneous emphysema—usually associated with a pneumothorax). Palpate the sternum to determine if there are any deformities or rib-sternum separations.

Abdomen

Check the abdomen for wounds or distention using DCAP-BTLS. Palpate all four quadrants for firmness, softness, or distention. Use the pads of your fingers and a rolling motion rather than a sharp, poking motion. Palpate each quadrant separately and note abnormalities in each. Distention is an indication of bleeding into the abdomen. Tenderness or rigidity is a sign of peritonitis or some sort of internal injury. Observe the reaction of the patient as you do this exam. Abdominal injuries are extremely painful. The patient usually flinches or cries out if you press on an injured area. The patient may protect his or her abdomen by tightening the abdominal muscles or by actually pushing your hands away. Such a reaction is called *guarding.*

Pelvis

Check the pelvic area for DCAP-BTLS, pain, tenderness, and motion. Abnormal movement, tenderness, and crepitus are all signs of a pelvic deformity fracture. Finally, incontinence may either be a sign of a CNS injury or simply an involuntary reaction to fear. Male patients may also experience a *priapism.*

Use discretion when you examine the pelvic or genital area. Provide privacy for the patient; avoid removing all the clothing unless you find some indication that there was trauma to the genital area.

Palpate the pelvic area much as you did the abdomen. Pelvic injuries are extremely painful, so use gentle pressure to avoid causing pain. Compress the pelvis from either side to check for instability or tenderness. Also, place your hands on the iliac crests and rock gently. If there is unilateral movement, crepitus, or extreme tenderness, the patient probably has a fractured pelvis. Be aware that pelvic injuries bleed heavily, internally and externally. Watch for distention and check both femoral pulses for equality of intensity and interruption of flow.

Extremities

Check the clavicles and arms. Rotate the shoulders gently to see if there is any joint separation. Palpate the arms to locate wounds or deformities. Make sure your fingers go completely around the arm, including dependent areas. Squeeze gently as you palpate to locate any tender areas. Palpate the near arm first and then reach across to palpate the far arm. Palpate the radial pulse and check for capillary refill on each side.

After palpating both sides, check for grip strength by having the patient squeeze your fingers with both hands. One-sided weakness is a sign of possible stroke, fracture, or spinal injury. If both sides are weak or if the patient is unable to squeeze at all, he or she may have a spinal injury (cervical spine). If the patient is unconscious, you can perform the same test by hyperextending and hyperflexing the patient's wrists. If the patient flinches when you do this, he or she may have an injury of some sort.

Palpate the lower extremities using DCAP-BTLS. Use the same techniques you used with the upper extremities—palpate each leg thoroughly. Pain and deformity are usually signs of a fracture. Again, do not squeeze or palpate obvious wounds or fractures. Remove clothing as needed to check the entire leg, but make sure you protect your patient's privacy as you do so. Palpate for pulses as you examine each leg. You should be able to find femoral, posterior patellar, posterior tibial, and dorsalis pedis pulses in each extremity. The absence of a pulse in an area usually indicates that a fracture or wound is interrupting the blood flow. It may also indicate that the patient is in a state of shock. In any case, it certainly tells that you need to look a little harder.

Check the patient's ability to move while you are in the area. Have the patient push with his or her foot against your hand and then pull against your hand. Check for sensation and ability to move on each side and compare the strength of the two sides. If the patient has a spinal injury, he or she may not be able to move the lower extremities. A stroke victim may only be able to move one side.

Posterior

Using DCAP-BTLS, check as much of the back as possible. If the patient is on a backboard, the only part of his or her back you can check is the flanks.

Trauma patient with no significant mechanism of injury

In most cases, the patient with no significant mechanism of injury and who is responsive received all the assessment that was needed at the scene. If you become suspicious, you can go ahead and complete a detailed assessment.

Detailed physical on a medical patient

Medical patients seldom need a detailed physical exam. Most of the information you need was gathered in the focused history and physical. However, there may be an occasion when your patient is both trauma and medical. It is recommended you treat this situation from a trauma standpoint.

Observe and monitor patients

While en route to the hospital, the patient's condition can change. Be alert to any changes in mental status, anxiety level, restlessness, or sweating. The ongoing assessment involves four steps:

1. Repeat initial assessment continually checking for life-threatening problems.
2. Reassess and record baseline vital signs.
3. Repeat focused assessment regarding patient complaint or injuries.
4. Check the interventions.

The ongoing assessment is performed every 15 minutes for a stable, oriented patient and every 5 minutes for an unstable patient. An important aspect of the ongoing assessment is documentation.

Repeat initial assessment
Check for any life-threatening conditions. Talk with the patient to confirm his or her mental status.

Reassess and record baseline vital signs
Repeat and record the patient's vital signs. Has the pulse stayed the same or changed? Is the blood pressure lower or higher? Is the skin warm and dry or cool and moist?

Repeat focused assessment
Ask the patient about his or her chief complaint. This helps you determine if the problem is getting worse or better.

Check interventions
If you have performed any interventions to alleviate the patient's problem, ask if they helped. If the patient cannot speak, you may have to rely on the patient's vitals and other signs.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

030. Scene sizeup
1. What type of information do you gather at the scene sizeup?

2. What are the five aspects of a scene sizeup?

3. What PPE does the EMT wear for protection against contacting a bloodborne pathogen?

4. How far out from the accident scene does the danger zone extend when there are no apparent hazards?

5. How far out from the accident scene does the danger zone extend when there is a vehicle fire?

6. While arriving at a scene there is loud shouting and gunfire, what would you do?

031. Administer initial assessment
1. What are the six parts to the initial assessment?

2. What does the acronym AVPU mean?

3. If you suspect a patient has a spinal cord injury, what technique would you use to open his or her airway?

4. What action do you take if the patient is not alert and his or her breathing is slower than eight breaths per minute?

5. What is the most common cause of airway obstruction in the conscious patient?

6. What pulse do you palpate if you are having difficulty locating the radial?

7. Name five patient situations that would require immediate transport after the initial assessment.

032. Trauma patient history and physical

1. In performing the trauma patient's history and physical, after the initial assessment, what must you first reconsider?

2. What acronym is used to help you remember what to look for when conducting a physical exam, and what do the letters mean?

3. How often are vital signs taken on a stable patient and an unstable patient?

4. What does SAMPLE assist you in remembering when you are checking the patient?

5. What parts of the body are inspected during a rapid trauma assessment?

6. What are indications of internal bleeding?

7. If the patient has a priapism, what should you suspect?

033. Medical patient history and physical

1. After the initial assessment, you determine that your patient is a medical patient; what would be your next determination?

2. If your conscious medical patient is complaining of pain, what would you need to ask when gathering the history?

3. For the unresponsive medical patient, what should you look for to give you knowledge of the patient's medical history?

034. Gaining access

1. What does the term *extrication* mean?

2. What is a hazardous material?

3. What is considered a safe zone after a hazardous materials incident?

4. What are the three steps used to disentangle patients from a wrecked car, crashed plane, or collapsed building?

5. What is done by the first EMT to reach the patient?

6. When using the KED, when is the head secured?

7. What is a disadvantage of the scoop stretcher?

8. What cautions should the EMT take when loading or unloading a patient into an ambulance on a stretcher?

9. What actions should you take when preparing to assist a patient from a vehicle into a wheelchair?

035. The detailed physical exam

1. What is the purpose of a detailed physical exam and on what type of patient is it performed?

2. When examining the scalp or cranium while performing the detailed physical exam, what do you look for?

3. What is “Battle’s sign?”

4. When exposing the patient’s pupils to light, what could it indicate if the pupils remain dilated?

5. What are the three simple papillary tests?

6. What is consensual papillary reflex testing?

7. Define guarding?

8. What steps are accomplished during an ongoing assessment and how often is it performed?

5–3. Emergency Procedures

036. Sprains, strains, fractures and soft-tissue injuries

A sprain is a joint injury in which the joint is partially, temporarily dislocated, and some of the supporting ligaments are either stretched or torn.

Following the injury, the joint surfaces fall back into alignment so that immediately after the injury, persistent displacement of the joint surfaces does not occur. Sprains vary in severity from mild to severe, depending on the amount of damage done to the supporting ligaments. A severe sprain often causes as much damage to the supporting ligaments and the joint capsule as a complete dislocation.

Sprains are characterized by *joint tenderness, swelling and ecchymosis, and inability to use the extremity*. As you can see, the signs of sprain are the same as the signs of fracture. In fact, it is sometimes very difficult to tell the difference. It is important to remember that, although the injury may appear to only be a sprain, a fracture may exist as well. In case of doubt, treat the injury as a fracture. The basic principle of field management is to treat fractures (referred to as a PSD or painful, swollen, or deformed extremity), dislocations, and sprains in the same manner.

A strain, or muscle pull, is stretching or tearing of a muscle. Unlike the sprain, no ligament or joint damage occurs. A strain is a muscle injury. The muscle fibers are partially pulled apart, produce pain and occasional swelling, and ecchymosis of the local soft tissues.

The most effective strain treatment is to have the patient avoid aggravating the injury by refraining from placing any additional stress or weight on the injured area. A common place for patients to experience a strain is the back muscles. It is generally best to let patients dictate the position they are most comfortable in. Your job is to ensure the position they are in is safe (if in a wheelchair or on a stretcher, ensure they do not fall). Encourage them to get plenty of fluids and rest. Providers may give an anti-inflammatory medication and a muscle relaxer to help with pain and stiffness. Providers may also put in a referral for Physical Therapy to assist the patient in getting the muscles moving and stretching as soon as possible. A provider may also order ice or heat treatments and may even have the patient use both intermittently (first one then the other) as the ice treatment helps reduce inflammation and the heat treatment increases blood flow to the injured area, thereby improving healing. Ensure you ask or check the doctor's orders for the treatment he or she wants you to apply.

Painful, swollen, or deformed extremity

Since it takes an x-ray machine to determine if a patient has a fracture, the terminology used today by the EMT is painful, swollen deformity (PSD). A fracture is any break in the continuity of a bone. The break may range in severity from a simple crack to severe shattering that produces multiple fracture fragments. The break can occur anywhere on the surface of the bone, even across the articular surface. Since any joint that is PSD has the possibility of being fractured, all PSDs are treated as if they *were a fracture.*

A *dislocation* is a disruption of a joint so that the bone ends are no longer in contact. Such a disruption can happen only if the supporting ligaments and capsule of the joint tear, allowing the bone ends to separate completely from each other. Fractures and dislocations frequently occur together producing a two-fold injury in which the bone is dislocated and a part of the bone near the joint also fractures.

A significant amount of force is required to break or dislocate a bone. This force may be applied as a direct blow, indirect force, twisting force, or high-energy injury. The type of force also has a direct bearing on the type and location of the fracture. Attempt to learn as much as possible about the circumstances surrounding the injury during your assessment process.

A *direct blow* is one of the most common causes of fractures. The fracture occurs at the point of impact and may also involve fragmentation of the bone and dislocation of the proximal joint. *Indirect forces* also cause fractures when the force is transmitted from the point of impact to a stress point on a different part of the bone or on another bone. A good example of indirect force occurs when someone falls on his or her outstretched hand. The force is transmitted from the hand to the arm and up to the shoulder. A fracture may occur in the wrist, forearm, upper arm, or shoulder. *Twisting forces* are a somewhat more obvious source of fractures. Something has to give when a bone is fixed at one end and turning at the other. Skiing injuries frequently cause twisting forces and fractures. *High-energy injuries*, as in automobile accidents, falls from heights, and gunshot wounds, cause severe damage to bones, surrounding soft tissues, and underlying organs. Such injuries usually include more than one bone or body part. Fractures also occur when destructive lesions of bone, such as *bone tumors*, weaken the bone so that only a slight force causes a break. *Osteoporosis* is an example of a disease that weakens a bone and causes it to be susceptible to fractures with minimal force.

Fracture classifications

A PSD is classified as *open* or *closed*. An open PSD is when the overlying skin is damaged. Laceration of the skin can occur when the bone ends protrude or when an object lacerates the skin at the same time it breaks the bone. The wound may vary in size and the bone may or may not be visible, but any PSD associated with damage to the skin is classified as open. Closed PSDs do not have any associated wounds or penetrating injuries.

It is very important for you to determine whether a PSD or fracture is open or closed. Open PSDs are usually more serious because they involve a greater blood loss and possibility of contamination. Infected PSDs sometimes cause life-long problems for the patient.

Signs and symptoms of painful, swollen deformity fractures

The signs and symptoms of PSD fractures may include pain, swelling, deformity, tenderness, guarding, edema and ecchymosis, crepitus, exposed fragments, and false motion. Some or all of these signs may be present, but the presence of any should alert you to the possibility of a fracture. Most of these manifestations can be checked by gentle palpation or visual examination. However, crepitus and false motion only appear when the limb is moved or manipulated. Since motion causes extreme pain for the patient, do not routinely manipulate.

Deformities include unnatural positions, angulation, shortening, and rotation. Always compare the injured limb with the uninjured when checking for deformity. In some cases, an apparent deformity is the natural appearance of the limb. *Tenderness* is the sensitivity felt around the site of the injury. You can locate the site by gently palpating along the bone with the tip of one finger. This sign is called point tenderness and is the most reliable indicator of an underlying fracture. *Guarding* is the inability or refusal to use the injured extremity. A patient who has a fracture or serious injury usually guards the injured part and refuses to use it because the motion causes pain. Guarding is not always a definitive sign. In some cases, individuals have fractured bones but continue to use them anyway. *Edema* and *ecchymosis* almost always occur with fractures, but they also occur with other injuries too. Rapid swelling immediately after an injury usually indicates bleeding from the fracture site into the soft tissues. In some cases, the swelling is so severe it masks the deformity of the fracture. Generalized swelling of the extremity also occurs a few hours after the injury. *Bone fragments* are an obvious indication of a fracture. The fragments may be inside the wound or protruding from the skin. *Crepitus* is a grating or grinding sensation that can be felt and sometimes heard when the bone ends rub together. *False motion* is unnatural movement of a limb or motion at a point where movement does not normally occur. For example, if the patient's leg is bent at a 90° angle between the knee and the ankle, you can assume the leg is broken.

Signs and symptoms of dislocations

When a joint is dislocated, injury to the supporting ligaments and capsule is so severe that the joint surfaces are completely displaced from one another. The bone ends lock in the displaced position, making any attempt at motion of the joint very difficult as well as very painful. Among the joints most susceptible to dislocation are the small joints of the fingers, shoulders, elbows, hips, and ankles. Signs and symptoms of dislocation include *deformity* of the joint, *swelling* around the joint, *pain* that is aggravated with movement, virtually a complete *loss of normal joint motion*, and *tenderness* to palpation around the joint.

Documentation in the emergency room

There are different forms used in the emergency room setting to track patient visits. Information collected can include demographics, patient diagnosis, public health data, and any other pertinent information that needs to be tracked. The two specific forms that will be discussed below are the AF Form 560, Authorization and Treatment Statement and the emergency room log.

Admission and disposition sheets

The AF Form 560, Authorization and Treatment Statement, or a locally developed form, is used to document admissions and dispositions. It provides a listing of patients admitted to or released from the hospital. This information is used to track patients on flying status that may have been admitted or discharged after duty hours. The flight surgeon will receive this information to ensure appropriate follow up care and maintain operational readiness of flying personnel. Admission and disposition sheets are also reviewed by medical facility senior leadership to ensure accountability for any military personnel who may have been treated off base and to detect any trends in illness or injury. For example, if five people were admitted overnight for nausea, vomiting or diarrhea symptoms, the senior staff will most likely follow up to see if public health has been notified. If there is a trend detected, that information will be up channeled to the wing or base level. This information is especially important if there is any anticipated mission degradation (loss or slowing down of mission capability) or risk of an illness outbreak, food poisoning, or safety issue.

Emergency room log

The Emergency Room (ER) log is a document that provides a listing of patients seen in the emergency room within a 24-hour period (2400 to 2400 daily). This document is generated daily. The format the information is collected on depends on the facility and may be a computer-generated or manually developed product. Generally, the information collected states the following information:

- Date and time the patient presented to the ER.
- Date and time of patient departure from ER.
- Disposition status (admitted, transferred, home on quarters etc) patient and diagnosis.
- Patient status (active duty, retired, dependent, etc.) to include personnel reliability program (PRP) and/or Flying status.
  - PRP decertification/Fly—Does not include flying/does not include controlling (DNIF/DNIC) notifications: includes date/time and person notified of decertification.
  - Active duty (AD)—If sent home, quarters, or admission: includes who was notified in member's chain of command.
- Patient's treatment and follow-up if required.

Ambulance Runs

The shift leader responsible for running report ensures all information is correct/compiled, copies, and delivers or sends the ER log electronically to the Aerospace Medicine Clinic and senior leadership (dictated by facility). The log is reviewed for any potential flyers that may have had care rendered after hours and any additional information that requires follow up.

037. Miscellaneous procedures

This unit covers some additional procedures you may be required to perform or assist with in an emergency situation. It is best to practice these skills whenever possible to ensure you can perform swiftly in the event of an emergency.

Contact lens removal

It is not uncommon for someone to splash a chemical or have a foreign object blow into an eye. If this happens, the patient will likely go to the emergency room or may show up at the clinic you are working in. You need to know what to do and how to take care of the problem quickly. Delay in care could risk the patient losing eyesight! First, you need to determine whether the patient is wearing contact lenses and if so, which type. If the patient has a chemical in the eye, the provider will most likely want you to remove the contact lens immediately. Leaving a contact lens in place when there is an infection or injury to the eye can compound the damage. You should have the patient sit in a wheel chair and take the patient to a room as he or she probably will not be able to see due to the burning, pain in the injured eye, and both eyes will tear up preventing good vision. If a chemical or foreign object is in the eye, notify the provider immediately and follow his or her directions to splint the object, remove contacts or begin irrigation. You may have the patient remove the contact lenses if he or she is able to or you may need to remove them. The steps are the same whether the patient removes the lenses or you do it.

To remove contact lenses, follow these steps:

1. Wash hands.
2. Determine whether the patient has soft or hard contact lenses. You can ask the patient which kind he or she wears or identify the type of lenses yourself. Hard lenses will feel like a hard plastic disk and soft lenses feel like a thick piece of plastic wrap.

Hard Lenses

1. Cup one hand under the patient's eye (fig 5–18).
2. Pull the upper eyelid up above the edge of the lens, pull the lower lid down to the lower edge of the lens.
3. Press slightly on the lower lid at the edge of the lens, the lens should slide out between the eyelids.
4. Place the lenses in separate containers with sterile water, label which eye the lens was removed from.


Figure 5–18. Removing a hard contact lens.

Soft Lenses

1. Place a drop of wetting solution or sterile saline in the eyes to moisten the contact surface.
2. Using your non-dominant hand, open the eye with your middle finger and thumb.
3. Use the index finger of your dominant hand and place it gently on the lower edge of the lens and slide it down towards the lower lid. (Fig. 5–19)
4. Gently pinch the lens between your index finger and third finger. (Fig 5–20).
5. Gently lift out the lens with the index finger and thumb. (Fig 5–21).
6. If you cannot remove the lens, get a contact lens suction cup to remove the contact lens.
7. Place the lenses in separate containers with sterile water, label which eye the lens was removed from.


Figure 5–19. Removing a soft contact lens.


Figure 5–20. Removing a soft contact lens.

Note: As mentioned in step 6, an additional method uses a suction cup device and normal saline to remove a contact lens.

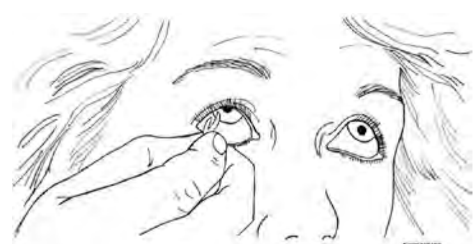


Figure 5–21. Removing a soft contact lens.

Eye irrigation

Eye irrigations are performed when there is the possibility of a foreign body or a caustic substance in the eye. Examples may range from an eyelash to a scrap of metal or jet fuel. It is an uncomfortable experience for most people and they may be very anxious about future eye damage or loss of eyesight. It is very important you are careful but thorough when irrigating the eye. In some instances, you may go to a scene of a patient with a chemical in the eye. Most areas on base that deal with fuels or chemicals have an emergency eyewash station. If it is available, the patient should use it immediately and then be transported to the hospital for further treatment. You may also have a patient who splashed chemical into his or her eye walk into your ER or clinic. You should ask if the patient used an emergency eye wash station or running tap water prior to their arrival. Report that information to the provider and he or she will normally want immediate and thorough flushing with sterile saline or water for 20 minutes. In a controlled situation, the provider will normally have you irrigate the eye with an irrigation set. A quick set up is an IV bag with normal saline and IV tubing. Here are the basic steps:

1. Verify the provider's orders.
2. Gather required supplies and equipment (IV bag, IV tubing, chux or towels, non-sterile gloves, an IV pole and a basin if no sink is available).
3. Wash hands and don gloves.
4. Place the patient in a supine position on a gurney or exam table.
5. Turn the patients head toward the affected side.
6. Place chux or towel on the gurney or exam table.
7. Place the basin next to the patient's face.
8. Prepare irrigation set and fluid.
9. Remove any discharge or debris with a cotton ball moistened with sterile water.
10. Gently but firmly pull the upper eyelid up toward the eyebrow with your non-dominant hand and stabilize the lower lid in an open position.
11. Have the patient look down and let them know that they will feel the fluid begin to flow across their eye.
12. Hold the irrigation tubing ½ to 1 inch above the eye.
13. Direct the stream of fluid from the nasal edge and let it flow across the eye and out on the temporal side.
14. Flush with the amount ordered by the provider.
15. Once the irrigation has been complete, notify the provider. The provider may want to stain the eye to look for foreign material or scratches (corneal or conjunctival abrasion), irrigate with more fluid or dry the area around the eye or patch the eye. Staining the eye uses a procedure called a fluorescein stain and will be covered in volume 2. (**NOTE:** Make sure contacts are removed prior to staining the eye!)
16. Document the procedure you performed including the type and amount of solution used to irrigate the eye.

Ear Irrigation

This type of irrigation is used to remove cerumen (earwax) or foreign bodies that occlude the canal. It should not be done if there is a possibility that the tympanic membrane is perforated.

1. Verify the provider's order.
2. Gather supplies and equipment (two basins, a large syringe, hydrogen peroxide (if ordered), chux or towels).
3. Remove any external discharge from the outer ear.
4. Place one basin under the patient's ear.
5. Fill the other basin with warm water or warm water and hydrogen peroxide (Do NOT use cold water, it may make the patient feel very dizzy and nauseous).
6. Fill the syringe with the irrigation fluid.
7. Gently pull back on the patient's ear.
8. Place the tip of the syringe at the opening of the ear, depress the plunger and direct the stream of fluid against the sides of the ear canal.

9. Carefully remove any large chunks of cerumen with sterile gauze and irrigate for prescribed time.
10. Have the patient lie on the irrigated side to allow the ear to drain. Let the provider know you have finished and he or she will normally take another look into the patient's ear.
11. Document the procedure

Set up cardiac devices

Cardiac pacemakers are electrical devices that send a direct stimulation to the heart to initiate and maintain a patient's heart rate when his or her heart is unable to do so. There are three primary types of pacemakers: a permanent implantable system; a temporary system that uses an external pulse generator with percutaneously threaded leads (leads are threaded through the skin); and a transcutaneous external system (send the electrical impulse through the skin) with chest electrodes. We will briefly cover the two types most commonly seen or used in an emergency room or inpatient unit: temporary system with external pulse generator and transcutaneous cardiac pacing.

Temporary system with external pulse generator

To set up for pacemaker insertion, gather the pulse generator (ensure proper functioning), cutdown tray, pacemaker lead, antiseptic solution, and sterile gloves. Assist the physician by handing the pacemaker lead when access to the venous system is established. Once the pacemaker lead is properly inserted into the right atrium, connect the generator. The provider will adjust the generator to the appropriate setting to reestablish the patient's heartbeat. Pacemaker insertion is similar to central line insertion (discussed in Volume 2). Follow steps 6–8 below.

Transcutaneous cardiac pacing

You will need disposable electrode pads and the external pacer (ensure proper functioning). Placement of the electrodes depends on whether the suspected problem is in the Sinoatrial (SA) Node or the Atrioventricular (AV) Node. The provider should determine which placement to use. Electrodes must be placed in the direction of the current to pass through as much of the heart (myocardium) as possible with the least amount of distance between the pads.

Sinoatrial node failure

Anterior and posterior placement: Place the negative electrode on the chest at the V3-V1 position. Place the positive electrode on the patient's back to the left of the spine.

Atrioventricular node failure

Anterior to anterior placement: Place the negative electrode under the right clavicle and the positive electrode at the V6 position.

After pads are properly placed, you are ready to move on to the next step.

1. Place pacing unit in off or standby mode and ensure the milliamp output is set at the minimal level prior to connecting the electrodes to the pacer.
2. Connect electrodes to the external pacer.
3. Determine the rate setting (provider responsibility). Normally 70–80 for heart rate that is consistently too low to maintain adequate cardiac output and 60 for heart rate that intermittently low.
4. Provider will gradually increase milliamp output until a pacing spike along with the corresponding QRS complex is seen.
5. Check pulse to ensure there is adequate response to electric stimulation.
6. Check electrode pads frequently to ensure secure placement.
7. Vital signs are normally checked every 15 minutes when continuous pacing is used.
8. Monitor ECG for proper pacer function.

Set up cardiac monitor

Cardiac monitoring is used during surgical procedures, cardiac catheter and other cardiac procedures, in emergency situations such as chest pain or difficulty breathing, critically ill patients or during the transfer of unstable patients, and any time the patient's condition requires hospitalization on a coronary unit or admission to an intensive care unit.

Set up of the monitor/defibrillator will depend on the particular model you are working with. You should become familiar with the equipment your facility uses so you will be prepared should an emergency arise.

Preparation

1. Verify orders, wash your hands and gather equipment.
2. Identify the correct patient and explain the procedure to the patient (an abbreviated version can be given while you are assembling the equipment in an emergency).

Procedure

1. Prepare the patient. Place the patient in the supine position, select skin sites and clean with an alcohol pad (this step may be skipped in an emergency as long as the electrodes will stick), shave electrode sites if the chest is extremely hairy and wipe clean.
2. Check electrode expiration date and ensure the electrode gel is moist. If the electrode is dry, obtain another package. A dry electrode will not accurately transmit tracing and an outdated electrode is more likely to be dried out.
3. Attach electrodes per manufacturer's operating instructions. The number of leads and colors may differ depending on the machine. Select a new siter for electrode application if the patient is being monitored for a long period of time to prevent skin breakdown.
   a. Peel the paper from the back of the electrode. Gently but firmly press the electrode to the selected site, ensuring the edges of the electrode are secure.
   b. Apply to an area that does not have excessive movement and is not directly on a bony surface, joints, breasts or skin creases as this may cause artifact (inaccurate observation or result) on the monitor. An exception is for patients who are overly obese. Large amount of tissue may result in a poor tracing.
4. Attach leads to the electrodes (if using a snap-on type electrode, you may want to attach the lead and electrode before placing on patient to eliminate the need to push down on the patient, especially with very young, elderly or fragile individuals).
5. Turn on the power and select Lead II unless directed otherwise. Run an ECG tracing and place with nursing notes.

NOTE: Always check accuracy of the date and time printed on the ECG tracing! If it is wrong, make sure it is corrected. ECG strips are legal documents and are used as documentation during code blue and other events. These documents are used for review of treatment and in law suits.

Defibrillator

A defibrillator may be a stand-alone unit such as an Automated External Defibrillator (AED) or as part of a cardiac monitor. The defibrillator is used to terminate Ventricular Fibrillation (V-Fib), Ventricular Tachycardia (V-Tach), or may be synchronized for cardioversion (manual defibrillator). You should be familiar with the AED, so this portion is aimed to give you an understanding of a stand alone or manually operated defibrillator (fig. 5–22). Prepare the patient as you would in the preparation steps and procedure steps 1–4 of cardiac monitor set up.

1. Depending on the machine you are using, you may need to place gel defibrillator pads onto the patient or apply gel to the paddles. Hands-free defibrillation method is preferred as the

chance of accidental shock of treatment personnel is reduced. Ensure you check the manufacture's directions for pad placement if using an AED.

2. Once the pads have been applied, turn on power and verify leads are connected. The AED or provider will identify if a life-threatening, shockable rhythm is present.
3. If shockable rhythm exists, provider will select joules. Normally follows a sequence of 200, 300 and 360 joules.
4. Call "Clear!" and ensure no one is touching the patient and oxygen source is removed. Yell, "Shocking!" and press the "Shock" button or the provider will depress the button on the defibrillator paddles.
5. Evaluate the patient for pulse, respirations, and need for additional shocks.
6. Repeat step 3–5 as indicated by protocols or provider.

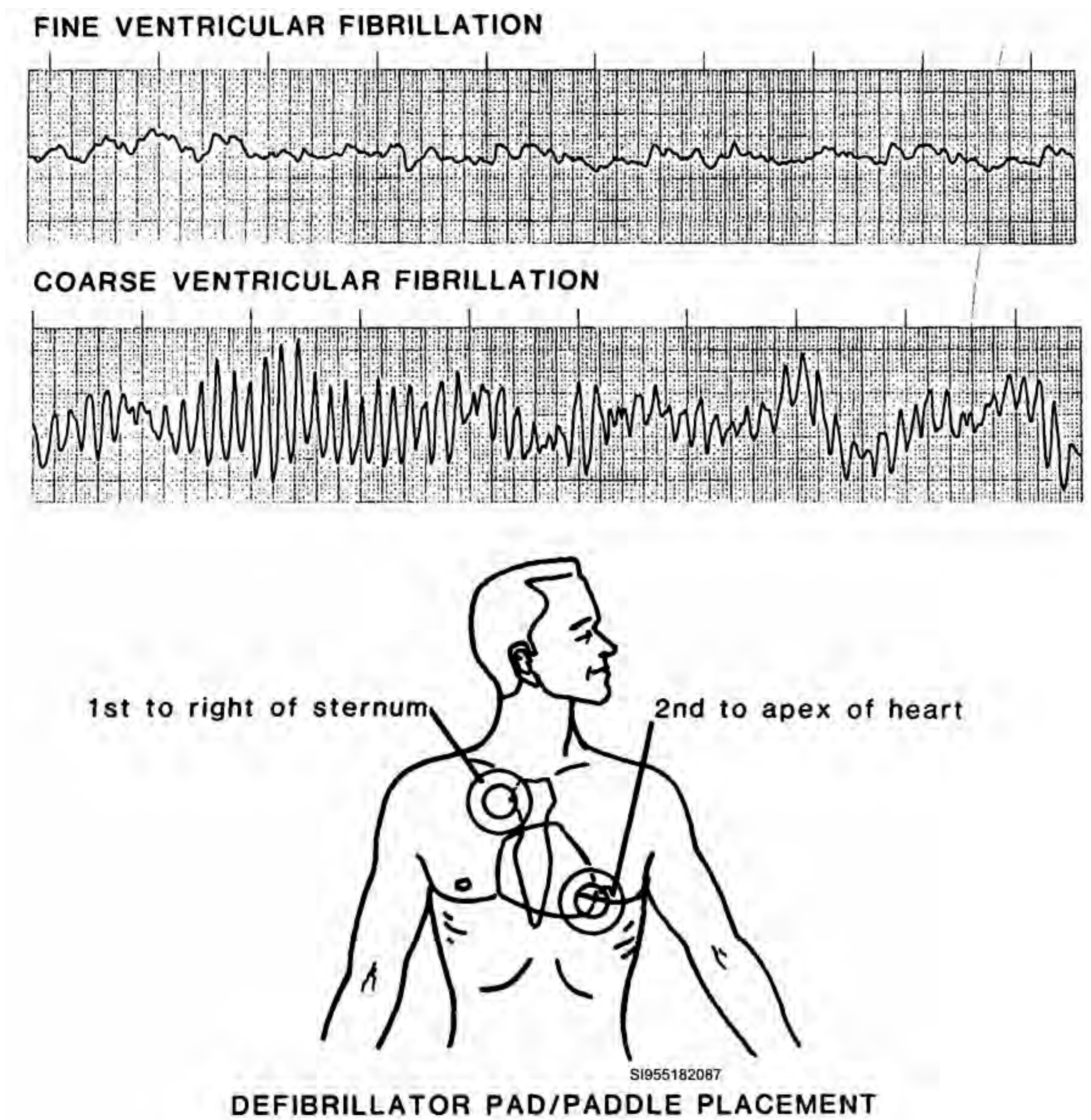


Figure 5–22. Defibrillator pad/paddle placement.

Recognize/report normal sinus rhythms

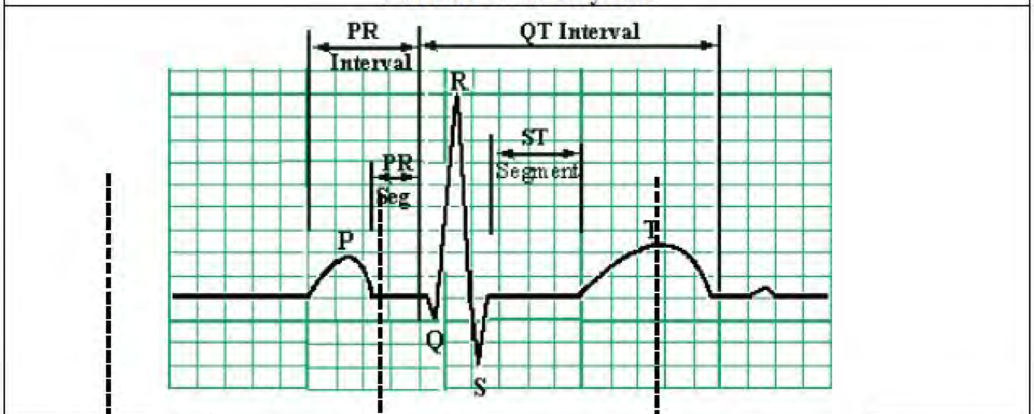
The following information explains how to recognize and report several types of ECG rhythms. Each area details what medical technicians must do to accurately analyze:

- Normal sinus rhythms.
- Ventricular Tachycardia.
- Ventricular Fibrillation.

To recognize and report normal sinus rhythms (fig. 5–23):

1. Verify physician order for telemetry.
2. Identify patient/explain procedure.
3. Wash hands/don gloves.
4. Gather supplies/equipment (EKG strips or EKG simulator).
5. Verify lead placement.
6. Evaluate the ECG monitor pattern for rate 60-100 beats per minute, rhythm is regular, the presence of P waves, P-R interval .12-.20 seconds, QRS complexes<.12 seconds, a clear baseline, and absence of artifact.
7. Obtain a rhythm strip on admission, at intervals dictated by local protocol, and where there is any rhythm change.
8. Evaluate the ECG pattern continually for dysrhythmias, assess the patient's tolerance to the change and notify RN and physician for interventions.

Normal Sinus Rhythm



ECG in relation to BP	Diastole	Systole	Diastole

P-R Interval	Q-T Interval
.12 to .20 seconds	Time of ventricle depolarization to repolarization

P-Wave	PR segment	QRS complex	ST segment	T-wave
Before each QRS identical	Atrial pause (repolarization hidden)	< .12 seconds	Ventricle pause	Ventricle repolarization

NOTE: Heart rate 60–100 bpm with a regular rhythm

Figure. 5–23. Normal sinus rhythm.

To recognize and report Ventricular Tachycardia (V-Tach) (fig. 5–24), note the following:

1. Rate—Usually 140-220 beats per minute (bpm). Normal heart rate can be 40 bpm or lower; 100 bpm may be considered tachycardia.
2. Rhythm—May be regular or irregular.
3. P wave—Not present.
4. P-R interval—Immeasurable.
5. QRS complex—Broad, bizarre configuration, greater than 0.12 seconds wide.
6. T wave—deflected opposite to the QRS complex.
    a. Obtain a rhythm strip on admission, at intervals dictated by local protocal, and when there is any rhythm change.
    b. Evaluate the ECG pattern continually for dysrhythmias, assess the patient’s tolerance to the change and notify the RN and physician for interventions.

V-Tach

ALWAYS CHECK THE PULSE

Both rhythm strips represent V-Tach though theyare different in formation.

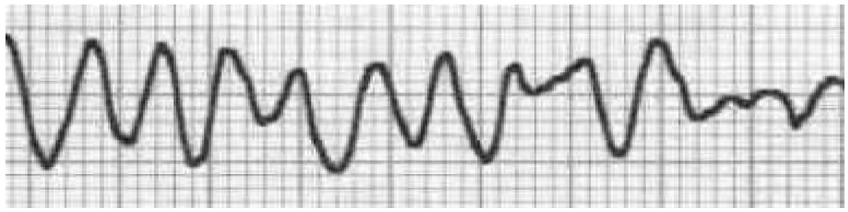
NOTE: V-Tach and pulseless V-Tach look the same on the rhythm strip. Check the patients pulse to determine the proper interventions needed.

Figure. 5–24. Ventricular Tachycardia

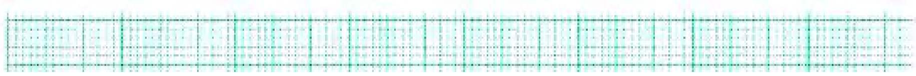
To recognize and report a Ventricular Fibrillation (fig. 5–25), follow these steps:

1. Identify Ventricular Fibrillation (V-Fib) by noting the following:
    a. Rate—Immeasurable because of the absence of QRS complexes.
    b. Rhythm—Chaotic.
    c. P wave—Not present.
    d. QRS complex—Bizarre, chaotic, not well defined.
    e. T wave—Not apparent.
2. Signs/Symptoms include no reponse from patient when assessing:
    a. Level of consciousness.
    b. No normal breathing when airway is assessed (look, listen, feel).
3. If witnessed, start CPR immediately, call for help and get an AED if one is available. If not witnessed, perform five cycles of CPR before applying AED.

V-fib



Both rhythm strips represent V-fib though they are different in formation.



Note the ECG pattern is irregular, fast, and *LIFE THREATENING*!

Figure. 5–25. Ventricular Fibrillation.

Multi-lumen airways

In an earlier volume, we discussed oxygen therapy and several types of airway adjuncts. The next two items in this lesson are generally used in a pre-hospital setting. The pharyngeotrachael lumen airway (PtL) and esophageal tracheal combitube (ETC) are multi-lumen airways that are inserted blindly (without visualization of the vocal cords). They have been designed to deliver ventilation to the lungs when placed into the trachea or the esophagus. We will briefly discuss the esophageal tracheal combitube and the pharyngeotrachael lumen airway.

Note: It is important to remember you must be trained and authorized to use either of these devices prior to attempting to insert on a patient!

Pharyngeo-tracheal lumen airway

The PtL consists of two tubes, one inside the other, two balloon cuffs, a bite block, and a neck-retaining strap. A long endotracheal-type tube is built inside a short tube with a large diameter. The long tube can be placed in the trachea or esophagus, and the shorter tube opens into the pharynx above the epiglottis. If the long tube goes into the trachea, it acts as an endotracheal tube. The inflated balloon provides a seal for the trachea or esophagus based on the passage it is in. If the tube goes into the esophagus, you can still give adequate ventilations as the balloon cuff prevents gastric contents from entering the lungs. The short outer tube prevents air from escaping out the mouth and nose by sealing the pharynx and prevents blood and debris from going down the airway. Another advantage to this airway is that it relieves the need to have to seal a face mask. Both of the external tubes have an adaptor that a bag-valve mask (BVM) can be attached to. The tubes have lines to inflate the cuffs and a metal stylet to assist in guiding the tubes into position. The bite block keeps the patient from biting down and occluding the airway tube, and a neck strap enables you to secure the airway to the patient’s head.

Precautions

PtLs are NOT used on conscious patients or patients who have a gag reflex, patient’s less than 16 years of age, any patient that swallowed a corrosive agent, or a patient who has an esophageal disease.

Procedure

1. Establish whether the PtL can be used on a patient using the information listed above as a guide. Gather required supplies and equipment to include gloves, PtL, stylet, BVM, suction, and water-soluble lubricant (the patient’s saliva can be used if you do not have lubricant). Local policy may also require an end-tidal carbon dioxide monitor.

2. Inflate cuffs to ensure proper function and then deflate.
3. Ensure the inner tube has a bend in the middle and the white cap is securely over the deflation port.
4. Lubricate the long tube with a water-soluble product or the patient's saliva. (Do NOT use silicone or petroleum based products as they can cause lung damage.)
5. For patients with facial trauma, sweep the mouth with a gloved finger and remove debris such as broken teeth or loose dentures.
6. Have a partner stabilize the head in a neutral position and open the airway using a thumb-jaw lift or tongue lift to open the airway. If there is no spinal injury, hyperextend the neck, grasp the tongue and lower jaw with your thumb and index finger and then lift straight up.
7. The PtL should be held in your free hand with the lumen curved in the same direction as the natural curvature of the patient's pharynx. Insert the tip of the PtL into the mouth and advance it carefully behind the tongue until the teeth strap contacts the teeth and lips. (If the patient is very small, you may need to withdraw the PtL as much as an inch from the teeth.) Keep in mind while care must be taken, insertion of airway should be accomplished quickly and between ventilations.
8. Flip the neck strap over the patient's head and secure both sides.
9. Ensure white cap is in place over the deflection port and inflate both cuffs simultaneously by delivering sustained ventilation into the inflation valve. The exterior balloons will inflate when the cuffs at the bottom of the tubes are inflated. Failure of the exterior balloon to inflate, or air escaping through the mouth or nose, indicates a problem with one of the cuffs (generally the large cuff may be torn). Once you see the balloons are inflated, give a few puffs of air to increase the pressure in the cuffs and improve the seal.
10. Determine placement of the long tube by ventilating through the short, green tube. If the chest rises, the long tube is in the esophagus and air is being diverted through the trachea into the lungs. Continue to deliver oxygen with a BVM.
11. If the chest does not rise when ventilating through the short green tube, you know the long tube is probably in the trachea. Remove the stylet and deliver ventilations through the long tube.
12. Verify proper ventilation delivery by listening to lung fields (you should hear air entering the lungs) and epigastrium (the sound of air should NOT be heard here). Also ensure the chest rises with each breath.
13. Ventilate until the patient's gag reflex returns or the patient regains consciousness or care is passed on in the emergency department. Continually monitor the patient and monitor the exterior balloons to ensure they stay inflated. If the balloons lose pressure, the cuffs will have lost pressure and will not provide protection of the airway.

Esophageal tracheal combitube

The ETC is also a double-lumen airway and functions much like the PtL, except the ETC tubes are separated by a partition and not one lumen inside the other. The distal end of the ETC is sealed and there are small holes or perforations in the pharynx area. If the tube is in the esophagus, ventilations are given and the air is through the tube. The sealed end prevents air from entering the esophagus and stomach and diverts the air through the perforations to the pharynx and into the trachea and lungs. The other lumen is open at the distal end and ventilations are delivered through this tube if the lumen is in the trachea. There is a distal cuff that inflates and seals the esophagus or trachea, depending on its placement. There is also a pharyngeal balloon that seals and prevents air from escaping through the mouth and nose and keeps blood and debris from entering the airway.

Precautions

The guidelines on which patients you should NOT use an ETC on are the same as the PtL. Establish whether the ETC can be used on a patient using the information listed above as a guide, as well as other equipment precautions.

Procedure

1. Gather required supplies and equipment including gloves, ETC, BVM, suction, water-soluble lubricant (patient's saliva can be used if you do not have lubricant), and 20 ml and 140 ml syringes. Local policy may also require an end-tidal carbon dioxide monitor.
2. Inflate cuffs to ensure proper function and then deflate.
3. Insert ETC in the same manner as the PtL; watch for the two black rings on the tube that measure depth of insertion.
4. Inflate the large pharyngeal cuff with 100 ml of air. The device will then seat itself in place in the posterior pharynx, behind the hard palate.
5. Inflate the distal cuff with 10 ml–15 ml of air.
6. The tube will normally go into the esophagus, so ventilate through the esophageal connector (longer tube marked with a 1). Follow the procedures used with the PtL to assess presence of breath sounds in the lungs and absence of sounds in the epigastrium.
7. If there is an absence of lung sounds and presence of sound in the epigastrium, the tube is in the trachea. If this happens, simply change the ventilator to the shorter tube marked with a 2. Re-check breath sounds to ensure ventilation.
8. Follow step 13 from above in the PtL lesson.

Laryngeal mask airway

In absence of a gag reflex the 4N emergency medical technician (EMT) may establish the laryngeal mask airway (LMA) if trained and signed off by a trainer in Air Force Training Records (AFTR). Paramedics will also use this airway as a secondary airway with a failed endotracheal intubation or if the paramedic does not feel comfortable with the endotracheal intubation.

Preparation of the LMA for insertion

Before the LMA can be inserted, it must be properly selected, inspected, and prepared.

Step 1—Size selection

The first step is selecting the proper size based on the weight of the patient. Sizes range from 1–5 with weights beginning with 5 kg and lower, then up to 30 kg for a small adult. There are also two additional sizes for large adults. The most important function in this step is to select a proper size to ensure no leakage of air will occur when the KMA is inseted into the mouth.

Recommended size guidelines:

- Size 1—Under 5 kg.
- Size 1.5—5 to 10 kg.
- Size 2—10 to 20 kg.
- Size 2.5—20 to 30 kg.
- Size 3—30 kg to small adult.
- Size 4—Adult.
- Size 5—Large adult/poor seal with size 4.

Step 2—Examination of the LMA

- Step 1—Visually inspect the LMA cuff for tears or other abnormalities.
- Step 2—Inspect the tube to ensure that it is free of blockage or loose particles.
- Step 3—Deflate the cuff to ensure that it will maintain a vacuum.
- Step 4—Inflate the cuff to ensure that it does not leak.

Step 3—Check deflation and inflation of the cuff

Slowly deflate the cuff to form a smooth flat wedge shape which will pass easily around the back of the tongue and behind the epiglottis.

During inflation the maximum air in cuff should not exceed:

- Size 1—4 ml.
- Size 1.5—7 ml.
- Size 2—10 ml.
- Size 2.5—14 ml.
- Size 3—20 ml.
- Size 4—30 ml.
- Size 5—40 ml.

Step 4—Lubrication of the LMA

- Use a water-soluble lubricant to lubricate the LMA.
- Only lubricate the LMA just prior to insertion.
- Lubricate the back of the mask thoroughly.

NOTE: Avoid excessive amounts of lubrication on the anterior surface of the cuff or in the bowl of the mask. Inhalation of the lubricant following placement may result in coughing or obstruction.

Step 5: Position the airway

- Step 1—Extend the headflex the neck.
- Step 2—Avoid LMA fold over:
  - Assistant pulls the lower jaw downwards.
  - Visualize the posterior oral airway.
  - Ensure that the LMA is not folding over in the oral cavity as it is inserted.

LMA insertion technique

At this point, you have the proper size based on weight, the cuff has been deflated and the LMA lubricated. Follow the steps below to ensure the LMA is placed properly in the right area inside the mouth.

- Step 1—Hold the LMA like a pen, with the index finger of the dominant hand at the junction of the mask and the tube.
- Step 2—Under direct vision, press the mask tip upwards against the hard palate to flatten out the mask tip.
  - Using the index finger, keep pressing upwards as you advance the mask into the pharynx to ensure the tip remains flattened and avoids the tongue.
- Step 3—Keep the neck flexed and head extended
  - Press the mask into the posterior pharyngeal wall using the index finger.
- Step 4—Continue pushing with your index finger. Guide the mask downward into position.

- Step 5—Grasp the tube firmly with the other hand then withdraw your index finger from the pharynx.
    - Press gently downward with your other hand to ensure the mask is fully inserted.
- Step 6—Inflate the mask with the recommended volume of air.
    - Do not over-inflate the LMA.
    - Do not touch the LMA tube while it is being inflated unless the position is obviously unstable.
    - Normally the mask should be allowed to rise up slightly out of the hypopharynx as it is inflated to find its correct position.

Verify Placement of the LMA

- Connect the LMA to a BVM device or low pressure ventilator.
- Ventilate the patient while confirming equal breath sounds over both lungs in all fields and the absence of ventilatory sounds over the epigastrium.

Securing the LMA

- Insert a bite-block or roll of gauze to prevent occlusion of the tube should the patient bite down.
- Now the LMA can be secured using the same techniques as those employed in the securing of an endotracheal tube.

Potential Problems with LMA Insertion

- Failure to press the deflated mask up against the hard palate or inadequate lubrication or deflation can cause the mask tip to fold back on itself.
- Once the mask tip has started to fold over, this may progress, pushing the epiglottis into its down-folded position causing mechanical obstruction.
- If the mask tip is deflated forward it can push down the epiglottis causing obstruction. If the mask is inadequately deflated it may either push down the epiglottis penetrate the glottis.

Continuous Positive Airway Pressure

4N EMTs may provide continuous positive airway pressure (CPAP) therapy when indicated by protocol while performing duties in an ambulance.

AF EMT protocol indicates CPAP is needed for:

- Acute respiratory insufficiency defined as moderate/severe respiratory distress of five-word-or-less sentences concurrent with signs and symptoms of hypoxia (cyanosis, pulse oximetry readings of less than 90 percent, etc.), and/or accessory muscle use.
- Acute pulmonary edema or respiratory insufficiency.

There are different types of CPAP units, always check manufacturers instructions before applying to patient. The following list general steps of CPAP usage in the field:

General steps of CPAP usage

- Step 1—Connect the CPAP tubing to device.
- Step 2—Connect face mask to the tubing.
- Step 3—Turn the device on and apply to patients face.
- Step 4—Instruct patient to hold mask on face while you secure strap to patient’s head.
- Step 5—Adjust the device setting according to local protocol to maintain adequate oxygenation and ventilation.

- Step 6—Reassess the patient.

Apply wound packing

Proper wound care promotes care of damaged tissue and prevents infection during the process of healing. There are several kinds of dressing used; follow the steps below to apply initially and during follow-up evaluation. Gather the following supplies to prepare for wound packing:

List of Supplies

- Clean gloves (several pairs).
- Sterile gloves.
- Additional personal protective equipment (PPE)—gown, mask, eye protection, if risk for splashing from wound exists.
- Sterile dressing set (scissors, forceps)—May be optional, check institution policy.
- Sterile drape (optional).
- Sterile dressings (for packing wound and for outer dressing).
- Sterile basin (optional)
- Antiseptic ointment (as prescribed).
- Cleansing solution (as prescribed).
- Sterile normal saline or prescribed solution.
- Tape, ties, or bandage as needed (including nonallergenic tape, if necessary).
- Protective waterproof pad.
- Waterproof bag.
- Adhesive remover (optional).
- Measurement device (optional)—Tape measure, camera.
- Additional lighting, if needed (e.g., flashlight, treatment light).

List of Steps

1. Perform hand hygiene before patient contact.
2. Verify the correct patient using two identifiers per institution policy.
3. Verify practitioner's orders for dressing change.
4. Determine patient's level of comfort using a pain scale. Administer prescribed analgesic as needed before dressing change.
5. Identify patients with risk factors for wound-healing problems, including the following:
    a. Aging.
    b. Prematurity.
    c. Obesity.
    d. Diabetes.
    e. Compromised circulation.
    f. Poor nutritional state.
    g. Immunosuppressive drugs.
    h. Irradiation in area of wound.
    i. High levels of stress.
    j. Steroids.
6. Ask if patient has an allergy or a history of reaction to tape.

7. Assess location and size of wound.
8. Perform hand hygiene and don appropriate personal protective equipment (PPE)—gown, mask, eye protection, if risk of splashing from wound exists.
9. Close room door or pull curtain around bed to ensure patient privacy.
10. Position patient comfortably. Drape patient to expose only wound site. Instruct patient not to touch wound or sterile supplies.
11. Place disposable waterproof bag within reach of work area. Fold top of bag to make cuff.
12. Perform hand hygiene and don clean gloves.
13. Remove tape, bandages, or ties from existing dressing. Pull tape parallel to skin, toward dressing, and hold down uninjured skin. If over hairy areas, remove in the direction of hair growth. Obtain patient permission to clip hair from area. Remove any adhesive from skin. With gloved hand or forceps, remove dressing, one layer at a time. Carefully remove outer secondary dressing first, and then remove inner primary dressing that is in contact with the wound bed. If drains are present, slowly and carefully remove dressings and avoid tension on any drainage devices. Keep soiled undersurface of dressing from patient's sight.
    a. If a dry dressing sticks to wound, moisten with saline and remove.
    b. If a moist-to-dry dressing sticks to wound, alert patient to possibility of discomfort while gently freeing the dressing.
14. Observe appearance of drainage on dressing. Assess for odor.
15. Fold dressing with drainage contained inside, and remove gloves inside out. With small dressing, remove gloves inside out over the dressing. Discard gloves and soiled dressing in appropriate trash receptacle.
16. Perform hand hygiene and don clean gloves.
17. Inspect wound for color, drains, exudate, and integrity. Gently palpate wound edges for induration, bogginess, or patient report of increased pain. Measure wound size (length, width, and depth [if indicated]). Probe wound edges and wound bed with a moistened cotton-tipped applicator for presence of undermining, tunneling, or sinus tract.
18. Describe to the patient the appearance of the wound and any indicators of wound healing or delayed wound healing.
19. Remove gloves and perform hand hygiene.
20. Create sterile field with a sterile dressing tray or individually wrapped sterile supplies on over-bed table. Pour any prescribed solution into sterile basin.
21. Cleanse wound.
    a. Don clean gloves.
    b. Use a sterile swab or gauze for each cleansing stroke, or spray the wound surface. Clean from least contaminated area to most contaminated area.
    c. Cleanse around the drain (if present), using circular stroke starting near drain and moving outward and away from the insertion site.
    d. Use dry dressing to blot wound dry, blotting from least contaminated area to most contaminated area. If a drain is present, use circular strokes starting near drain and moving outward and away from the insertion site.
    e. Apply antiseptic ointment, if ordered, using same application technique as for cleansing.
22. Fill the wound.
    a. If a packing strip is used to fill the wound, use sterile scissors to cut the amount of dressing needed to fill the wound. Pour prescribed solution over the packing dressing or strip to moisten it. **Do not let the packing strip touch the side of the bottle.**

   b. If the wound is deep, gently lay moistened woven dressing over the wound surface with forceps until all surfaces are in contact with moist gauze and the wound is loosely filled.
   c. Fill the wound, but avoid packing the wound too tightly or having the gauze extend beyond the top of the wound.
23. Apply dressing.
   a. Dry dressing.
      i. Remove gloves, perform hand hygiene, and don sterile gloves.
      ii. Apply loose dressing as primary contact layer.
      iii. If drain is present, apply precut dressing flat around drain.
      iv. Apply additional layers of dressing, as needed.
      v. Apply thicker woven pad (e.g., Surgipad, abdominal dressing).
   b. Moist-to-dry dressing.
      i. Remove gloves, perform hand hygiene, and don sterile gloves.
      ii. Place fine-mesh, open-weave dressing in container of prescribed sterile solution. Wring out excess solution.
      iii. Apply moistened dressing as a single layer directly onto wound surface. If wound is deep, gently pack gauze into wound with sterile gloved hand or sterile forceps until all wound surfaces are in contact with moist dressing. Make sure dressing does not touch periwound skin. **Do not pack the wound too tightly because it may cause wound trauma when the dressing is removed.**
      iv. Apply dry sterile secondary dressing over the moist dressing.
      v. Cover with an abdominal pad, Surgipad, or any close-weaved dressing.
24. Secure dressing with roll gauze (for circumferential dressings), tape, Montgomery ties or straps (applied perpendicular to the wound), or binder.
25. On a label or piece of tape on the dressing, write in ink (not marker) the date and time the dressing was applied.
26. Assist patient to a comfortable position.
27. Assess, treat, and reassess pain according to institution standard.
28. Discard supplies, remove PPE, and perform hand hygiene.
29. Document the procedure in the patient's record.

Subungual hematoma

Have you ever hit your thumbnail with a hammer or slammed your fingers in a door? If you haven't, you have probably witnessed someone else go through that painful experience. If you looked at the fingernails after such trauma, you may have noticed that the nail appeared dark red or black. That dark color is blood that has collected in the space between the nail bed and the fingernail/thumbnail, and the medical term used to describe it is *subungual hematoma*. Subungual hematomas are caused by some type of crush injury to the tips of the fingers or toes. There is a great amount of pressure with this injury, and most people experience intense pain. The good news is that you can help relieve some of the pain by releasing the pressure caused by the collection of blood. Aside from having the patient apply an ice pack and elevating the hand, the provider will often ask you to drain the hematoma.

There are several methods to drain a subungual hematoma, so make sure you follow your provider's direction and local policy. We will briefly cover three methods: cautery, needle, and paper clip. As always, ensure you have checked the provider's orders, washed your hands, gathered all materials, explained the procedure to the patient (he or she will likely be very apprehensive about the procedure), and have the patient sign a consent form. Ensure you clean the nail with an antimicrobial so bacteria is not introduced into the hole. An easy and less painful way to do this is to have the patient soak the affected digit in a Betadine® solution. Carefully remove any debris prior to starting the procedure. If the digit is too painful to handle, the provider may authorize a digital block. You should wear a protective gown, goggles, and a face mask as the blood may spray out from the built-up pressure as you go through the nail. Ensure your patient is sitting or lying down so he or she does not fall down during the procedure!

Cautery method

This method uses a battery-operated cautery device (normally used in minor surgical procedures) to burn a hole in the nail.

1. Once the nail has been cleaned well, activate the cautery for a few seconds, release the activator button and place the tip of the cautery at a 90 degree angle to the nail in the middle of the hematoma.
2. Stabilize the digit on a hard surface such as an over the bed table.
3. Apply gentle, but firm pressure for a few seconds. If the cautery is quite hot it will normally burn through the nail in a few seconds.
4. As soon as blood starts to flow, remove the cautery tip.
5. Most providers will have you prepare a clean solution of weak Betadine® solution and have the patient soak the digit again.
6. Dry the digit and apply dressing as directed.

Needle method

This method takes a little bit longer and requires the technician to drill or bore the hole into the nail.

1. Select a needle with a large diameter.
2. Stabilize the digit on a hard surface such as an over-the-bed table.
3. Hold the hub of the needle and remove the cap.
4. Apply gentle but firm pressure and twist the needle at a 90 degree angle to the nail in the middle of the hematoma until blood starts to flow or you have gone through the nail.
5. Follow steps 5–6 in the cautery method.

Paper-clip method

This is an optional method that is a little older, but some providers still use it. The paper-clip method combines the two methods above. Follow the same cleaning techniques and then:

1. Open a paper clip so a pointed end is free.
2. Clean the paper clip with an alcohol pad and let it dry for a few moments.
3. Stabilize the digit on a hard surface such as an over the bed table.
4. Heat the pointed end with a flame (normally a lighter as matches may accidentally be thrown away and start a fire).
5. Apply gentle but firm pressure and twist the paper clip at a 90 degree angle to the nail in the middle of the hematoma until blood starts to flow or you have gone through the nail. This may take a couple of tries.
6. Follow steps 5–6 in the cautery method.

Note: If using a cautery, ensure the batteries are removed prior to throwing it away (normally in a sharps container). Otherwise a fire can easily start in the trash or in a sharps container if other objects press on the activator. No joke, it really happens.

Ensure the patient is instructed on wound-care follow up as well as the signs and symptoms that would require the patient to return to the MTF immediately.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

036. Sprains, strains, fractures and soft-tissue injuries

1. What is a sprain?

2. Because you cannot diagnose a fracture, how do you refer to the possibility of one in the field?

3. Why is it important to determine if the fracture is open or closed?

4. What are the signs and symptoms of a fracture (PSD)?

5. What is a dislocation?

6. How often is the emergency room log generated?

037. Miscellaneous procedures

1. Under what circumstances would you remove contact lenses in the field?

2. Explain how to remove a soft contact lens.

3. What is the treatment for chemical burns to the eyes?

4. What is normally the purpose for performing an ear irrigation?

5. What types of cardiac pacemaker will you be *most* likely to assist with?

6. What is the difference between anterior/anterior and anterior/posterior placement?

7. What should you check on the cardiac electrode? Why?

8. What is the normal sequence of joules given during defibrillation?

9. What should you use to lubricate a PtL or ETC? What should *not* be used?

10. How is an LMA selected, and why is selecting the proper size so important?

11. Prior to use, what is an LMA inspected for?

12. How should tape and bandages be removed?

13. How should a wound be cleaned?

14. What are three methods to treat a subungual hematoma?

15. What special precaution must be taken after using the cautery method to treat a subungual hematoma and why?

Answers to Self-Test Questions

028

1. Daily.
2. 300 mm Hg when the tube is clamped.
3. To help monitor respirations and to easily notice vomiting.
4. Wheeled litter, folding litter, and collapsible device.
5. Equipment should be checked for proper function and supplies for adequate quantity, cleanliness and expiration date to ensure you are able to provide the best care possible at a moment's notice.
6. Inpatient/outpatient and treatment rooms, crash carts and IV trays.
7. IV fluids, IV needles, blood tubes, antiseptic wipes and bandages.
8. Fluids should always be stored on the bottom shelf(s). If they leak, they will not contaminate other supplies below them.

029

1. Items should be stored according to their relative importance and frequency of use.
2. Receiving and processing calls. Other responsibilities include: providing medical instructions to patients, dispatching and coordinating emergency personnel, and possibly coordinating with other on-base/off-base agencies.
3. Code 3 refers to an emergency response using lights and sirens or HOT**.**
4. Names of those you are transporting and anything of a personal nature about them.
5. Gradually slow down without jamming on the brakes.
6. 15 mph.
7. 5 mph.
8. Arrival.
9. Two.
10. As soon as possible following the incident.
11. Ambulance driver.

030

1. Determine threats to yourself, patients, and bystanders. It is also the time when you determine the need for additional help.
2. (1) The need for body substance isolation (standard precautions).
   (2) Scene safety.
   (3) The need for additional resources.
   (4) The mechanism of injury.
   (5) Determining the number of patients.
3. Disposable gloves and protective eyewear or a mask.
4. 50 feet in all directions.
5. A minimum of 100 feet.
6. Retreat to a safe area and call for help from the Security Forces.

031

1. (1) General impression.
   (2) Mental status assessment.
   (3) Airway assessment.
   (4) Breathing assessment.
   (5) Circulation assessment.
   (6) Determination of priority.
2. A=alert, V=responsive to verbal stimulus, P=responsive to painful stimulus, and U=unresponsive.
3. Jaw-thrust.
4. Provide ventilations with a BVM and high-flow oxygen (100 percent oxygen).
5. Large, poorly chewed food particles.
6. The carotid.
7. (1) Poor general impression, unresponsiveness, responsive, but not following commands.
   (2) Difficulty breathing.
   (3) Shock.
   (4) Complicated childbirth.
   (5) Chest pain with a systolic blood pressure less than 100.
   (6) Uncontrolled bleeding.
   (7) Severe pain anywhere.

032

1. The mechanism of injury.
2. DCAP-BTLS: **D**—Deformities, body shapes that no longer appear normal; **C**—Contusions, bruises; **A**—Abrasions, scrapes; **P**—Punctures/penetrations, holes in the body; **B**—Burns, reddened, blistered, or charred skin; **T**—Tenderness, areas of pain identified by the patient during palpation; **L**—Lacerations, cuts, open wounds; **S**—Swelling, enlarged edematous areas.
3. Every 15 minutes for the stable patient; every five minutes for the unstable patient.
4. **S**—Signs or symptoms; **A**—Allergies; **M**—Medications; **P**—Pertinent past history; **L**—Last oral intake; **E**—Events leading to the illness or injury.
5. Areas of the body where the greatest threats to the patient are.
6. Distention and firmness of the abdomen.
7. Possible spinal cord injury.

033

1. Whether the medical patient is responsive or unresponsive.
2. Use the OPQRST acronym: **O**—Onset. What was the patient doing when the pain started? **P**—Provoke. What is the cause of the pain? What affects it or makes it feel better or worse? **Q**—Quality. What does the pain feel like? Describe it as sharp, dull, burning, stabbing or crushing. **R**—Radiation. Does the pain spread from one part of the body to another? Cardiac pain, for example, is commonly characterized by radiating to other areas such as the jaw or shoulder. **S**—Severity. Is the pain moderate, mild, or severe? Again, this is strictly a matter of individual interpretation. **T**—Time. Is the pain constant or intermittent? Has the pain occurred before? When did it start, how does the intensity change, and how long does the pain last?
3. Medic alert devices or Vial of life and information from family or bystanders.

034

1. It is the process by which entrapped patients are rescued from vehicles, buildings, tunnels, or other places.
2. Any substance or material in a form that poses an unreasonable risk to health, safety, and property when transported in commerce.
3. The safe zone is at the same level as, and upwind from, the hazardous materials accident site.
4. (a) Gain access by disposing of the roof.
   (b) Create exitways by displacing doors and roof posts.
   (c) Disentangle occupants by displacing the front end of the vehicle.
5. Manual in-line stabilization for the head and neck is performed. If necessary, this stabilization is done during assessment of the airway, breathing and circulation.
6. You must secure the torso first and the head last.
7. It pinches the patient as the sides are brought together.
8. Provide safety for the patient and rescue personnel. Ensure you have at least two personnel to load a patient. EMTs must use proper lifting techniques to minimize the risk of dropping a patient or incurring a back injury to themselves and other rescue personnel.
9. Move the wheelchair to the patient side of the car, open the door, and introduce yourself. It is best to ask if you can help the patient move into the wheelchair. Lock the wheels of the wheelchair to keep it from sliding away. Ask the patient if it is okay if you place your hands under his or her arms or around the waist once he or she stands to keep him or her from swaying, falling over, or collapsing down.

035

1. To gather additional information to help in further interventions you may need to do and provide more information for the emergency room staff. In most cases, you only need to perform a detailed exam on a trauma patient with a significant mechanism of injury and less often on the trauma patient with no significant mechanism of injury. The detailed physical exam is seldom done on a medical patient.
2. DCAP-BTLS, bleeding, tender areas, and crepitation.
3. Bluish discoloration on the area behind the ears (mastoid process).

4. The patient may be severely frightened, unconscious, in pain, hypoxic, or have suffered brain injury, a stroke, or has taken drugs such as atropine.
5. Direct, consensual, accommodative.
6. Where you shine the light into one eye but actually observe the opposite eye for a reaction, which would be constricting of the pupil.
7. The patient may protect his or her abdomen by tightening the abdominal muscles or by actually pushing your hands away.
8. Repeat initial assessment continually checking for life-threatening problems, reassess and record baseline vital signs, repeat focused assessment regarding patient complaint or injuries, and check the interventions. The ongoing assessment is performed every 15 minutes for a stable, oriented patient and every 5 minutes for an unstable patient.

036

1. It is a joint injury in which the joint is partially, temporarily dislocated, and some of the supporting ligaments are either stretched or torn.
2. PSD.
3. Open PSDs are usually more serious because they involve a greater blood loss and possibility of contamination.
4. Pain, swelling, deformity, tenderness, guarding, edema and ecchymosis, crepitus, exposed fragments, and false motion.
5. The injury to the supporting ligaments and capsule is so severe that the joint surfaces are completely displaced from one another. The bone ends lock in the displaced position, making any attempt at motion of the joint very difficult as well as very painful.
6. Every 24 hours.

037

1. If the patient has a chemical or foreign object in the eye and is unable to remove the contacts by himself or herself.
2. Wash hands, place a drop of wetting solution or sterile saline in the eyes to moisten the contact surface, open the eye with your middle finger and thumb of nondominant hand, use the index finger of your dominant hand and place it gently on the lower edge of the lens and slide it down towards the lower lid, gently pinch the lens between your index finger and thumb and lift it out. If you can’t remove the lens, try a contact lens suction cup to remove the contact lens. Place the lenses in separate containers with sterile water, label which eye the lens was removed from.
3. Immediate and thorough flushing with sterile saline or water for 20 minutes.
4. To remove cerumen or a foreign body.
5. Temporary system with external pulse generator and transcutaneous cardiac pacing.
6. In anterior to anterior placement (AV Node failure), the negative electrode is placed under the right clavicle and the positive electrode is placed at the V6 position. In anterior and posterior placement (SA Node failure), the negative electrode is placed at the chest at the V3-V1 position and the positive electrode is placed on the patient’s back to the left of the spine.
7. It needs to be checked frequently to secure placement on the patient. The expiration date must be checked, and the gel on the electrode must be moist. An outdated electrode is more likely to be dried out, and a dry electrode will not accurately transmit tracing.
8. 200, 300, and 360 joules.
9. A water-soluble product or the patient’s saliva. Do NOT use silicone or petroleum-based products as they can cause lung damage.
10. The LMA is selected based on the weight of the patient. The proper size ensures no leakage of air when inserted.
11. Inspect the cuff for tears and other abnormalities, inspect the tube for blockage or loose particles, deflate the cuff to verify it will hold a vacuum, and inflate the cuff to check for leaks.

12. Pull tape parallel to skin, toward dressing, and hold down uninjured skin. If over hairy areas, remove in the direction of hair growth. Obtain patient permission to clip hair from area. Remove any adhesive from skin.
13. Use a sterile swab or gauze for each cleansing stroke, or spray the wound surface. Clean from least contaminated area to most contaminated area.
14. Cautery, needle, and paper clip.
15. Ensure the batteries are removed prior to throwing it away (normally in a sharps container). Otherwise a fire can easily start in the trash or in a sharps container if other objects press on the activator.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to the Air Force Career Development Academy (AFCDA).

80. (028) How much vacuum must suction units provide when the tube is clamped?
    a. 100 mm Hg.
    b. 150 mm Hg.
    c. 200 mm Hg.
    d. 300 mm Hg.

81. (028) When performing a crash cart check, what should you do *after* ensuring the defibrillator or cardiac monitor operate?
    a. Annotate date and time on a rhythm strip.
    b. Remove paddles and release joules.
    c. Make a list of expired medications.
    d. Remove the battery and recharge.

82. (029) When transmitting information about a patient over the radio, what information *should not* be broadcast?
    a. Age.
    b. Name.
    c. Chief complaint.
    d. Medications and allergies.

83. (029) In the Air Force, you can use lights and sirens on an ambulance call *only*
    a. when the senior medical technician on board approves it.
    b. when local protocol authorizes it.
    c. during the response phase.
    d. during the transport phase.

84. (030) The action of assessing the scene of an accident to provide valuable information to the emergency medical technician (EMT) is called
    a. expanded primary survey.
    b. secondary survey.
    c. trauma history.
    d. scene sizeup.

85. (030) When there is an apparent vehicle fire, how many feet should the ambulance be parked from the affected vehicle?
    a. 50.
    b. 100.
    c. 150.
    d. 200.

86. (031) When performing an initial assessment on a patient and the patient responds by spontaneously opening his or her eyes or answers clearly, how would you assess the patient's mental status?
    a. Able.
    b. Alert.
    c. Ambulatory.
    d. Asymptomatic.

87. (031) If the patient is not alert and his or her breathing is slower than eight breaths per minute, provide
    a. high-concentration oxygen with a positive pressure aviators mask.
    b. ventilations with a bag-valve-mask (BVM) and high-flow oxygen.
    c. high-concentration oxygen with a nonrebreather mask.
    d. low concentration oxygen with nasal cannula.

88. (032) As a general rule, apply a cervical collar if there is any blow above the
    a. nose.
    b. hips.
    c. neck.
    d. clavicles.

89. (032) A rapid trauma assessment is performed on a patient with
    a. a significant mechanism of injury, and focuses on the area of the body where the greatest threats to the patient are.
    b. an insignificant mechanism of injury, and focuses on the area of the body where the greatest threats to the patient are.
    c. a significant mechanism of injury, and focuses on other areas of the body not already attended to.
    d. an insignificant mechanism of injury, and focuses on other areas of the body not already attended to.

90. (033) When you ask a medical patient what may have triggered his or her pain, you are questioning about
    a. onset.
    b. quality.
    c. radiation.
    d. provocation.

91. (033) While gathering a history of illness, when you ask a medical patient if the pain is constant or intermittent, what are you trying to determine?
    a. Time.
    b. Quality.
    c. Severity.
    d. Radiation.

92. (034) What are your responsibilities as an emergency medical technician (EMT) at the scene of a hazmat incident?
    a. Caring for the injured and monitor and rehabilitating the hazmat team members.
    b. Determining wind flow and type of chemical involved.
    c. Putting out the fire and gaining access to the patient.
    d. Stabilizing the incident as fast as possible.

93. (034) Which device is commonly used for patient transfers in wartime and disaster situations?
    a. Army field litter.
    b. Long backboard.
    c. Scoop stretcher.
    d. Stoke's basket.

94. (034) If an individual walks in to a medical treatment facility (MTF) and asks for assistance bringing in a family member, you should ask
    a. if the patient can walk to determine if you need to call for help.
    b. how old the patient is to determine if you should call another clinic.
    c. what is wrong with the patient to determine the appropriate transfer device.
    d. if the patient is authorized care at your facility.

95. (035) If you are treating a severely injured patient with a life-threatening problem, it may be appropriate to skip the
    a. initial patient assessment.
    b. detailed physical exam.
    c. initial physical exam.
    d. vital signs.

96. (035) In minutes, what is the recommended interval for reassessment of an *unstable* patient?
    a. 5.
    b. 10.
    c. 15.
    d. 20.

97. (036) Which acronym is used by emergency medical technicians (EMT) in the field to describe a possible fracture?
    a. Range of motion (ROM).
    b. Painful, swollen deformity (PSD).
    c. Purified protein derivative (PPD).
    d. Alert, verbal, painful, unresponsive (AVPU).

98. (036) Which classifications of fracture are considered more serious because greater blood loss or contamination is possible?
    a. Open.
    b. Closed.
    c. Internal fixation.
    d. External fixation.

99. (037) While working in the emergency room, a patient comes in and states that he or she has splashed a chemical in his or her eye, what should you determine first?
    a. The patient's visual acuity.
    b. If the patient is experiencing any pain.
    c. Whether the patient is authorized care in the facility.
    d. If the patient is wearing contact lenses and which type.

100. (037) In what anatomical location is the pacemaker lead inserted when using a temporary external pulse generator system?
    a. Left atrium.
    b. Right atrium.
    c. Left ventricle.
    d. Right ventricle.

Student Notes

Glossary

Abbreviations and Acronyms

ABC	airway, breathing, and circulation
ABU	airman battle uniform
ABG	arterial blood gas
ACS	American College of Surgeons
AD	active duty
AED	automated external defibrillator
AIDS	Acquired Immunodeficiency Syndrome
AF	Air Force
AFI	Air Force Instruction
AIDS	acquired immunodeficiency syndrome
AFPAM	Air Force Pamphlet
AFMS	Air Force Medical Service
AHLTA	Armed Forces Health Longitudinal Technology Application (medical treatment facility computer system), *formerly CHCS II*
AORN	Association of periOperative Registered Nurses
ARC	AIDS-related complex
ARMD	age-related macular degeneration
A/SAED	auto or semiautomatic external defibrillator
AV	atrtioventicular
AVPU	alert, verbal, pain, unresponsive
B-CELLS	B-lymphocytes
BCG	Bacilli calmette-guerin
BCLS	basic cardiac life support
BID	"bis in die" in Latin for "twice a day"
BLS	basic life support
bpm	beats per minute
BSI	body substance isolation
BUN	blood urea nitrogen
BVM	bag-valve mask
CBC	complete blood count
Cc	cubic centimeter
CDC	Centers for Disease Control and Prevention
CFETP	Career Field Education & Training Plan

CHCS	Composite Health Care System
CISD	Critical Incident Stress Debriefing
CL	contact lenses
CME	cystoid macular edema
CNS	central nervous system
CO_2	carbon dioxide
COPD	chronic obstructed pulmonary disease
CPR	cardio pulmonary resuscitation
C&S	culture & sensitivity
CS	central supply
CSF	cerebrospinal fluid
CSS	central sterile supply
DCAP-BTLS	deformities; contusions, bruises; abrasions, scrapes; punctures or penetrations; burns, reddened, blistered or charred; tenderness; lacerations, cuts, open wounds; Swelling, enlarged edematous areas.
DL or dl	deciliter
DNA	deoxyribonucleic acid
DOT	Department of Transportation
DNIC	duties not including controlling
DNIF	duties not including flying
DT	delirium tremens
ECG or EKG	electrocardiogram
E. COLI	escherichia coli
EID	electronic infusion devices
ELISA	Enzyme-Linked Immuno-Sorbent Assay
EMT	emergency medical technician
ENT	ear, nose and throat
EOM	extraocular movement
EPA	Environmental Protection Agency
ER	emergency room
ERV	expiratory reserve volume
ETC	esophageal tracheal combitube
FCC	Federal Communications Commission
FEV	forced expiratory volume
FHM	Force Health Management

FMM	flight/missile medicine
FRC	functional residual capacity
FTFC	full to finger counting
FVC	forced vital capacity
FVD	fluid volume deficit
FVE	fluid volume excess
Gtts	drops
GI	gastrointestinal
GYN	gynecological
HAZMAT	hazardous materials
HAV	Hepatitis A virus
HBV	Hepatitis B virus
HCTZ	Hydrochlorothiazide
HDL	high-density lipoprotein
Hg	mercury
HIV	human immunodeficiency virus
HPV	human papillomavirus
HSV	herpes simplex virus
HSV1	HSV Type 1
HSV2	HSV Type 2
HTLV-III	Human T-lymphotrophic virus type III
IC	inspiratory capacity
IFE	in-flight emergency
IgE	Immunoglobulin E
IgG	Immunoglobulin G
IgM	Immunoglobulin M
IM	Intramuscularly
INH	Isoniazid
IRV	inspiratory reserve volume
IU	international units
IV	intravenous
K	potassium
KED	Kendrick Extrication Device
KVO	keep vein open
LAV	lymphadenopathy associated virus

LDL	low-density lipoprotein
LOC	level of consciousness
LP	lumbar puncture
LMA	laryngeal mask airway
mEq/L	milliequivalent
mg	milligram
mm	millimeter
ML or ml	milliliter
MTF	medical treatment facility
MTP	Master Traing Plan
Na	sodium
NFPA	National Fire Protection Association
NGU	non-gonoccocal urethritis
nm	nanometers
NPSG	National Patient Safety Guidelines
NREMT	Nationally Registered Emergency Medical Technician
OF	optional form
OI	operating instructions
OSHA	Occupational Safety and Health Administration
OTC	over-the-counter
OVT	Optec 2300 Vision Tester
PAP	papanicolaou
PASG	pneumatic antishock garment
$PaCO_2$	partial pressure carbon dioxide
PFB	pseudofolliculitis barbae
PFT	pulmonary function test
PH	public health; also refers to the measure of the acidity or alkalinity of a solution
PHA	physical health assessment
PID	pelvic inflammatory disease
PIP	pseudoisochromatic plate set
PPE	personal protective equipment
PPD	purified protein derivative
PRP	personnel reliability program
PSD	painful, swollen deformity
PtL	pharyngeotrachael lumen

QRS	deflections in an electrocardiographic tracing that represent ventricular activity of the heart
RBC	red blood cells
RDA	recommended daily allowance
RNA	ribonucleic Acid
ROM	range-of-motion
RV	residual volume
SA	sinoatrial
S&A	sugar and acetone test
SAMPLE	Signs or symptoms; Allergies; Medications; Pertinent past history; Last oral intake; Events leading to illness or injury
SC	subcutaneous
SF	standard form
SOAPP	subjective, objective, assessment, plan and prevention
SSN	social security number
STD	sexually transmitted disease
SV	Sinoatrial
T-CELLS	T-lymphocytes
TJC	The Joint Commission
TLC	total lung capacity
TV	tidal volume
USAF	United States Air Force
USDA	United States Department of Agriculture
UTI	urinary tract infection
UV	ultraviolet
V	vector
VA	visual acuity
VC	vital capacity
V-Fib	ventricular fibrillation
VLDL	very low-density lipoprotein
V-Tach	ventricular tachycardia
VTA-ND	Vision Test Apparatus—Near and Distant
VTS-CV	Vision Test Set—Color Vision
WBC	white blood cells, or “white blood count”

Student Notes

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