Reading Material for

CSST

Punjab Medical Faculty

Specialized Healthcare & Medical Education Department

Government of the Punjab

Author: Dr. Ahmad Naeem Akhtar
M.B.B.S (Pb); MS (G. Surg); CMT (UHS)
PGMI, AMC, LGH, Lahore.

Book-1

PREFACE

After introduction of the new service structure for AHPs in 2012 the qualification requirement for entry in service has been changed to a diploma of two years' duration. This decision has necessitated the development of curricula for the new scheme of studies. The evolving health needs of the community, exponential advances in medical and allied technologies and changes in health services provision, functions and structure also demand continual and responsive changes in education and training programs meant for AHPs. The revised curricula would carry out the following important functions:

- link pre-service education and training with actual task AHPCSST have to perform after being employed, especially in the public sector

The CSST Profession continues to evolve at a rapid pace, with new surgical items being introduced regularly. The processing of robotic, endoscopic, complex orthopedic, spinal and other related instruments and equipment requires special skills and knowledge of decontamination and sterilization process.

By necessity, CSST training has also changed from an on-the-job, hands-on model to a more formal course of study. This CSST manual PMF is design to provide CSST Information needed to understand the basic concept of be contamination sterilization sterility maintenance and related processes so they are batter equipped to handle the increasingly specialized requirements of medical devices reprocessing.

Best Wishes to All AHP Students.

Dr. Ahmad Naeem Akhtar
M.B.B.S (Pb); MS (G. Surg); CMT (UHS)
PGMI, AMC, LGH, Lahore.

Dr. Amina Asif
Muhammad Hasnain

Dedication

I dedicate all the work done to the students so that they may be able to contribute for the provision of the quality health services to the ailing humanity.

The ownership of Muhammad Husnain to his students of CSST in future is really exemplary. It will be unfair if I shall miss the name of Dr. Amina Asif who has been a flag bearer for infection prevention for role projects.

I am really thankful to Dr. Balakh Sher Zaman, AP, North Surgical Ward, Mayo Hospital, Lahore who reviewed the book.

Dr. Ahmad Naeem Akhtar
M.B.B.S (Pb); MS (G. Surg); CMT (UHS)
PGMI, AMC, LGH, Lahore.

TABLE OF CONTENTS

Chapter 1

Introduction to Central Service

Learning Objectives

As a result of successfully completing this chapter, readers will be able to:

1. Explain the importance of the Central Service department, with an emphasis on the service provided and the role of CS in quality patient care
2. Review the work flow process in an effectively organized Central Service department
3. Identify basic knowledge and skills required for effective Central Service technicians
4. Define job responsibilities of Central Service technicians
5. Discuss the role of education and training in the field of Central Service

INTRODUCTION

The majority of medical procedures require the use of supplies, instruments and/or equipment. Some items are used once and then discarded, while others are reused multiple times. Reusable items must be thoroughly cleaned, inspected, disinfected, and/or sterilized before they can be used to treat other patients. The Central Service (CS) department in a healthcare facility performs these important reprocessing activities.

Advancing Technologies

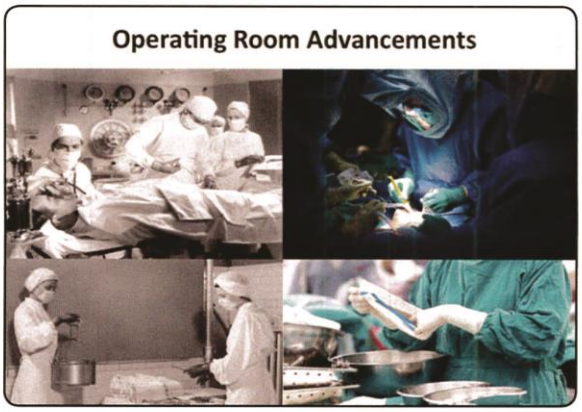


Figure 1.1

Medical technology is rapidly advancing. The medical devices used in the Operating Room (OR) and throughout the healthcare facility have changed dramatically over the years. (See **Figure 1.1**) As these devices become more complex, the same can be said of the methods required to reprocess them. (See **Figure 1.2**)

Figure 1.2

Like the entire medical field, the CS profession has evolved significantly throughout the years. The advances experienced in patient treatment and care have come with advances in the medical devices used to provide those services. Today's increasingly sophisticated medical devices require more complex handling and processing, which has resulted in many changes for CS technicians. These changes have not happened overnight, but have been introduced steadily throughout the past years. For example, one need only to look back a short time to identify changes that have enabled **minimally invasive procedures.** (See **Figure 1.3**) These procedures provide many benefits to patients, including shortened stays, smaller incisions, reduced trauma and shorter recovery times. These procedures require complex instrumentation and that instrumentation requires complex processing protocols.

Medical technologies will continue to advance, devices will become more complex and CS technicians will be required to keep up with advances. This chapter will provide an introduction to the field of CS, and an overview of the knowledge and skills required to meet the demand for timely, safe and functional medical devices.

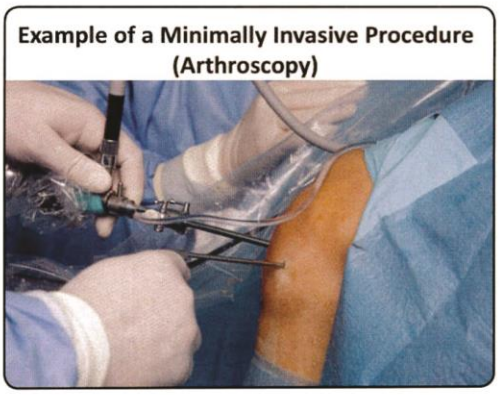


Figure 1.3

Minimally invasive procedure A surgical procedure done in a manner that causes little or no trauma or injury to the patient; it is often performed through a cannula using lasers, endoscopes or laparoscopes. Compared with other procedures, minimally invasive procedures involve smaller incisions, less bleeding, smaller amounts of anesthesia, less pain and minimal scarring.

The "Central" in Central Service

The term "central" suggests that services are centralized. Processing soiled goods and sterilizing devices so they are ready for the next procedure is typically conducted in one centralized location. Many healthcare facilities find an increased demand for processing services, partially as a result of a growing trend: the use of more reusable and more complex medical devices. In addition, many facilities have expanded to clinics, ambulatory surgery centers, professional offices, and other service venues that may be remote from the facility's main location.

In response to this growing demand for processing services, satellite processing units with centralized management have been established. Others have consolidated (centralized) services into an entire **integrated delivery network (IDN).** Other organizations outsource required services to specialized businesses. Regardless of where processing activities are conducted, quality practices must be standardized in compliance with CS policies and procedures to enable standards of practice to be consistent and uniform.

Integrated delivery network (IDN) A system of healthcare providers and organizations that provides (or arranges to provide) a coordinated range of services to a specific population.

Centralized management helps provide maximum utilization of human and materiel resources. This eliminates the costly duplication of processing equipment, utilities, space and personnel. Educated and skilled CS technicians must be knowledgeable about the complexities, precautions and techniques required for their job. They must carry out tasks in a manner that protects the welfare and safety of patients, co-workers, themselves, and their community. Proven material handling techniques are employed to provide high levels of efficiency.

When services are centralized, when the most effective processing equipment is used and when a better educated and prepared work force is available, staff can process a greater volume of materials in less time. This helps to meet the demands of increased workloads in today's healthcare environment.

The "Service" In Central Service

The term "service" is the key to what CS is all about. In most cases, the services delivered by CS personnel assist direct patient care providers by providing the items that are essential for proper patient treatment. Other departments (customers) within the healthcare facility depend on CS for processed sterile supplies, instruments, equipment and/or ready-to-use products provided by medical suppliers. CS personnel must remember that they are an integral part of quality patient care.

Central Service by Many Names

The title "Central Service" is the accepted name for this department in many healthcare facilities and professional organizations. In some facilities, the title "Central Service" is changed to reflect the scope of service or other needs. Not all CS departments provide the same services to their customers. Some departments only provide services to surgery, while others may provide services to many other departments in addition to surgery. No matter how many departments are served, the services provided are always guided by the same principles and standards of operation.

Common names for the department include: Central Processing; Sterile Processing and Distribution; Central Sterile Supply; and Surgical Supply and Processing.

Note: The U.S. Department of Labor uses the name "Medical Equipment Preparers" when discussing this field.

CENTRAL SERVICE WORK FLOW

Because the CS department is the central location for the delivery of soiled (used) medical devices and the distribution of clean and sterile items, proper work flow is important to help ensure safety. Soiled materials must be isolated from their clean counterparts to ensure acceptable processing conditions. A one-way flow of materials from the soiled area to the clean processing area, and on to the sterile storage area is required. (See **Figure 1.4**)

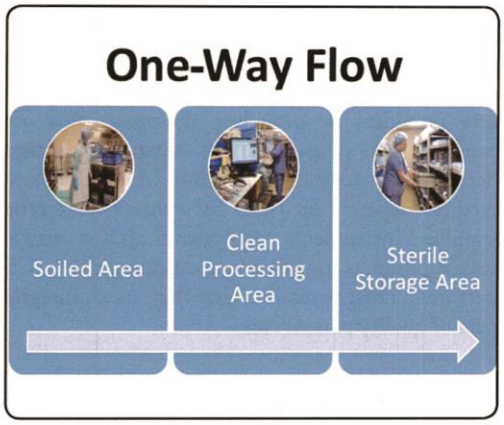


Figure 1.4

To facilitate one-way flow of goods and maintain distinction between soiled and clean work areas, physical barriers or walls are used to segregate the functional areas of CS. These areas include decontamination, preparation and packaging (prep and pack), sterilization and sterile storage/ distribution.

Decontamination

The **decontamination** area is where all soiled instruments and other items are received from user departments. Decontamination is the physical or chemical process that renders an inanimate object, such as a medical device that may be contaminated with harmful microbes, safe for further handling. It involves a thorough cleaning process that may be accomplished with manual and/or mechanical cleaning. Cleaning is the first step in the sterilization process. All items returned to this area are considered contaminated and potentially infectious, and items cannot be considered sterile or high-level disinfected if they are not effectively cleaned. CS technicians must have an in-depth knowledge of the items to be cleaned in this area, and must select the appropriate method of decontamination as recommended by the device manufacturer. Medical devices must then be properly sorted, disassembled and cleaned using the established protocols. (See **Figure 1.5**)

Figure 1.5

Decontamination To make safe by removing or reducing contamination by infectious organisms or other harmful substances; the reduction of contamination to an acceptable level.

Working in the decontamination area requires a thorough knowledge and understanding of microbiology and the decontamination process. CS staff must be able to identify and clean a wide variety of medical devices. Knowledge

Figure 1.6

about cleaning and disinfecting agents and their proper use is critical. Proper protocols for waste disposal, transportation of contaminated items, and operation of equipment used in the cleaning process, including washer-disinfectors, ultrasonic cleaners, cart washers, steam guns and specialty washers, are also required. (See **Figure 1.6**)

CS technicians working in the decontamination area must be protected from the environment. The physical layout of this area, as well as cleaning equipment used in it, must meet the appropriate standards of governmental agencies and the recommendations of professional organizations. Policies and procedures must be developed and followed to ensure that work practices minimize employee injury and exposure to pathogens. To meet the facility's and the Occupational Safety and Health Administration's (OSHA's) safety requirements, CS technicians must wear special attire, called **personal protective equipment (PPE)**. PPE minimizes exposure to bloodborne pathogens and other contaminants. PPE includes fluid-resistant facemask, eye protection, a fluid-resistant cover gown, general purpose utility gloves, and fluid-resistant shoe covers.

Personal protective equipment (PPE) A part of standard precautions for all healthcare workers to prevent skin and mucous membrane exposure when in contact with blood and body fluid of any patient. PPE includes fluid fluid-resistant protective clothing, disposable gloves, eye protection, face masks and shoe covers.

Preparation and Packaging

After items are safe for handling, they are delivered to the prep and pack area of the CS department. Each item is carefully inspected for cleanliness, proper function and possible defects. Instruments and other devices are assembled, packaged and labeled in preparation for sterilization.

CS technicians must be able to identify hundreds of surgical instruments. They must understand

how instruments are manufactured, how they are constructed, how to test them and how to best maintain them. They must be able to inspect devices for cleanliness, proper condition and function. It is essential that CS professionals have the knowledge and training to maintain instruments properly, consistently and safely. (**Figures 1.7** and **1.8** provide examples of inspection and assembly activities.)

Figure 1.7

Figure 1.8

Surgical specialty instruments, equipment and implants also require special knowledge and expertise. CS technicians must be able to select the proper packaging system and use proper techniques for wrapping and packaging items for sterilization. (See **Figure 1.9**)

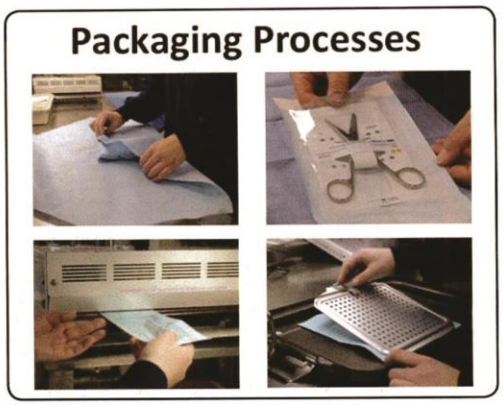


Figure 1.9

Sterilization

Items to be sterilized must be properly identified, and the correct methods and parameters for sterilization must be followed according to the manufacturer's **Instructions for Use (IFU).** The principles necessary to achieve sterilization must be understood and applied. Sterilizers must be loaded and operated properly, and sterilization quality assurance measures must be followed to help ensure that sterilization parameters have been met. Records must be maintained, and factors that can compromise sterile packaging must be understood, prevented and detected. (See **Figure 1.10**)

Instructions for Use (IFU) Information provided by a device manufacturer that provides detailed instructions on how to properly use and process the device.

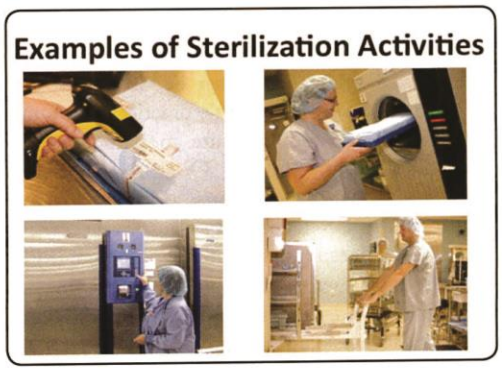


Figure 1.10

Personnel working in the preparation, packaging and sterilization areas of CS must wear facility-restricted attire, such as a scrub suit and hair coverings. It is essential that CS professionals diligently adhere to dress codes and safe work practices to protect the environment from contamination.

Sterile Storage and Distribution

The supply area of CS is dedicated to the storage of sterile instruments and clean or sterile supplies. A separate area for removing supplies from shipping cartons and containers should be provided. The major portion of the work in this area involves receiving, storing, and dispensing supplies and sterile instruments. (See **Figure 1.11**)

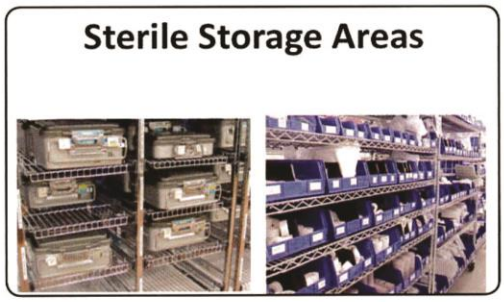


Figure 1.11

While items may be dispensed to almost all departments within a healthcare facility, the major focus of this area is servicing the OR. This is usually accomplished through the use of a **case cart system**. The bulk of surgical supplies may be stored in a central location (the CS department). A dependable system must be in place to supply items to surgery from the sterile storage area. (See **Figure 1.12**)

Figure 1.12

Surgical procedures are usually scheduled through a surgery scheduling office using a special computer program. When surgical procedures are scheduled, authorized personnel assign a **case cart** or **doctor's (physician's) preference card** to each procedure. This generates a **case cart pull sheet (pick list)** that identifies items specific to the doctor and procedure. CS technicians use this sheet to place supplies from the sterile storage area storage shelves onto the case carts that transport these items to the appropriate OR/surgical suite. Personnel working in this area usually gather instruments and supplies needed for all scheduled surgical procedures during the day or evening before they will be used.

Other areas within the healthcare facility may be supplied from the sterile storage area. Also, hospital personnel from different departments frequently require items that are only available from CS. Those working in the sterile storage area must be familiar with all supplies within the location in order to provide fast and accurate customer service.

Open lines of communication must be maintained between those in CS and sterile storage areas to help ensure that an adequate stock of sterile items is always available. Also, the **Materiel Management department** is an important link in the supply process; therefore, effective communication and effective problem solving skills must be fostered between personnel in these two important departments.

Personnel working in the sterile storage area must have thorough knowledge of every item, how it is used, where it is located and the process for obtaining it. Other knowledge and skills include those needed for:

- Inventory control and supply distribution.
- Surgical specialties and procedures.
- Sterile storage and handling requirements.
- Computer systems relating to inventory and case carts.

- Acquisition and disposition of supplies.
- Resolution of supply problems.

All CS areas must exercise careful environmental control conditions. Each work area should be restricted to assigned and authorized personnel who consistently follow the facility's dress code policies. Strict traffic control patterns must control the movement of people and goods through the department. Air pressure levels must be maintained to control air movements. Proper air pressure control helps to prevent the flow of bacteria-laden particulates and dust from the soiled to the clean areas.

Case cart system An inventory control system for products/equipment typically used in an Operating Room that involves use of an enclosed or covered cart generally prepared for one surgical case, and not used for general supply replenishment.

Case cart A cart prepared for an individual procedure. Case carts usually contain all instruments, supplies and utensils needed for a specific procedure.

Doctor's (Physician's) preference card A document that identifies a physician's needs (requests and preferences) for a specific medical procedure. Preference cards usually contain information regarding the instruments, equipment, supplies and utensils used by a specific physician. They may also include reminders for the staff of the physician's preferences regarding patient draping, instruments and supplies.

Case cart pull sheet (pick list) A list of specific supplies, utensils and instruments for a specific procedure. Central Service technicians use these lists to assemble the items needed for individual procedures.

Materiel Management department The healthcare department responsible for researching, ordering, receiving, and managing inventory (consumable supplies).

THE PROCESSING CYCLE

Work performed in CS usually follows the following processing cycle. (See **Figure 1.13**) After use, items that can be reprocessed are returned to the decontamination area to start the process all over again. It is important to note that at each step in the process, items are inspected to ensure that they are clean, in good repair, assembled and processed correctly. It is also important to ensure that packaging materials are not damaged, which could compromise sterility.

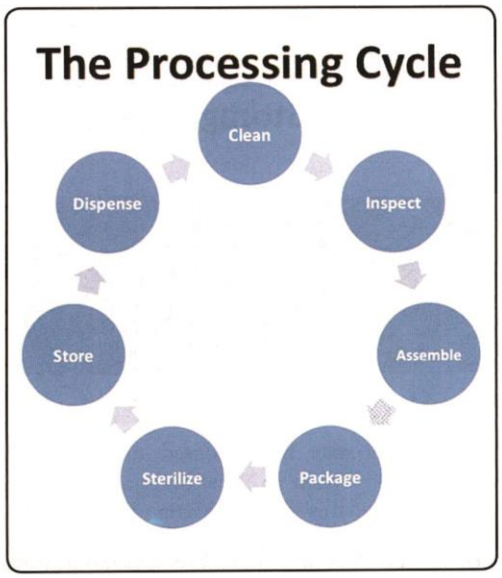


Figure 1.13

CS technicians must not only master specific skills in each work area to perform the job, but they must also learn new ones as technologies, regulations, standards, and best practices evolve. **Figure 1.14** provides some examples of skills CS technicians may routinely perform.

Figure 1.14

A Basic Educational Foundation Is Needed

Numerous dimensions of knowledge and skills are required for Central Service technicians to be successful in their jobs. A basic educational foundation is necessary to form the base for more specialized knowledge and skills. Examples of this education foundation include the ability to:

- Read and write, including the use of reports, manuals and Instructions for Use.
- Communicate with inter- and intra-departmental team members.
- Interpret technical materials used for CS practices and procedures.
- Understand concepts of microbial transmission and infection prevention.
- Understand and use surgical and medical terminology.
- Operate tracking and other CS-related computer systems.

BASIC JOB KNOWLEDGE AND SKILLS

CS professionals require significant knowledge and skill sets to perform effectively on the job. Knowledge and skill sets should include the following:

Communication Skills

CS technicians must know alternative methods of providing and obtaining information; they must be effective oral and written communicators. To do so, they must be able to:

- Assess the ability of other people to understand what is being communicated.
- Adapt communication style to individual needs.
- Apply active listening skills using reflection, restatement and clarification techniques.
- Interact appropriately and respectfully with diverse groups in numerous employment situations.
- Communicate in a straightforward, understandable, accurate and timely manner.

- Use facility-specific guidelines and methods to send and receive information.
- Access and use electronically-produced information.

Facility Systems

CS technicians must understand how their role fits into their department, their organization and the overall healthcare environment. They must be able to identify how key systems affect the services they perform and the quality of care they provide. To do so requires that they:

- Are aware of the range of services offered to customers.
- Prevent unnecessary waste and duplication.
- Participate in quality improvement activities.
- Use resources, including other staff members, manuals and training opportunities.

Employability Skills

Successful CS technicians practice employability skills to enhance their employment opportunities and job satisfaction, and they maintain and upgrade those skills as required. Examples include:

- Maintaining appropriate personal skills, such as attendance and time management, and assume individual responsibility for their actions.
- Maintaining professional conduct standards.
- Using analytical skills to solve problems and make decisions.
- Formulating solutions to problems using critical thinking skills (analyze, synthesize, evaluate), independently and in teams.
- Adapt to changing situations.
- Practice personal integrity and honesty.
- Engage in continuous self-assessment and goal modification for their personal and professional improvement.
- Exhibit respectful and empathetic behavior as they interact with peers, superiors, subordinates and customers in one-on-one and group situations.
- Listen attentively to verbal instructions, requests and other information to verify accuracy.
- Understand various career options and the preparation required for them.

Legal Responsibilities

CS technicians must understand and maintain an awareness of the legal responsibilities and limitations, and the implications of their actions within the healthcare delivery setting. To do so, they must:

- Solve problems relating to legal dilemmas or issues.
- Comply with established risk management factors and procedures.
- Determine when an incident must be reported.
- Maintain confidentiality.
- Operate within the required scope of practice.
- Follow mandated standards for workplace safety.
- Apply mandated standards for harassment, labor and other employment laws.
- Comply with legal requirements for documentation.

Ethics

Ethics relates to knowing the difference between "right" and "wrong." In the healthcare environment, it means conforming to accepted and professional

standards of conduct. Ethical behavior is "doing the right thing in the right way." Ethics should govern and guide the way CS technicians act and make decisions. They must always:

- Respect patient rights.
- Promote justice and the equal treatment of all individuals.
- Recognize the importance of the patient's needs over other considerations.
- Exhibit loyalty to fellow workers and the healthcare facility.
- Report any activity that adversely affects the health, safety or welfare of patients, visitors or fellow workers.
- Comply at all times with pertinent regulatory guidelines, facility policies, departmental policies and procedures.
- Respect interdisciplinary differences among team members.
- Differentiate between ethical and legal issues.
- Demonstrate professionalism when interacting with co-workers and customers.

Safety Practices

Successful CS technicians understand existing and potential hazards to patients, co-workers, and themselves. They prevent injury or illness through safe work practices, and they consistently follow health and safety policies and procedures. They do so as they:

- Practice infection control procedures.
- Use **standard precautions** to control the spread of infection.
- Practice appropriate cleaning, disinfecting and sterilizing processes.
- Apply principles of body mechanics, including use of proper lifting techniques.
- Recognize and correct fire and electrical hazards.
- Use equipment as directed.
- Manage hazardous materials.
- Use safety data sheets (SDS).
- Follow emergency procedures and protocols.
- Comply with pertinent regulatory guidelines, including OSHA standards.

Standard precautions Method of using appropriate barriers to reduce the risk of transmission of bloodborne and other pathogens from both recognized and unrecognized sources. It is the basic level of infection control to prevent transmission of infectious organisms from contact with blood and all other body fluids to non-intact skin, and mucous membranes. This standard applies to all patients, regardless of diagnosis or presumed infectious status.

Teamwork

CS technicians must understand the roles and responsibilities of individual members as part of the healthcare team, including their ability to promote the delivery of quality healthcare. They must interact effectively and sensitively with all members of their team, and do so when they:

- Practice team membership skills, such as cooperation, leadership and anticipation of their co-workers' needs.
- Respect diversity within their team.
- Interact with others in a manner consistent with the healthcare team's structure and lines of authority.
- Manage conflict within the workplace by considering the points of view of others.

- Respect and value the expertise and contributions of all team members.
- Accept compromise as necessary to ensure the best outcomes.

Resource Management

CS technicians must understand and practice principles and techniques of resource management. CS technicians manage resources effectively when they:

- Control costs and reduce waste.
- Provide quality service.
- Practice time management skills.
- Identify and solve potential problems and anticipate customers' needs.
- Know and use inventory appropriately.
- Practice recycling and sustainability, whenever possible.

Other Skills

Other skills are also required by CS technicians. For example, they must:

- Practice prescribed techniques to prevent **healthcare-associated infections (HAI)**.
- Keep departmental work areas in good repair.
- Keep their work environment clean and organized.

New healthcare roles demand higher levels of skill than ever before for those working in CS. The complexities created by technology continue to grow and a new breed of healthcare professional is emerging.

Healthcare-associated infection (HAI) An infection that is not present when a patient is admitted to a hospital or healthcare facility. If the infection develops in a patient on or after day three of admission to the hospital or healthcare facility, the infection is referred to as a hospital-acquired or healthcare-associated infection.

BASIC JOB RESPONSIBILITIES

CS technicians are accountable for many tasks. **Job descriptions** are used to define and communicate job duties and requirements to employees within an organization. They are intended to be overviews that capture the general purpose and major accountabilities of a job, and they are used for the following reasons:

- To evaluate positions and determine compensation. They can be used in conjunction with other resources to establish a pay range for a given position.
- To clarify expectations. Job descriptions outline key job duties, which can be reviewed at the time of hire to clarify performance standards and expectations. They should be reviewed regularly (usually annually) by both the supervisor and those who occupy the position.
- To review performance. Job descriptions can be used during annual performance reviews.
- To recognize exceptional performance, restate performance expectations, determine growth opportunities and establish goals.

Because CS departments vary in size and scope of service, and because jobs within the CS department vary, there is no single job description that applies to all situations. When seeking a new position, it is important to review the job description to determine if the duties and expectations are a fit for your skills and abilities.

Job description A human resources tool that identifies the major tasks performed by individuals in specific positions.

Career Growth and Professional Development

Many CS departments still use on-the-job training to fulfill job demands; however, as CS has developed more fully into a profession, formal education and **certification** of CS technicians is frequently becoming a requirement for working in the department. Some states require certification to work in CS, and many healthcare facilities require it as a condition of employment.

Formal CS technology training courses are becoming readily available through post-secondary education systems. Many healthcare systems are developing their own training courses for teaching CS technology. Long-distance learning courses are also available for those who do not have an organized training course readily available in their area.

Career growth and professional development opportunities for CS professionals typically depend on their individual motivation to achieve departmental and personal goals. Many facilities offer career progression with more work responsibilities and higher compensation levels within the role of CS technician. As knowledge and responsibilities increase, a qualified and high-performing technician can advance. *Note: Additional information about professional development is discussed in Chapter 24.*

Certification Association/industry recognition attained by individuals with educational and/or work experience requirements who successfully complete an examination process demonstrating their knowledge of pertinent, job-related subject matter.

Education and Experience Are Critical

To survive in today's dynamic and complex environment, it is necessary to be prepared, and education and experience become absolutely critical to do so. Qualified and educated professionals are in demand to meet the new challenges in Central Service departments.

Upward mobility to supervisory and management positions requires experience, education and skills.

Compensation

Compensation, including benefits, is influenced by many factors, such as job descriptions, scope and span of responsibility, size of facility, organizational structure, job market and geographic location. At the department head level, the CS director should be fairly compensated relative to organizational peers. As previously mentioned, there are a growing number of healthcare facilities that compensate CS staff members with pay increments based on experience, high performance, additional education and training, and upon certification.

CONCLUSION

The Central Service environment is dynamic and fast paced. The work is challenging, highly technical and complex. The performance of this vital department has a major impact on the successful operation of the many departments to which it provides products and services.

Inefficiencies in productivity, errors that create the need for rework, and poor quality performance are costly to hospitals. With the ever-increasing costs of healthcare, CS professionals must conserve resources and minimize expenses. More important is the safety and welfare of patients who have entrusted the facility with their care. Negligence and carelessness in CS could cost a patient's life.

CS is an evolving occupational discipline. Over the years, there have been dramatic changes (ranging from the increased use of technology and support services provided to the job skills, training and educational requirements) needed to fulfill these job responsibilities. Changes continue at a rapid pace.

Conscientious CS professionals will find great satisfaction in knowing their efforts, service, special skills and due diligence are a part of every surgical procedure, every patient's recovery and every positive outcome.

RESOURCES

U.S. Department of Labor. *Medical Equipment Preparers*, http://www.bls.gov/oes/2006/may/oes319093.htm. Accessed September 2014.

Colbert BJ. *Workplace Readiness for Health Occupations*. Second Edition. Thomson Delmar Learning. 2006.

Booth KA. *Health Care Science Technology: Career Foundations*. McGraw-Hill Companies Inc. 2004.

U.S. Department of Education. *National Health Care Skill Standards*. The National Consortium on Health Science & Technology Education.

CENTRAL SERVICE TERMS

Minimally invasive surgery (MIS)

Integrated delivery network (IDN)

Decontamination

Personal protective equipment (PPE)

Instructions for Use (IFU)

Case cart system

Case cart

Doctor's (Physician's) preference card

Case cart pull sheet (pick list)

Materiel Management department

Standard precautions

Healthcare-associated Infection (HAI)

Job description

Certification

Chapter 2

Medical Terminology for Central Service Technicians

Learning Objectives

As a result of successfully completing this chapter, readers will be able to:

1. Explain the importance of medical terminology for Central Service technicians
2. Identify the various elements used in medical terminology including prefixes, roots and suffixes
3. Discuss how medical terminology can refer to the human anatomy, disease processes, surgical instruments and surgical procedures
4. Understand medical terminology used to refer to surgical procedures in surgery schedules
5. Understand the importance of medical terminology for service quality in the Operating Room

INTRODUCTION

Central Service (CS) technicians require knowledge of medical terms to help them succeed on the job. The special terminology used to describe parts of the body, diseases, instruments and surgical procedures will be addressed in this chapter.

IMPORTANCE OF MEDICAL TERMINOLOGY

The Healthcare Profession

The Association of periOperative Registered Nurses (AORN) specifically states that "skilled and competent allied health care providers and support personnel are valued members of the perioperative care team, contributing to safe patient care and positive patient outcomes." As such, CS technicians must have a grasp of the medical terminology that is used by healthcare customers, as well as by fellow CS professionals. The American National Standards Institute (ANSI) and the Association for the Advancement of Medical Instrumentation (AAMI), in ANSI/AAMI ST79, 4.2.2, specifically states that CS technicians must be "knowledgeable and competent" to adequately perform the vital tasks that they perform. Indeed, The Joint Commission (TJC) states that in order to maintain a reliable system for medical device processing, institutions must place an emphasis upon the "orientation, training and competency of health care workers" responsible for this task. Understanding medical terminology is part of the training and competency that CS technicians should possess.

Understanding the Operating Room

CS professionals must provide Operating Room (OR) personnel with the instruments and supplies needed for surgical procedures. As these needs are conveyed, CS technicians must also understand the terminology/language spoken to them in order for them to provide quality customer service and contribute to positive patient outcomes.

For example, if the OR calls for instrumentation needed for an emergency pericardial window, a knowledgeable CS technician will know that this is a cardiac procedure that involves cutting into the pericardium (a membranous sac that surrounds the heart) in order to drain fluid from the pericardial space into the pleural cavity. Also, if the OR calls for a case cart for a **STAT** Repair of an Abdominal Aortic Aneurysm (AAA), this request will be responded to immediately as the CS technician will understand that the patient is at risk of losing his/her life. If the OR issues a request for a case cart for a routine Laparoscopic Cholecystectomy, the CS technician will know that this is not an emergency case. The case cart will still be picked and the instruments and supplies will still be prepared and organized; however, this is usually not an emergency situation.

STAT Abbreviation for the Latin "statim" meaning immediately or at once.

Providing Quality of Service to the Patient

It is through knowing and understanding medical terminology that CS technicians are able to understand what is being asked of them. This knowledge of medical terminology enables the CS technician to react in an appropriate manner when the OR or medical staff makes a request; however, the opposite is also true. If the OR makes a request that is not understood, the productivity of the OR is compromised. This interruption of the perioperative process will compromise the quality of service rendered to the patient and may cause a delay in treatment. Nothing is more important than quality. For this reason, TJC and the Centers for Disease Control and Prevention (CDC) recommend that all healthcare institutions provide comprehensive and intensive training for all staff involved in the processing of medical instrumentation.

ANATOMY OF A MEDICAL TERM

CS technicians frequently encounter specialized medical terms in their daily work activities, and each of those terms contains key elements to help staff better understand the words' origin and meaning. As technicians learn the meanings of these names, they will have a greater understanding of what their work involves, and their competency and job satisfaction will increase.

Word Elements

The majority of medical terms are of either Greek or Latin origin. The word "pericardium," for example, is composed of two Greek **word elements:** peri (meaning around), and kardia (meaning heart). Hence, the term is used to refer to the membranous sac that surrounds the heart, as well as the roots of the great vessels of the heart. The term "rigor mortis" is composed of two Latin word elements: rigor (stiffness) and mortis (meaning "of death"); hence, the term is used to refer to the stiffening of the body that occurs after death. Many terms combine both Greek and Latin word elements to form a single medical term. For example, the term "claustrophobia" (meaning fear of enclosed spaces) joins the Latin word element "claustrum" (enclosed space) to a Greek word element "phobia" (fear). Another example of this blending of Greek and Latin in the formation of medical terms can be seen in the term "autoclave" (a term that is very important for CS). The term "auto" (Greek) refers to self while the term "clavis" (Latin) refers to a key; hence, an autoclave is a type of self-locking device (a sterilizer is designed to not open until its cycle is finished).

At first, medical terminology may seem daunting and overwhelming; however, after a working knowledge of these word elements is gained, it becomes easier to analyze and use the words effectively.

Medical terminology changes with the dynamics of evolving technology in healthcare. New terms, abbreviations and words are constantly being created to meet the needs of this new technology. Through word association and memorization of basic medical terms and word elements, CS professionals can establish a solid foundation upon which to build an extensive vocabulary. A CS professional's vocabulary must be in a constant state of growth, evolution and development.

Prefixes, Roots and Suffixes

The anatomy of a medical word may (but will not always) consist of three types of word elements:

- **Root word element** Tells the primary meaning of a medical term, which can then be modified by either a prefix, suffix or both. Many roots signify a procedure, disease or body part. Again, let's use "cardio," the medical term for "heart" as an example. The term "cardiology" features the root "cardio" in combination with the suffix "ology," which, in this instance, refers to the study of things related to the heart. The term "endocarditis" also features the root "cardio," but here the root is modified by a prefix "endo" (meaning within,) as well as a suffix "itis" (meaning inflammation); therefore when the entire word is analyzed, the word means inflammation of the inner portion of the heart. The term "Cardiothoracic" features two roots: "cardio" (meaning heart), and "thoracic" (meaning chest); hence, a Cardiothoracic surgeon performs surgery on the heart, its major vessels, and the lungs. The term "electrosurgery" also features a combination of two roots. While the root "electro" refers to the use of electrical current, the root "surgery" refers to the act of performing surgery (the use of electrical current to cut and cauterize during surgery).
- **Prefix word element** Comes before the root. When added to a root (at the beginning of a word), the prefix can alter or modify its meaning. For example, the medical term for the prefix "around" is "peri"; therefore, the term "pericardial" means "around the heart." The term "perioperative" refers to the entire process surrounding a surgical procedure: before (preoperative), during

(intraoperative), and after (postoperative). The prefix "peri" is also found in the surgical instrument called periosteal elevator. Here, the prefix "peri" (around) is attached to the root "osteo" (bone); hence, a periosteal elevator is an instrument used to remove tissue from around a bone (the periosteum). Even the term "abnormal" functions in this way. The "ab" functions as a prefix to negate the meaning of the root "normal"; hence, the meaning of the word is not "normal."

- **Suffix word element** Comes after the root. When added to the root (at the end of a word), the suffix can also alter or modify its meaning. For example, the medical term for the suffix that means inflammation is "itis"; therefore, the term "pericarditis" refers to inflammation (itis) around (peri) the heart (cardio). Most of us are acquainted with the term "tonsillitis" as referring to the inflammation of the tonsils. Bronchitis refers to the inflammation of the bronchi, which are the tubes extending from the trachea into both sides of the lungs; hence, whenever the suffix "itis" is found at the end of a medical term (modifying a root word preceding it), a meaning of inflammation will be present.

Of special note with the term "pericarditis" is that the "o" in the root "cardio" is dropped in the word "pericarditis." This reflects something called a **combining vowel**. In many cases, a combining vowel (usually an "o") is either added to a root or removed from it to ease the pronunciation of the word. The use of combining vowels can result in some rather long medical words. The linguistic effect of this addition or elimination of the combining vowel is to ease the pronunciation of the word. For example, the term "herniorraphy" which refers to the suturing/repairing (-rrhaphy) of a rupture/hernia (herni), contains an "o" which has been added as a combining vowel (herni-o-rrhaphy). Conversely, the term "proctitis," which refers to inflammation of the rectum, features the dropping of the combining vowel "o" (procto/rectum + itis/inflammation = proctitis). While the addition or elimination of a combining vowel is common in medical terminology, it is important to understand that not all medical terms have combining vowels.

Word elements Parts of a word.

Root word element Tells the primary meaning of a word; also called base word element.

Prefix word element The word element that comes before the root word element.

Suffix word element The word element that comes after the root word element.

Combining vowel A letter (usually an "o") that is sometimes used to ease the pronounciation of a medical word.

An easy way to remember the difference between prefix (which comes before the root) and suffix (which comes after the root) is to put the words in alphabetical order: prefix, root and suffix. This tells you that prefix is the first word element and suffix is the last word element.

Note: Not all medical terms consist of all three word elements. A medical term may be formed by a root alone, by combining two roots, a root and suffix, or a prefix and root. Some medical terms can even be formed by combining three roots together.

The best way to learn the meaning of a medical term is to analyze and understand its components, so that the word can be taken apart. Begin with the suffix (if present) since it most often gives a clue and meaning about the root, and how it is being used. Then consider the root and prefix (if present). In other words, consider the overall relationship between each word element in the term. Medical terms can be a lot like building blocks; if one can figure out how they fit together, one can determine what they mean.

Prefix	Root	Suffix	Word
hemi- (half)	arthro (joint)	-plasty (surgical restoration)	hemiarthroplasty (surgical restoration of half of a joint, the femoral portion of the hip joint, the proximal femur, a form of hip replacement surgery)
hemi- (half)	gastro (stomach)	-ectomy (surgical removal)	hemigastrectomy (removal of half of the stomach) *Note: The combining vowel "o" is dropped in this word.*
hemi- (half)	colo (colon)	-ectomy (surgical removal)	hemicolectomy (removal of half of the large intestine) *Note: The combining vowel "o" dropped from this word.*
para- (beside,near)	thyroid (thyroid)	-ectomy (surgical removal)	parathyroidectomy (surgical removal of parathyroid glands)
septo- (dividing wall)	rhino (nose)	-plasty (surgical restoration)	septorhinoplasty (surgical restoration of the nose) *Note: Two roots combined with a suffix.*
chole- (bile)	cyst (fluid-filled sac)	-ectomy (surgical removal)	cholecystectomy (surgical removal of the gallbladder) *Note: Two roots combined with a suffix.*
electro- (electrical activity)	cardio (heart)	-gram (written record of)	electrocardiogram (written record of the electrical activity of the heart) *Note: Two roots combined with a suffix.*
electro- (electrical activity)	encephalo (brain)	-gram (written record of)	electroencephalogram (EEG) (the tracing of brain wave activity) *Note: Two roots combined with a suffix.*

Figure 2.1 Combined Word Elements

Figure 2.1 shows additional examples of how word elements are combined to form medical terms. Sample words shown here contain a prefix, a root and a suffix. While not all medical terms feature all three word elements in the same word, it is important to understand that many medical terms do feature all three word elements.

When analyzing medical terms, several suffixes meaning "pertaining to" may be encountered. **Figure 2.2** provides several examples of suffixes, words in which they are used, and the meaning of the words.

Figure 2.2 Suffixes that Mean "Pertaining To"

Suffix	Example	Meaning
-ac	cardi-ac	pertaining to the heart ("o" in cardio is dropped)
-al	derm-al	pertaining to the skin
-ic	hem-ic	pertaining to blood
-eal	esophag-eal	pertaining to the esophagus
-ary	pulmon-ary	pertaining to lungs
-ous	cancer-ous	pertaining to cancer

Just as with the English language, certain rules of grammar apply to medical terminology. Making medical terms conform to the basic rules of spelling and pronunciation may result in letters in the word element being changed, dropped or added. **Figure 2.3** shows some examples.

Figure 2.3 Letters in Word Elements May Be Dropped or Added

Prefix	Root	Suffix	Word	Letters Changed
	procto (rectum)	-itis (inflammation)	proctitis	"o" is dropped
	broncho (bronchus)	-itis (inflammation)	bronchitis	"o" is dropped
	endo (within)	-oscopy	endoscopy	"o" is dropped
	artery (artery)	-ectomy (removal)	endarterectomy	"o" and "y" are dropped
	fascia	-otomy	fasciotomy	"a" is dropped
	chir (hand)	-plasty (surgical repair)	chiroplasty	"o" is added
	herni (rupture)	-rrhaphy (to suture)	herniorrhaphy	"o" is added
	hyster (uterus)	-pexy	hysteropexy	"o" is added

As noted above, when analyzing a medical term, it is sometimes best to start with the meaning of the suffix. In this way, one can readily identify if the word relates to a surgical procedure, a medical condition or a portion of the human anatomy. **Figures 2.4** and **2.5** list some common medical and surgical suffixes. Suffixes are word elements that come after the root word, and may be one or two syllables.

Figure 2.4 Common Medical Suffixes

Suffix	Meaning	Example	Combined Meaning
-algia	pain	neuralgia	nerve pain
-cide	kill	bactericide	a substance that kills bacteria
		virucide	a substance that kills viruses
		fungicide	a substance than kills fungi
-emia	blood	hyperglycemia	high blood sugar
		hypoglycemia	low blood sugar
-genic	origin	osteogenic	originating in the bones
		iatrogenic	an adverse effect or complication originating from a physician
-gram	record/image of	mammogram	a radiographic image of the breast for early detection of breast cancer
		cholangiogram	a radiographic image of the bile ducts using contrast medium to check for blockage (frequently done during a cholecystectomy)
		arthrogram	a radiographic image of a joint after injection of a contrast medium
		angiogram	a radiographic image of the inside, or lumen, of blood vessels and organs of the body using a contrast agent
-itis	inflammation	tonsillitis	inflammation of the tonsils
		hepatitis	inflammation of the liver
		arthritis	inflammation of a joint
		bronchitis	inflammation of the bronchi
		meningitis	inflammation of the meninges (the membranous layer surrounding the brain and spinal cord)
-megaly	large or enlargement	cardiomegaly	enlargement of the heart
-necrosis	death of tissue	arterionecrosis	tissue death of an artery
-ology	study of	bacteriology	the study of bacteria
		oncology	study of cancer
		neurology	study of the nervous system
		cardiology	study of the heart
		nephrology	study of the kidney
-oma	tumor	carcinoma	malignant tumor
		myoma	tumor consisting of muscular tissue
		meningioma	tumor of the meninges (the membranous layer surrounding the brain and spinal cord)
		fibroadenoma	a breast lump composed of fibrous and glandular tissue
		papilloma	a benign tumor which grows on the skin or mucous membrane, can be caused by a virus
-pathy	disease	encephalopathy	disorder or disease of the brain
		cardiomyopathy	disorder or disease of the heart
-rrhage	flow	hemorrhage	uncontrolled flow of blood

Figure 2.5 Common Surgical Suffixes

Suffix	Meaning	Example	Combined Meaning
-cise	cut	excise	to cut out
		incise	to cut into
-ectomy	surgical removal	cystectomy	removal of a cyst
		tonsillectomy	removal of the tonsils
		pneumonectomy	removal of a lung
		laminectomy	removal of a portion of a lamina (part of the vertebra in the spine)
		hysterectomy	removal of the uterus
		appendectomy	removal of the appendix
		thrombectomy	removal of a blood clot
		orchiectomy	removal of a testicle
		nephrectomy	removal of a kidney
		vitrectomy	removal of some or all of the vitreous humor from the eye
		hemorroidectomy	removal of swollen or inflamed vascular structures in the anal canal
		bunionectomy	removal (realignment) of a misaligned bone in the big toe
		discectomy	removal of a herniated disc in the spine
		microdiscectomy	minimally invasive removal of a herniated disc in the spine
		thyroidectomy	removal of the thyroid gland
-oscopy	visual examination and possible treatment of an organ or joint	laparoscopy	visual examination of organs in the abdomen
		arthroscopy	visual examination of a joint
		cystoscopy	visual examination of the bladder
		bronchoscopy	visual examination of the bronchi
		colonoscopy	visual examination of the large intestine
		thoracoscopy	visual examination of the thoracic cavity
		fluoroscopy	an imaging technique which provides live images (motion included) of a surgical site during surgery, referred to as C-Arm due to its shape
-ostomy	creation of an opening	colostomy	creation of new opening to colon
		tracheostomy	creation of new opening to trachea
		urostomy	creation of new opening for the urinary system
		nephrostomy	creation of a new opening to the kidney for the urinary system

Suffix	Meaning	Example	Combined Meaning
		ventriculostomy	creation of an opening within a cerebral ventricle for drainage
		ileostomy	creation of a new opening to the ileum (a portion of the small intestine near the colon/large intestine)
-otomy	incision into an organ	craniotomy	incision into the skull
		thoracotomy	incision into the pleural space of the chest
		arthrotomy	incision into a joint
		osteotomy	incision into a bone
		fasciotomy	incision into the fibrous membrane (fascia) which covers a muscle
		urethrotomy	incision into the urethra
		fistulotomy	incision into a fistula (an abnormal connection between two organs or vessels)
		sternotomy	incision into/splitting of the sternum (breastbone)
-pexy	surgical fixation	orchiopexy	surgical fixation of an undescended testicle to the correct location
		hysteropexy	abdominal fixation of the uterus
-plasty	surgical restoration	rhinoplasty	surgical repair of the nose
		arthroplasty	surgical repair of a joint
		cranioplasty	surgical repair of the skull
		tympanoplasty	surgical repair of the ear drum
		urethroplasty	surgical repair of the urethra
		kyphoplasty	surgical repair of a fractured vertebra by percutaneous (through the skin) injection of bone cement
-rrhaphy	to suture	myorraphy	to suture a muscle wound
		herniorraphy	to suture a hernia
-tome	a cutting instrument	dermatome	an instrument used for cutting skin
		osteotome	an instrument used for cutting bone

As can be seen by the brief listing of suffixes in **Figures 2.4** and **2.5**, medical terms can be complex and can mean entirely different things depending on how they are composed. For example, while the word "tonsillitis" means inflammation of the tonsils, the word "tonsillectomy" refers to the surgical removal of the tonsils. Herein lies the adventure of building a medical terminology vocabulary: words can mean entirely different things depending on how the root is used in concert with a prefix, suffix or both. **Figures 2.6** and **2.7** contain a listing of common roots found in medical terminology. Roots are base word elements that refer to the main body of a medical word.

Figure 2.6 Common Medical Roots

Root	Meaning	Example	Meaning
adeno	gland	adenoma	glandular tumor
aero	air	aerobic	requiring oxygen for growth
		anaerobic	not requiring oxygen for growth
arthro	joint	arthritis	inflammation of a joint
broncho	bronchus	bronchoscope	endoscope used to visualize the bronchi
cardio	heart	endocarditis	inflammation of the inner layer (endocardium) of the heart
		cardiomyopathy	heart muscle disease
		cardiopulmonary resuscitation (CPR)	emergency efforts to revive a person in cardiac arrest by means of chest compressions and rescue breaths
		myocardium	cardiac/heart muscle
cerebro	brain	cerebrospinal	referring to the brain and spinal cord
chole	bile	cholecyst	gallbladder
chondro/io	cartilage	chondroma	cartilaginous tumor
costo	rib	intercosto	between the ribs
cysto	bladder	cyst	any fluid-filled sac
cyto	cell	erythrocyte	red blood cell
derma	skin	dermopathy	skin disease
gastro	stomach	gastrointestinal	pertaining to the stomach and intestines
gyne	woman	gynecology	the study of diseases affecting the female
hema or hemat	blood	hemophilia	inability of the blood to clot
		hemostat	instrument used to control bleeding
		hematoma	collection of blood in tissue
		hemodialysis	filtration of the blood mechanically, occurring outside the body
hepat	liver	hepatitis	inflammation of the liver
leuko	white	leukocyte	white blood cell
		leukemia	a form of cancer of the blood or bone marrow involving abnormal white blood cells
nephros	kidney	nephritis	inflammation of the nephrons in the kidneys
		nephrosis	degenerative disease of the kidneys
thrombus	blood clot	thrombosis	formation of a blood clot inside a blood vessel obstructing the flow of blood (DVT= deep vein thrombosis)

Figure 2.7 Common Surgical Roots

Root	Meaning	Example	Meaning
arthro	joint	arthroscopy	visual examination of a joint
		arthrocentesis	joint puncture for the aspiration of synovial fluid
		arthrodesis	surgical fusion of a joint
colo	colon	colectomy	removal of part of the large intestine
cranio	skull	craniotomy	surgical opening into the skull
herni	rupture	herniorrhaphy	surgical repair of a rupture
hyster	uterus	hysteropexy	abdominal fixation of the uterus
		hysteroscopy	visual examination of the uterus
lipo	fat	liposuction	aspiration of fat cells
litho	stone	lithotripsy	crushing of a stone
mast	breast	mastectomy	surgical removal of a breast
oopher	ovary	oophorectomy	surgical removal of an ovary
osteo	bone	osteosynthesis	surgical reduction and fixation of a bone fracture
rhino	nose	rhinoplasty	surgical repair of the nose
tracheo	trachea	tracheostomy	creation of new opening to trachea
stoma	opening	anastomosis	a connection or reconnection of two separate tubular structures; for example, blood vessels or portions of intestines

Figures 2.6 and **2.7** above list common roots that show how medical terms can mean a variety of things depending on how they are constructed. Roots can be modified by prefixes, suffixes or both. Roots can also be combined to form their own words, or they can be modified by prefixes/suffixes. Meanwhile, the terms themselves can refer to either a portion of the human anatomy, a disease process or a surgical procedure. While this might seem difficult at first, it becomes much easier when one learns how to identify the suffixes and prefixes (if present) attached to the root/roots involved. By learning common suffixes and prefixes, the reader can identify whether the term is referring to the human anatomy, a disease process, a surgical procedure or a surgical instrument. **Figures 2.8** and **2.9** provides a listing of common prefixes used in medical terminology. Prefixes are word elements that are placed before the root to alter or modify its meaning.

Figure 2.8 Common Medical Prefixes

Prefix	Meaning	Example	Combined Meaning
a, an-	without	asepsis	without infection; sterile
		anesthesia	without sensation (local or general)
		atraumatic	not inflicting injury or wound
		analgesia	without pain
		atrophy	a reduction in size of a part of the body (wasting away) due to poor circulation, poor nutrition or a disease process.
ad-	toward (in the direction of)	addiction	toward dependence on a drug
ante-	before	antepartum	before the onset of labor
anti-	against	antiseptic	preventing sepsis (infection)
dis-	apart, away	hip dislocation	displacement of femur from pelvic joint
		disinfectant	chemical used to kill microorganisms
dys-	painful	dysentery	painful inflammation of the intestine
endo-	within	endotracheal	within the trachea
		endoscope	instrument used to visualize a joint or organ in the body
		endoscopy	visualization within, and possible treatment of, a part of the body using an endoscope and endoscopic instrumentation
extra-	outside	extracorporal	outside of the body
hyper-	above, excessive	hyperacidity	excessive acid in the stomach
		hypertensive	high blood pressure
		hypertrophy	excessive growth/size of a part of the body due to cellular enlargement
hypo-	below, deficient	hypoglycemia	low sugar content in the blood
		hypotensive	low blood pressure
inter-	between	intercellular	between, or among, cells
		interstitial	an empty space
		interdepartmental	between departments
		intercostal	between the ribs
intra-	within, inside	intravenous	in, or into, a vein
		intramuscular	located in, or injected into, a muscle
		intraabdominal	within the abdomen
		intraoperative	during surgery
		intraarticular	within a joint
		intraocular	within the eye
		intracranial	within the skull
neo-	new	neonatal	newborn
per-	through	percutaneous	through the skin
post-	after	postpartum	after delivery of a baby
		postoperative	after surgery
pre-	before	preoperative	before surgery
sub-	under, beneath	subcutaneous	beneath the skin
		subclavian	located under the clavicle
		subdural	located under the dura mater (the outermost membrane surrounding the brain)
supra-	above	suprapubic	above the pubis
		supracondylar fracture	fracture of the distal humerus above the elbow joint

Figure 2.9 Common Surgical Prefixes

Prefix	Meaning	Example	Meaning
bi-	two/both sides	bilateral total hip reconstruction (THR)	two (both) total hip reconstructions
		bilateral myringotomy with tubes	incision into (both) ear drums (tympanic membrane) in order to place drainage tubes
		bilateral salpingo-oophorectomy	surgical removal of both fallopian tubes and ovaries
		bilateral strabismus repair	surgery performed on the extraocular muscles to correct eye misalignment
hemi-	half	hemigastrectomy	surgical removal of half of the stomach
		hemiarthroplasty	a form of hip replacement surgery
		hemicolectomy	removal of half of the large intestine
para-	beside, near	parathyroidectomy	surgical removal of parathyroid glands
		paratracheal	beside the trachea
peri-	around, about	periosteal elevator	instrument used to remove tissue around the bone (the periosteum)
		perioperative	all aspects of the surgical process (before, during and after)
		pericardium	the serous (fluid emitting) membrane that stretches around the heart and lines the mediastinum
		peritoneum	the serous (fluid emitting) membrane that stretches around the abdominal cavity and is its lining
post-	after	postoperative	after surgery
trans-	across, through	transanal	through the anus
		transoral	through the mouth
		transesophageal	through the esophagus
		transurethral	through the urethra

Understanding Usage

Learning medical terminology can be an almost endless process, which multiplies as various body parts, procedure types and disease processes are combined to mean different things. As new surgical procedures are created (utilizing new approaches, instruments and technologies), new medical terminology will also be created to refer to these procedures. CS technicians must understand the language spoken to them by the OR and medical staff in order to provide them with the goods and services they need for their procedures. Language frequently used by the OR utilizes abbreviations or acronyms to refer to various types of surgeries. **Figure 2.10** contains a brief listing of some surgical procedure abbreviations or acronyms.

Figure 2.10 Abbreviations/Acronyms for Surgical Procedures

Abbreviation	Surgical Procedure	Meaning
AAA	Repair of abdominal aortic aneurysm	Surgical repair of a weakening/ballooning area of the abdominal portion of the aorta (the largest artery in the body).
ACL	Anterior cruciate ligament	Reconstruction or repairing of the anterior cruciate ligament. In an ACL reconstruction a graft is used to replace the ligament, and in an ACL repair the torn ligament is put back together.
ACF	Anterior cervical fusion	Surgical fusion of vertebrae in the cervical spine, approached from the front side of the patient's body.
ALIF	Anterior lumbar interbody fusion	Spinal surgery in which bone grafts/implants are used to fuse vertebrae in the lumbar spine, approached from the front side of the patient's body.
AKA	Above the knee amputation	Surgical removal of the leg above the knee.
AV Graft	Arteriovenous graft	A surgical connection is made between an artery and a vein to allow hemodialysis access.
BMT	Bilateral myringotomy with tubes	Incision into the eardrum (tympanic membrane, both sides) for drainage via tube placement.
BSO	Bilateral salpingo-oopherectomy	Surgical removal of both fallopian tubes and ovaries.
BKA	Below the knee amputation	Surgical removal of the leg below the knee.
CABG	Coronary artery bypass graft	Creation of a new blood supply to an area of the heart with a clogged/blocked artery using the patient's own blood vessel to function as the graft (frequently harvested from the leg).
CR	Closed reduction	Treatment of a fractured bone without a surgical incision.
D&C	Dilation and curettage	Dilation of the uterine cervix and scrapping of the inner lining of the uterus (endometrium) with a uterine curette.
EGD	Esophagogastroduodenoscopy	Endoscopic procedure that visualizes the upper portion of the gastrointestinal tract up to the duodenum (where the stomach connects to the small intestine).
ESS	Endoscopic sinus surgery	Use of endoscopic instrumentation to operate on the nose.
EUA	Exam under anesthesia	The use of anesthesia to conduct a surgical examination of a sensitive part of the body such as the eye or rectum.
I&D	Incision and drainage	Incision into and removal (drainage) of pus/fluid from an abscess, boil or infected wound/area of the body.
ICD	Implantable cardioverter-defibrillator	Insertion/implantation of a battery-powered device that can deliver a jolt of electricity to treat cardiac arrhythmia (dangerous irregular heartbeats, frequently performed in cardiac catheterization labs).

Abbreviation	Surgical Procedure	Meaning
IMN	Intramedullary nail	Insertion/implantation of a nail or rod, into the medullary cavity (center) of a long bone, such as the femur or tibia.
IOL	Intraocular lens	Insertion/implantation of a lens within the eye to treat cataracts (clouding of the lens of the eye) or myopia (nearsightedness).
IORT	Intraoperative radiation therapy	Use of therapeutic levels of radiation to treat exposed cancer tumors during surgery, frequently done during breast surgery.
LAVH	Laparoscopic-assisted vaginal hysterectomy	A visualization and treatment of pelvic organs (laparoscopy) followed by removal of the uterus through the vagina.
L&B	Laryngoscopy and bronchoscopy	A visual examination of the larynx and the bronchi.
LP	Lumbar puncture	A collection of cerebrospinal fluid (CSF) for diagnostic or therapeutic purposes. Commonly referred to as a spinal tap (not a surgical procedure, but frequently done in surgery for children).
MIDCAB	Minimally invasive direct coronary artery bypass	Use of a small incision in the ribs (mini-thoracotomy) to access the heart to bypass diseased coronary arteries. This is done "off-pump" without the assistance of the heart-lung machine.
MIS	Minimally invasive surgery	A type of surgery that uses endoscopic techniques and instrumentation in order to reduce trauma to the body during surgery (this technique reduces not only trauma to the patient's body, but reduces recovery time and reduces infection risks, as well).
ORIF	Open reduction internal fixation	Treatment of a fractured bone with an incision and the use of plates and screws or pins to hold the fragments together.
PAL	Power assisted liposuction	Aspiration (suction) of fat cells by means of a motorized hand piece and cannula (tube).
PCI	Percutaneous coronary intervention	Coronary angioplasty; a procedure to open narrowed coronary arteries, normally performed in cardiac catheterization labs.
PDA	Patent ductus arteriosus	Repair of a congenital heart disorder in a neonate (a child less than one month old).
PEG	Percutaneous endoscopic gastrostomy	Insertion of a feeding tube (PEG tube) into the stomach through the abdominal wall.
PICC	Insertion of peripherally inserted central catheter	An intravenous catheter inserted in a peripheral vein (such as the arm) for long-term IV access (a sterile procedure, not a surgery).
PLIF	Posterior lumbar interbody fusion	Spinal surgery in which bone grafts/implants are used to fuse vertebrae in the lumbar spine—approached from the back side of the patient's body.

Abbreviation	Surgical Procedure	Meaning
STSG	Split thickness skin graft	Healthy skin is taken from a place on the body, called the donor site, and used as a skin graft elsewhere on the body.
TAH	Total abdominal hysterectomy	Surgical removal of the uterus through an incision in the abdomen.
TEE	Transesophageal echocardiogram	Obtaining an ultrasound image of the heart by means of a probe/transducer inserted into the esophagus (frequently done in connection with cardiac surgery).
THA	Total hip arthroplasty	Hip joint reconstruction by removing the bone and placing a plastic/metal component in the hip socket (the acetabulum), as well as the femoral head (the proximal femur), resulting in a completely rebuilt joint.
TKA	Total knee arthroplasty	Knee joint reconstruction by placing implants on the end of the femur and the top of the tibia, as well as on the knee cap (the patella), resulting in a completely rebuilt joint.
TURP	Transurethral resection of the prostate	Surgical removal of part of the prostate gland by inserting instruments across the urethra to reach the prostate internally.
VATS	Video assisted thoracoscopic surgery	Use of endoscopic instruments to access the chest cavity/lungs/thorax.
VP Shunt	Ventriculo-peritoneal shunt	Surgical placement of a drain (shunt) to transfer excess cerebrospinal fluid (CSF) from the brain (ventricle) to the abdominal lining (peritoneum).
Wound VAC	Wound vacuum assisted closure	Application of a device/dressing that provides negative pressure (vacuum) to facilitate wound closure.
XLIF	Extreme lateral interbody fusion	Spinal fusion surgery approaching from the side of the patient using special instrumentation to reduce trauma on the patient's body.

ANATOMY OF A SURGICAL PROCEDURE

Once CS professionals understand medical terminology with its numerous prefixes, roots and suffixes, they will also be able to better understand the surgical procedures referred to in surgery schedules and the instruments and supplies that will be requested. Challenges arise when the OR is supplied with incorrect instrumentation and supplies for a surgical procedure. When the OR receives a case cart for a scheduled procedure from CS with the incorrect instrumentation and supplies, their attention is diverted away from the patient and onto getting the correct items in the room.

FROM MINIMALLY INVASIVE SURGERY TO OPEN PROCEDURES

The current practice in surgery is always to use a minimally invasive procedure when possible. Over the last 100 years, the vast majority of surgical procedures performed on patients have been "open" procedures. These procedures feature an incision to "open" the patient's body in order to perform whatever the surgical procedure requires. For example, if a patient needed an appendectomy, an incision would be made in order to remove the appendix. Similarly, if the patient needed a cholecystectomy, an incision would be made to remove that patient's gallbladder. Even open heart surgery has been handled in the same manner. If the patient had a diseased heart, the only way to operate on the heart was to split the patient's sternum open in order to access the patient's heart. This is no longer the only way to do surgery.

In today's high-technology surgical climate, many procedures start with some kind of a minimally invasive surgery (MIS) approach (developed during the 1960-1970s). This means that instead of simply cutting the patient's body open to access an organ or body part, some kind of special instruments will be used in order to perform the surgery. For example, some orthopedic procedures begin with something called a closed reduction (treatment of a fractured bone without an incision) prior to attempting an open reduction internal fixation (implantation of plates/screws, etc.). If a closed reduction is not possible/successful, the surgeon might attempt a percutaneous pinning, which means that the surgeon might be able to access the broken bone through the skin (percutaneous) in order to reduce that fracture and stabilize it by insertion of a Steinmann pin/K-wire. If these approaches are unsuccessful (or not possible given the patient's condition), the surgeon will perform an open reduction internal fixation of the fracture (plates and screws will be used internally to stabilize the fracture).

Similarly, if the patient needs their gallbladder removed, in most cases the procedure will be booked as laparoscopic versus an open cholecystectomy. This means that the surgeon will start by attempting to remove the patient's gallbladder using endoscopic/laparoscopic instrumentation, as this technique is less traumatic to the patient's body. The surgeon will only convert to an open procedure (using a larger incision to access the involved organ) if the laparoscopic approach is unsuccessful. This is also very common in thoracic surgery as many surgical procedures involving the chest start with what is called a thoracoscopic surgery (use of endoscopic instruments to access the lungs) and only convert to an open thoracotomy (incision into the thorax/chest) if the thoracoscopic approach is unsuccessful.

Other surgical procedures are following a less-invasive approach in an effort to reduce trauma to the patient. In the case of breast surgery, for example, treatment will start with a minimally-invasive biopsy, followed by a lumpectomy, if indicated. If a mastectomy is required (surgical removal of a breast), the procedure will be booked in a manner that reduces trauma to the patient's body, while still effectively treating the disease. Therefore, a partial mastectomy can be performed (removal of a portion of the breast), or a radical mastectomy can be performed (complete removal of the breast). The same is also true for prostate surgery in men. If possible, the surgeon will attempt a transurethral resection of the prostate (TURP) using special instrumentation to reduce patient trauma. Only if the patient cannot be treated adequately using an endoscopic technique

will the surgeon perform an open procedure called a radical prostatectomy. In today's world of surgical technology, it is even possible to have a total joint replacement (arthroplasty) using some kind of MIS technique, such as a unicompartmental knee arthroplasty.

Not all patients are candidates for MIS. Some illnesses and injuries are not remedied by such an approach. For example, if a patient's cancer has grown significantly inside an organ or another area of the body, that cancer will need to be resected (removed) by means of an open procedure. Also, if a patient has a severely broken femur, this patient will require the introduction of a trochanteric (intramedullary) nail to stabilize that fracture (a form of open reduction internal fixation). If a patient's gallbladder is about to rupture, the surgeon might elect to perform an open cholecystectomy without attempting a laparoscopic approach.

CS technicians must understand that contemporary surgery is always attempted to be minimally invasive to the patient as these approaches cause less trauma to the patient's body, reduce pain, reduce recovery time, and shorten length of hospital stay. When reading surgery schedules, it is vital that CS professionals understand that, in many cases, a laparoscopy will precede a laparotomy, an arthroscopy will precede an arthrotomy, or a thoracoscopy will precede a thoracotomy. The CS professional must know that minimally invasive procedures utilize a different assortment of instruments and supplies than open procedures. In some cases, the OR will only require the endoscopic instrumentation and supplies. In other cases, OR personnel will require both "set ups," one for the endoscopic procedure and one for the open procedure.

As important as endoscopic procedures are in reducing patient trauma, new advances in surgical techniques have evolved, which can be even less invasive than traditional MIS. Whether it is the removal of the gallbladder (cholecystectomy), removal of the uterus (hysterectomy) or the removal of the prostate (prostatectomy), these procedures can now be done using robotic technology. Even open heart procedures can now be done by means of robotic technology. These procedures utilize a complex blend of highly-specialized instrumentation and supplies. This is the least invasive and most technologically-advanced form of surgery in history. CS professionals have the responsibility of processing these complex devices.

PROCEDURE APPROACH AND PURPOSE

When reading surgery schedules and interacting with OR staff, CS technicians need to understand how procedure approach and purpose are identified. When a surgical procedure is referred to in a surgery schedule, the suffix attached to the primary medical term will indicate the purpose of the procedure. For example, "oscopy" will refer to visual examination of and possible treatment, "otomy" will refer to an incision into, "ectomy" will refer to removal of, and "plasty" will refer to repair/reconstruction of.

Another key element in how a procedure can be understood relates to the approach that the surgeon will use in performing the surgery. The approach or method typically comes at the beginning of the surgical procedure term. A laparoscopic cholecystectomy will remove the patient's gallbladder using laparoscopic instrumentation and techniques. A robotically-assisted prostatectomy will remove the patient's prostate by using robotic instrumentation and techniques. A bilateral myringotomy will make incisions for drainage into the patient's eardrum/tympanic membrane on both sides. An anterior cervical fusion will fuse some of the patient's cervical vertebrae approaching from the front of the patient's body. A posterior lumbar interbody fusion will fuse some of the patient's lumbar vertebrae approaching from the back of the patient. A vaginal hysterectomy will remove the patient's uterus via the vaginal canal. A total abdominal hysterectomy will remove the uterus through an open incision in the abdomen. All of these procedures utilize completely different instrument sets and supply packs.

CASE CARTS AND INSTRUMENT TRAYS

In the past, the surgical team took responsibility for "picking" the needed instrumentation and supplies for their scheduled procedures. Some facilities still function in this manner; however, in recent years it has become more common for CS professionals to perform this function. Therefore, CS technicians may be responsible for reading the OR surgery schedule in order to print pick lists, obtain the needed instrumentation, and even find/obtain instrumentation that is already "in use" in another surgical procedure.

Surgery schedules are prioritized according to patient needs, which allows the OR to schedule procedures for the next day or following week. If a case is booked as a thoracoscopy (possible thoracotomy), for example, pick lists may be required (one for the endoscopic portion and another for the possible open procedure). **Figure 2.11** provides a basic example of a surgery schedule.

Many procedures in today's surgical climate require what is called "loaner" instrumentation. These are sets of instruments (frequently multiple sets of instruments) that are shipped to the hospital specifically for use by a specific physician on a specific patient. These instruments may be used one time and then returned to the vendor. To keep surgical procedures on schedule, it is also essential that CS professionals anticipate the need for loaner instrumentation. This helps ensure that devices are delivered well in advance to allow for safe, effective reprocessing and prompt delivery to the OR. More information on loaner instrumentation is discussed in Chapter 11.

Sample Surgery Schedule

Understanding Medical Terms can help CS Technicians better understand procedural needs.

Room	Start Time	Patient	Surgeon	Procedure	Comments
1	7:00	John Doe	Dr. Wells	Cystoscopy with Left Retrogrades, Left Stent Insertion	C-Arm
	TF	Tom Smith	Dr. Wells	Transurethral Resection of the Prostate	
2	7:00	Jon Williams	Dr. Green	Septoplasty, Possible Endoscopic Sinus Surgery	
	TF	Tammi Jones	Dr. Green	Tonsillectomy	
3	7:00	Mary Smith	Dr. Clark	TAH with BSO	
	TF	Jane Doe	Dr. Clark	D & C	
4	7:00	Bill Williams	Dr. Jones	TKA Right – Revision	Loaner Instruments
	TF	Sally Sims	Dr. Jones	ORIF – Left Ankle	
	TF	Bob Roberts	Dr. Jones	CR, Possible Pinning Right Thumb	Possible ORIF

Figure 2.11

THE VALUE OF MEDICAL TERMINOLOGY IN THE OPERATING ROOM

Awareness within the Operating Room

Knowledge of medical terminology and language is essential for ensuring that CS professionals have a clear understanding of what the OR and other healthcare customers require for their procedures. Prefixes, roots and suffixes discussed in this chapter are not mere items to remember or memorize. Instead, they are vital tools that will allow CS professionals to become more proficient in the department, improve communication with the OR and other healthcare customers, and provide safe, consistent, high-quality service that drives positive patient outcomes.

CONCLUSION

Medical and surgical staff members appreciate when everything goes smoothly with their patients/cases. The patient's needs are the motivating factor of every Central Service professional. CS professionals must respond to Operating Room staff in a timely, effective way. It is the responsibility of the CS department to assist the surgical and medical staff to deliver the highest quality of care to each and every patient. Communicating effectively and successfully meeting the needs of the OR and other healthcare customers requires CS professionals to possess a functional, ever-evolving understanding of medical terminology and language.

RESOURCES

Association for the Advancement of Medical Instrumentation. ANSI/AAMI ST79, A4 2013, Section 2. *Comprehensive Guide to Steam Sterilization and Sterility Assurance in Health Care Facilities.*

The Joint Commission. *Hospital Accreditation Standards, IC-10.* 2014.

Centers for Disease Control and Prevention. *Guideline for Disinfection and Sterilization in Healthcare Facilities.* 2008.

Leiken JB, Lipsky MS, Eds. *American Medical Association Complete Medical Encyclopedia.* Random House. 2003.

Stedman TL. *Stedman's Medical Dictionary 28th Ed.*, pp. 1047-1048. Lippincott Williams & Wilkins. 2005.

CENTRAL SERVICE TERMS

Case cart

STAT

Word elements

Root word element

Prefix word element

Suffix word element

Combining vowel

Chapter 3

Anatomy for Central Service Technicians

Learning Objectives

As a result of successfully completing this chapter, readers will be able to:

1. Review the structure, function, activities and role of cells, tissues and organs in the body
2. Identify and describe the structure and roles of each major body system and identify common surgical procedures that involve each system:
   - Skeletal
   - Muscular
   - Nervous
   - Endocrine
   - Reproductive
   - Urinary and excretory
   - Respiratory
   - Digestive
   - Circulatory
3. Explain how knowledge of anatomy can help with surgical instrument identification

INTRODUCTION

Many surgical interventions have been developed to treat the human body and enable it to heal. Central Service (CS) technicians play an important role in the surgical support process by providing the instruments and supplies needed to perform specific surgeries. As members of the surgical team, developing a basic understanding of the human body can aid in communication with the Operating Room (OR) and can help facilitate requests.

The study of the human body requires an understanding of **anatomy** and **physiology**. Our study begins by considering cells, tissues and organs.

Anatomy The study of the structure and relationships between body parts.

Physiology The study of the functions of body parts and the body, as a whole.

CELLS, TISSUES AND ORGANS

Cells

Here are some facts about **cells**:

- They are the basic living unit of life. The human body is made up of more than one hundred trillion of these tiny structures.
- They vary in size, shape and function, depending upon their location in the body.
- They are so small that they can only be seen with a microscope.
- Within each cell are still smaller structures called organelles: microscopic organs within a cell that perform specific functions.
- Functions of the cell include respiration, nutrition, energy production, waste elimination, and reproduction.
- Living cells come only from other living cells.

Regardless of their size and shape, each human cell consists of three main parts:

- The **cell membrane** is porous and flexible, and surrounds the cell to keep it separated from the outside environment. The cell membrane surrounds the cytoplasm and allows and controls the passage of materials in and out of the cell. Examples include the absorption of oxygen and food and the elimination of waste products produced by the cell. (See **Figure 3.1**)
- The **cytoplasm** is a clear jelly-like substance that surrounds the nucleus and contains the cell fluid and organelles.
- The **nucleus** is surrounded and protected by the cytoplasm. This oval structure acts as the brain center of the cell to direct and control all activities, including duplication into two new cells.

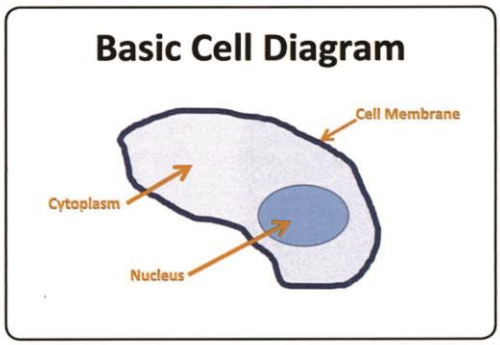


Figure 3.1

Cell The basic unit of life; the smallest structural unit of living organisms capable of performing all basic functions of life.

Cell membrane The outer covering of a cell that regulates what enters and leaves it.

Cytoplasm Clear, jelly-like substance of a cell between the cell membrane and nucleus.

Nucleus The functional center of a cell that governs activity and heredity.

Tissue

- Two or more cells that are similar in structure and function are joined together to form **tissue**.

The four primary tissues of the human body are:

- Epithelial tissue – This tissue covers the body's external surface (skin) and the linings of body cavities (the mouth, ears, nose and throat).

- Connective tissue – This tissue provides support, stores energy and connects other tissues and parts. Examples of connective tissue include bone, fat, blood and cartilage. Bones provide protection, support and shape to the body, and storage for calcium. Fat keeps the body warm, cushions organs and stores nutrients. Blood transports food and oxygen to all body parts and removes all waste products. A final example of connective tissue is cartilage, which provides framework and support to the human body.

- Muscular tissue – This tissue shortens as it contracts. When attached to bone, these contractions make body movement possible. Muscle tissues also line the inner walls of organs that contract to help food pass through the digestive system. As cardiac muscles contract, blood is pumped through the body.

- Nervous tissue – This tissue is located throughout the body. When stimulated, nervous tissue carries messages back and forth between the brain and every part of the body.

Organs

Organs are formed when two or more different types of tissues are grouped together to perform a specific function.

Examples of organs include the:

- Brain – An organ in the central nervous system that is the primary receiver, organizer and distributor of information in the body.

- Heart – The organ that pumps blood throughout the body.

- Stomach – An organ that is part of the digestive system and helps digest food by mixing it with digestive juices and converting it into a liquid.

- Skin – The largest organ of the body that serves as the body's outer covering.

Tissue A group of similar cells that perform a specialized function.

Organ A part of the body containing two or more tissues that function together for a specific purpose.

BODY SYSTEMS

A **system** is a group of organs that work together in the body to carry out a particular activity.

While each body system provides a specific bodily function, none are independent of any other. Each system must work together to help the body function as a total organism. With the exception of the reproductive system, each body system and its organs work together to help maintain life. The remainder of this chapter will provide details about the body's major systems and common procedures performed to treat issues that can occur in those systems.

Skeletal System

Without the skeletal system (See **Figure 3.2**), the body would just be an immovable mass. There are approximately 206 bones that, collectively, comprise the body's skeletal system. They are arranged in an orderly manner and are fastened together by tough connective tissue known as **tendons** and **ligaments**. The five main functions of the skeletal system are to:

- Give the body shape and support.

- Allow movement.

- Protect vital organs.

- Produce blood cells.

- Store calcium.

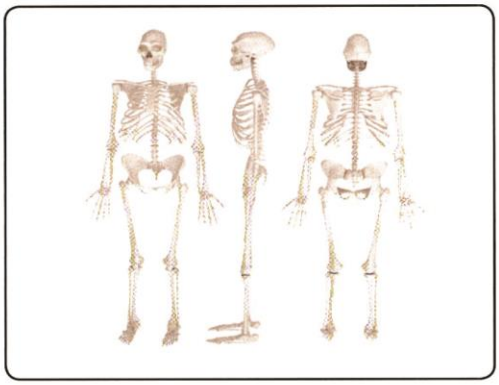


Figure 3.2

Most bones are made from **cartilage**, but through a process known as **ossification**, cartilage is sometimes replaced by bone. Cartilage is a flexible connective tissue that provides framework to the body; its purposes include:

- Supporting body structures, such as the ears and nose.
- Connecting the ribs to the sternum.
- Serving as a cushion between bones to prevent them from rubbing together at junctures and joints.

System A group of organs that work together to carry out a specific activity.

Tendon A cord of fibrous tissue that attaches a muscle to a bone.

Ligament A band of connective tissue that connects a bone to another bone.

Cartilage A type of flexible connective tissue.

Ossification The process by which cartilage is replaced by bone.

Joint Any place where two bones meet.

A **joint** is any place where two bones meet. Some are immovable, such as those found in the skull, and others, such as the knee and elbow joints, are movable and allow the bones that they connect to move. **Figure 3.3** shows the location of some joints in the body.

There are several types of joints:

- Gliding joints – Allow the head to lower as the vertebrae (bones in the spinal column) of the neck slide over one another.
- Ball and socket joints – Allow movements like swinging one's arm around in a circle. Ball and socket joints consist of a bone with a rounded head that fits into a rounded cup (hip and shoulder joints) socket of another bone.
- Pivot joints – Allow a turning motion, such as the palm of the hand rotating from up to down when a bone rotates on another ring-shaped bone.
- Hinge joints – Allow backward and forward bending motions, like a door hinge (knees, knuckles and elbows).

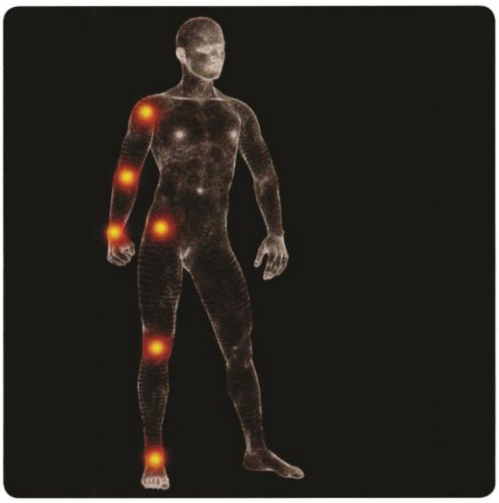


Figure 3.3

The overall covering or lining of a joint is called a synovial membrane. It secretes a fluid, called synovial fluid, to lubricate joint surfaces. (See **Figures 3.4** and **3.5**)

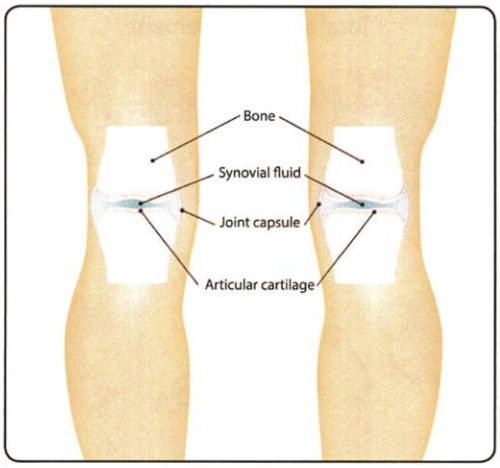


Figure 3.4

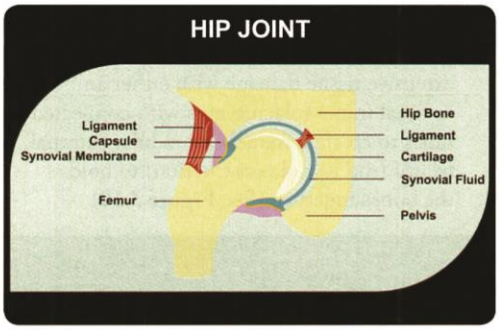


Figure 3.5

Bones are comprised of living tissue, and their strength and hardness comes from chemical substances, called minerals. Bone consists of two principal materials:

- A hard outer material called cortical or compact bone, that is dense and strong and consists of calcium and phosphorous. This hard outer surface is surrounded by the periosteum, a tough membrane that contains bone-forming cells and blood vessels.
- The inner section, called spongy or cancellous bone, is porous.

Bones are filled with a material called marrow. A pipeline of blood vessels and nerves runs through the middle of thick bones. (See **Figure 3.6**)

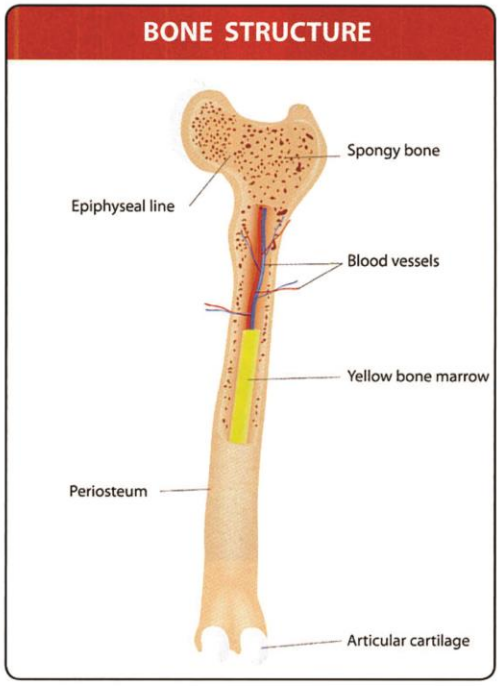


Figure 3.6

Examples of surgical procedures that involve the skeletal system:

- Craniotomy – Making an opening into the skull bone to access the brain.
- Anterior cervical fusion – Removal of disc tissue pressing on a nerve in the neck area by inserting a piece of bone between the vertebrae and fusing this area with plates and screws.
- Posterior lumbar interbody fusion (PLIF) – Removing disc tissue pressing on the lower spine area by inserting a piece of bone between the vertebra and fusing this area with plates and screws.
- Open reduction internal fixation (ORIF) – Making an incision in the skin, realigning a fractured bone, and inserting screws and plates to ensure the bone ends do not move, so healing can be promoted. (See **Figure 3.7**)

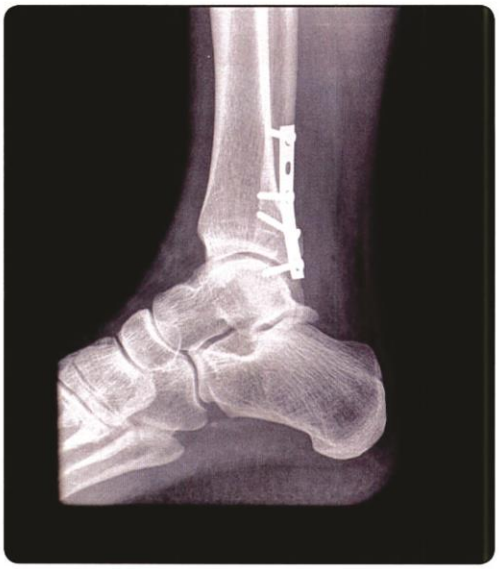


Figure 3.7

- Total knee arthroplasty (TKA) – Removing the bone at the distal (farthest) end of the femur and the bone at the proximal (nearest) end of the tibia, and replacing them with metal/plastic components. (See **Figure 3.8**)

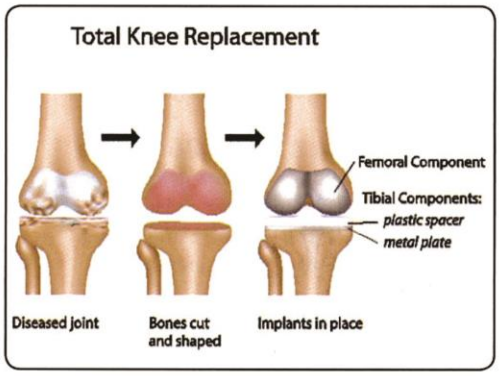


Figure 3.8

- Total hip arthroplasty (THA) – Removing the head of the femur and the socket where it fits in the hip bone, and replacing these structures with metal, ceramic and plastic components. (See **Figure 3.9**)

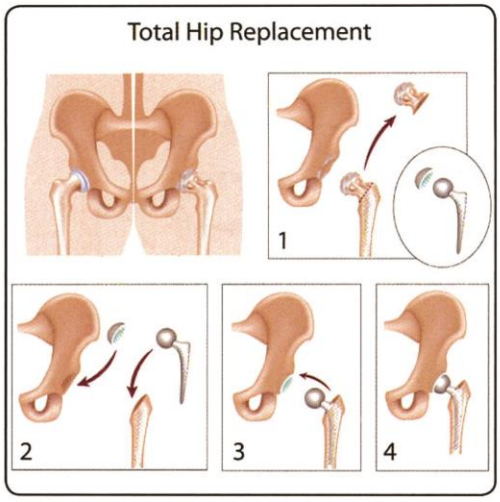


Figure 3.9

- External fixation – Treating fractures with extensive tissue damage with either an optimal frame (placing pins with connected tubes to create a frame) or modular external fixator (rod to rod construction) to hold the bones together. (See **Figure 3.10**)

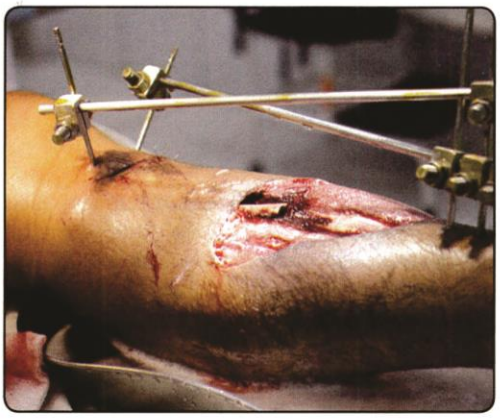


Figure 3.10

- Hip pinning – Stabilizing broken hip bones with surgical screws, nails, rods or plates. Also known as internal fixation of the hip. (See **Figure 3.11**)

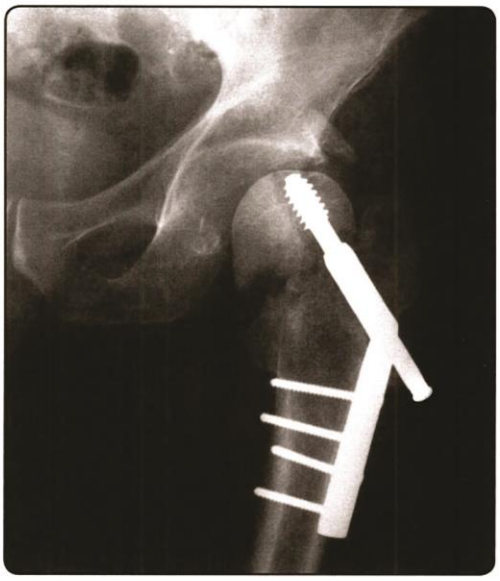


Figure 3.11

- Trigger finger release (stenosing tenosynovitis) – Making a small incision in the palm, then cutting the tendon sheath tunnel to widen it and allow the tendon to slide through it more easily.

- Tibial osteotomy – A procedure to realign the knee by wedging open the upper shin bone (tibia) to reconfigure the knee joint. The weight-bearing part of the knee is shifted from degenerative or worn tissue onto healthier tissue.

Muscular System

The muscular system works with the skeletal system to enable movement of the body or of materials through the body. (See **Figure 3.12**) Even as one sleeps, many of the more than 600 muscles in the body, including 400 which are skeletal, are actively at work to keep us alive. For example:

- Heart muscles contract to pump blood throughout the body.

- Chest muscles contract to move air in and out of the lungs.

- Muscles in the digestive tract move food and fluid through the body.

- Muscles throughout the body contract to produce heat and maintain the body's core temperature.

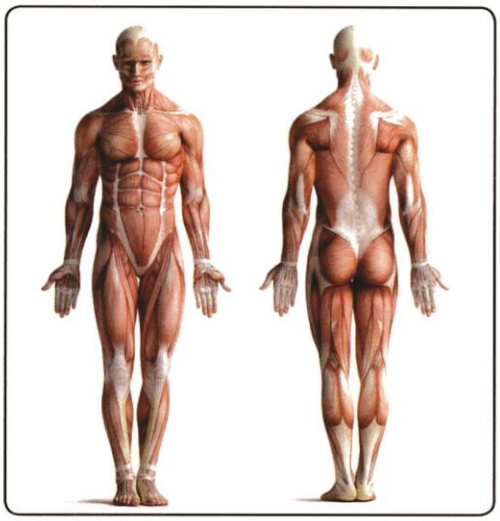


Figure 3.12

Muscles are made of up long, thin cells or fibers that run parallel to one another, and they are bundled together by connective tissue, called **fascia**. Muscle fibers have the ability to contract (shorten), and this contraction causes body movements.

Fascia Band or sheet of fibrous connective tissues.

There are three types of muscle tissue: skeletal, smooth and cardiac. (See **Figure 3.13**)

- Skeletal muscles – are attached to bones by tendons. As skeletal muscles contract, the arms, legs, head or other body parts to which they are attached move. We consciously control skeletal muscles; they move only when we want them to move.

- Smooth muscles – are organized into thin, flat sheets of tissue. Smooth muscles are called involuntary or visceral muscles because they

contract and function without our conscious control. They control breathing and the movement of food and fluid in the digestive system, movement of blood throughout the circulatory system and the movement of urine through the urinary system.

- Cardiac muscle – is similar to woven mesh fibers that branch out through the heart to give it more strength to pump blood. These involuntary durable muscle fibers contract and make the heart beat. In a healthy heart, they do not normally tire.

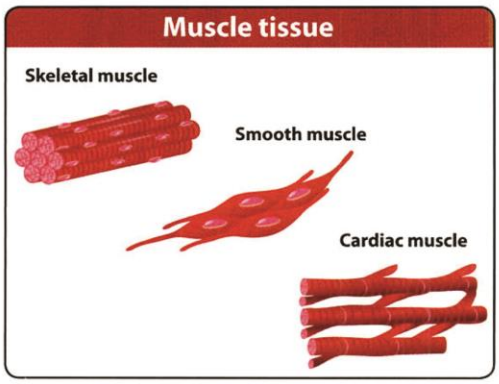


Figure 3.13

To function properly, these muscle fibers require energy (derived from consumed food) and oxygen (derived from the environment when we breathe). Their functions include movement and support, the maintenance of posture and body position and the production of body heat.

Examples of procedures involving the muscular system:

- Fasciotomy – Making an incision into the fibrous membrane covering a muscle, usually to relieve pressure from an injured or swollen muscle.

- Herniorrhaphy – Repairing a cavity wall/ muscle layer that is allowing all or part of an organ to project through the opening.

- Rotator cuff repair – Repairing the muscles and ligaments of shoulder joints depend on the size and shape of the tear. Frequently-used methods are the Bankart, Putti-Platt and Bristow procedures. (See **Figure 3.14**)

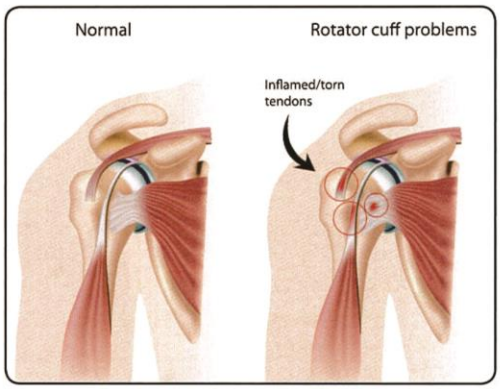


Figure 3.14

- Anterior cruciate ligament (ACL) repair – Rebuilding the ligament in the center of the knee with a new ligament from the patient's own body, or from a deceased donor, usually by knee arthroscopy. In some cases, ACL repair is done by making an incision into the knee (open procedure). (See **Figure 3.15**)

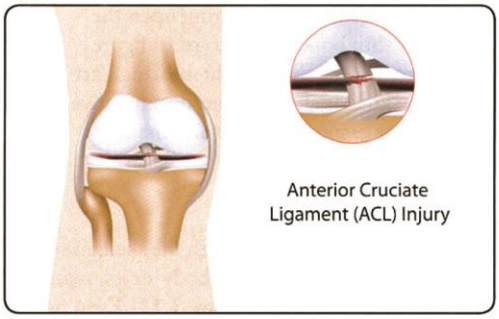


Figure 3.15

- Muscle biopsy – Removing a small sample of muscle tissue for testing in a laboratory using either a needle biopsy (inserting a needle into the muscle) or open biopsy (making a small cut in the skin and into the muscle).

- Tendon repair – Treatment that retrieves a torn tendon and reattaches it (tenodesis) to soft tissue or bone with either a small incision or arthroscopic techniques.

Nervous System (Including Sense Organs)

The nervous system is a vast communication network. It coordinates and carries messages between all parts of the body and enables us to be aware of changes in the environment—and to react accordingly. A complex series of nervous tissues, somewhat like electrical wiring, runs from the brain and spinal cord throughout the entire body. (See **Figure 3.16**)

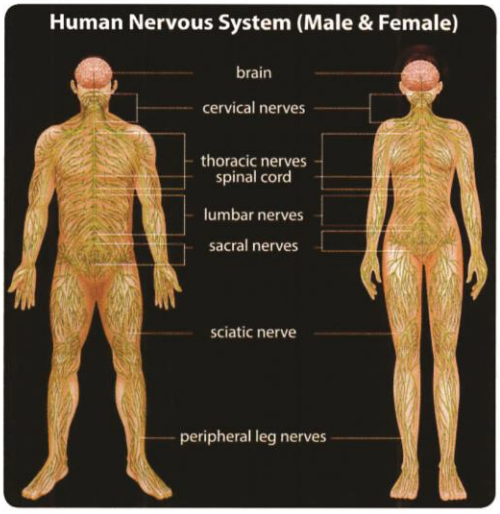


Figure 3.16

The nervous system controls all body activities and allows us to respond to stimuli. Many reactions are automatic, such as blinking when a foreign object approaches the eye. Nerve tissue carries electrical messages from the brain and spinal cord that signal muscles to contract. Other actions are more conscious and involve emotion, reason and memory. Like a computer, the brain stores information based on past experiences that can later be communicated to the body by the nervous system.

Anatomically, the nervous system is divided into two parts: **central nervous system (CNS)** and the **peripheral nervous system (PNS)**.

The CNS consists of the brain and spinal cord, which are covered by protective membranes called meninges. The CNS is the body's control center and is the storehouse for information about what is happening or has happened within or outside the body.

The **brain**, a spongy and complex organ, is the main control unit of the CNS. It is comprised of more than 100 billion nerve cells.

The brain is divided into three parts, each carries out a specific function: **cerebrum**, **cerebellum** and **brain stem**. (See **Figure 3.17**)

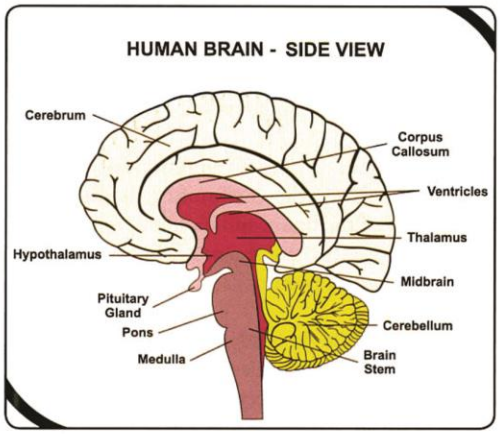


Figure 3.17

The cerebrum is the largest part of the human brain. It functions to:

- Manage the nerve impulses that allow us to think, speak and remember.
- Control most voluntary muscle contractions.
- Interpret information gathered by the senses.
- Influence the foundation of personality, emotions and attitudes.

Central nervous system (CNS) The part of the nervous system that includes the brain and spinal cord.

Peripheral nervous system (PNS) All nerve tissue outside the central nervous system.

Brain The main control unit of the central nervous system.

Cerebrum The largest part of the brain. It controls mental activities and movement.

Cerebellum The second largest part of the brain. It controls muscle coordination, body balance and posture.

Brain stem This controls many automatic body functions, such as heartbeat and breathing.

The cerebrum is divided into two halves (hemispheres). Each half controls different mental activities and movement on the opposite side of the body. A series of nerve pathways run between each half to facilitate communication.

The cerebellum is located inferior (below) and posterior (behind) the cerebrum. It is the second largest part of the brain, and its role is to adjust the motor impulses that control muscular coordination, body balance and posture.

The brain stem is located at the base of the brain and is formed by bundles of nerves that extend from the cerebrum and cerebellum. The lowest part of the brain stem (the medulla oblongata) joins the brain to the spinal cord. It contains nerve centers that control many automatic body functions, including heartbeat and breathing.

PNS involves the network of nerves and sense organs that branch out of the CNS and connect the CNS to other parts of the body. One part (the autonomic nervous system) controls all involuntary body processes, like heartbeat and peristalsis (the rippling motion of muscles in the digestive tract that mixes food with gastric juices to form a thin liquid). Other nerves are under direct control of the conscious mind. When we tell our hand to wave, for example, a message is sent from the brain down the spinal cord through a peripheral nerve to our hand.

The Sense Organs

The sense organs (eyes, ears, nose, tongue and skin) are accessory structures of the nervous system that provide an impression of all that surrounds us. They house special sensory receptors that are message-carrying structures. Most sense organs respond to stimuli from outside the body, while others keep track of the body's internal environment. They respond to light, sound, taste, chemicals, heat and pressure.

Eyes

Eyes (See **Figure 3.18**) are the organs of vision. They produce images by focusing light rays that are interpreted by the brain. The eyes consist of three layers of tissue:

- The sclera is the white portion of the eye and serves as an outer coat to provide protection. At the center front of the sclera is a transparent protective shield, called the cornea.
- The choroid is the middle layer of the eye that furnishes nourishment to the eye via blood vessels. The choroid layer includes the iris, a muscle that is the colored portion of the eye. A circular opening, called the pupil, is found at the center of the iris. It controls the amount of light entering the eye as it narrows or widens. Between the cornea and eye lens is the aqueous humor: a watery-like fluid that fills the anterior (front) compartment of the eye.
- The retina is the eye's third layer. It is located on the back surface of the eyeball. The eye lens focuses light onto the retina, which contains light-sensitive cells (receptors) that receive and transmit impressions to the brain through the optic nerve. The vitreous humor is a fluid-filled compartment of the eye that gives the eyeball its round shape.

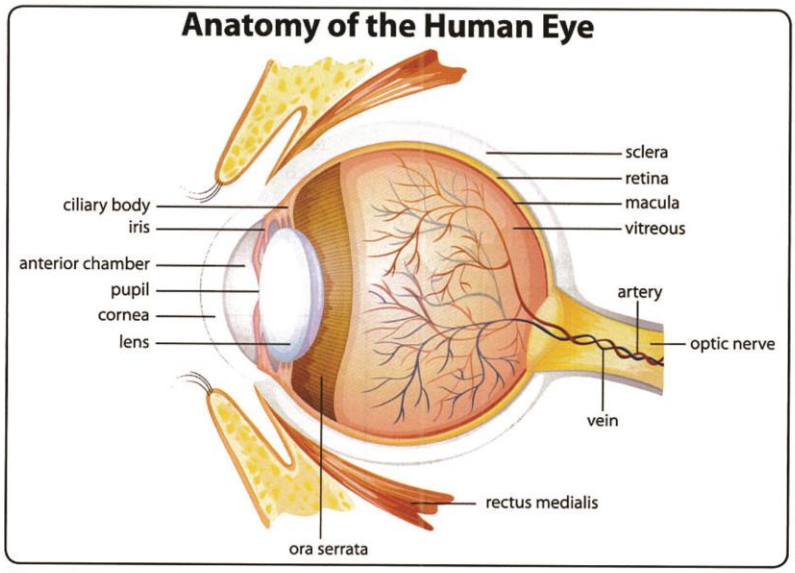


Figure 3.18

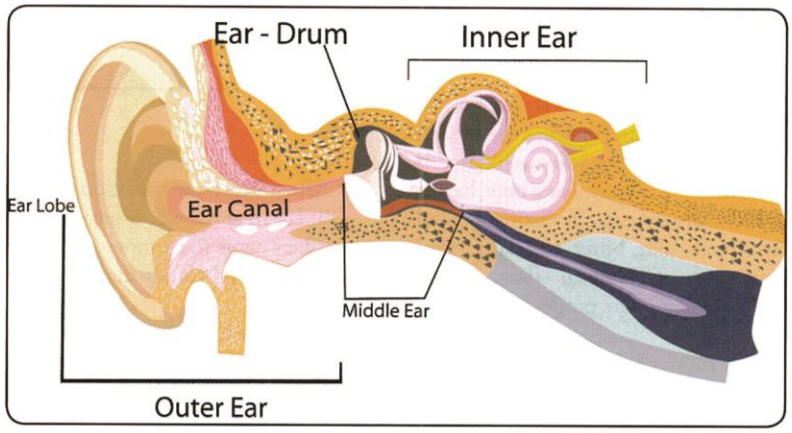


Figure 3.19

Ears

Ears are the organs of hearing. They are made of up three parts: the external, middle and inner ear. (See **Figure 3.19**) Sound waves travel through the ear to the auditory nerve that transmits nerve impulses to the brain. Here's how the ear allows us to hear:

- The external ear serves as a funnel that gathers sound waves and passes them through the ear canal to the tympanic membrane (also known as the eardrum).
- The eardrum consists of a tightly-stretched membrane that separates the outer ear canal from the middle ear. Vibrations of the eardrum enter the middle ear, which contains three tiny bones: the malleus, incus and stapes.
- The sound vibrations are then passed through these bones into the fluid-filled inner ear. There, vibrations are channeled through the fluid into a spiral-shaped tube called the cochlea, which contains

the receptors or nerve endings that transmit nerve impulses to the brain.

The inner ear also contains semi-circular canals consisting of three curved tubes filled with fluid. Body balance is regulated by this fluid as it shifts with body movement. As the fluid shifts, it presses against tiny hairs stimulating nerve impulses that travel to the brain. The brain responds to these impulses by coordinating muscle movement.

Nose

The nose is the organ of smell and consists of many sensory receptors or cells. These receptors are located in the mucous membranes of the nasal cavity and are sensitive to chemicals carried through the air. The olfactory nerve endings extend to the receptors and are stimulated by different odors. Olfactory bulbs are the enlarged portion at the ends of the olfactory nerves.

Tongue

The tongue is the organ of taste and is covered with taste buds (sensory receptors). The sense of taste, like smell, is a chemical sense. Chemicals are carried by the saliva throughout the mouth. Taste buds located in different areas of the tongue can distinguish four kinds of taste: sweet, sour, bitter and salty. There are 80 different types of chemical odors, and the combination of taste and odors produces flavors.

Skin

The skin is the largest body organ. It contains many nerve endings at and below its surface. The skin, therefore, acts as an important sensory organ. Touch receptors near the skin's surface allow us to distinguish textures and to respond to heat and cold. Further below the skin surface are receptors that respond to touch and pressure. The sense of pain stimulates nerves and sends messages of potential danger to the brain.

There are numerous surgical procedures involving the nervous system:

- Craniotomy – Creating an opening in the skull to expose the brain to facilitate procedures, such as the removal of tumors and clots.

- Carpal tunnel repair – Removal of tissue or displaced bone in the wrist area to release pressure on the median nerve. (See **Figure 3.20**)

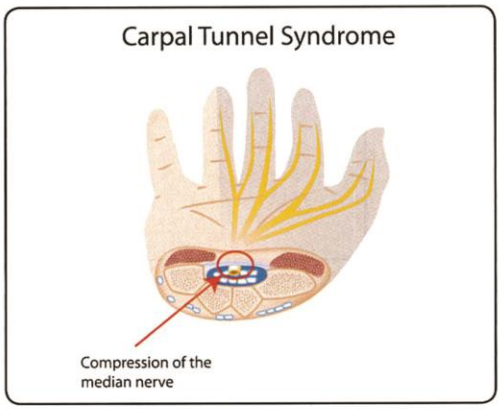


Figure 3.20

- Ulnar nerve transposition – Making an incision at the elbow area, allowing the ulnar nerve to be moved to an area that provides protection and comfort.

- Cataract extraction with implant – Removing a clouded eye lens and replacing it with a clear, artificial lens replacement. (See **Figure 3.21**)

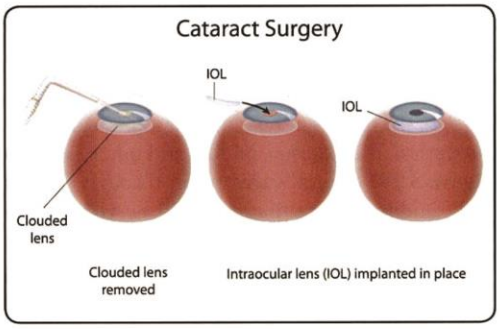


Figure 3.21

- Corneal transplant – Grafting corneal tissue from a donor eye to another to improve vision when the cornea is damaged or scarred.

- Bilateral myringotomy with tubes (BMT) – Making an incision into the tympanic membrane (eardrum) to permit fluid to drain. Small tubes are placed in the membrane to allow continuous drainage. The tubes fall out as the membrane heals.

- Stapedectomy – Removal of the stapes (an ear bone) when it has thickened and no longer transmits sound waves. It is replaced with an artificial implant to improve hearing.

- Tympanoplasty – Reconstructing the eardrum, so sound waves can be sent to the middle and inner ear.

- Split-thickness skin graft (STSG) – Cutting the skin (graft) from a donor site and using a graft mesher to expand the graft. The graft is then transplanted onto the surgical area.

Endocrine System

The endocrine system adapts to changes in the environment. During times of excitement, stress or when one feels threatened, how does the body react? Chances are, muscles tensed, the heartbeat quickened and breathing rhythm changed. These rapid changes in bodily functions are set in motion by the **hormones** or secretions produced by the glands of the endocrine system. (See **Figure 3.22**) These glands and the substances they produce have a profound influence on bodily functions, such as **metabolism**, growth and personality.

Since hormones are distributed throughout the body, the endocrine glands that produce them are not necessarily next to the organs they control. Regardless of where hormones enter the bloodstream, they continue their journey through the circulatory system until they reach their targeted organ. Tissue cells and organs recognize and accept hormones made for them and reject others that are not.

The nervous system and endocrine system work together. When the brain interprets information as a threat, it rapidly sends out nerve impulses that trigger certain endocrine glands to release their

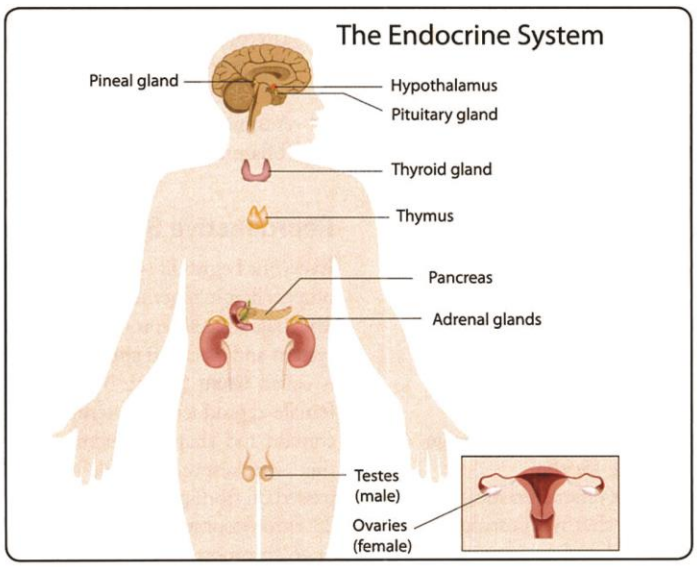


Figure 3.22

hormones into the bloodstream. In a fearful situation, the hormones cause the heartbeat to accelerate and prepare muscles for action. In this state, one is ready for fight or flight (to defend or run).

The major glands of the endocrine system include:

- Pituitary gland – A small, pea-shaped gland located at the base of the brain. It is considered the master gland because it helps control the activities of all other endocrine glands. Its secretions also stimulate skeletal and body growth, development of sex organs, regulation of blood pressure, the reproductive process and muscle development.
- Thyroid gland – Located at the base of the neck just below the larynx (voice box), its hormones help regulate the rate of metabolism and maintain the body's levels of calcium and phosphorous.
- Parathyroid gland – Four pea-shaped glands located on (or sometimes in) the thyroid that control the blood's calcium level.
- Adrenal glands – During sudden stress these glands, which are located on top of each kidney, release adrenalin that increases our heart rate and physical strength. Adrenalin also enhances our ability to think and to respond more quickly than usual in emergency situations.
- Pancreas – Located just below the stomach, this gland contains cells organized into groups, known as the Islets of Langerhans. Two primary hormones are produced by the pancreatic islets: **insulin**, which reduces the level of sugar in the bloodstream, and **glucagon**, which can increase the blood's sugar level.
- Ovaries (female sex glands) – Produce two hormones: estrogen and progesterone. Estrogen is responsible for the development of female characteristics, and progesterone, together with estrogen, regulates the menstrual cycle.
- Testes – Male sex glands that produce the hormone testosterone that stimulates the development of masculine characteristics.

Hormones Chemical messengers that travel through the blood and act on target organs.

Metabolism The total chemical changes by which the nutritional and functional activities of an organism are maintained.

Insulin A hormone that reduces the level of sugar in the blood.

Glucagon A hormone that can increase the blood sugar level.

Examples of surgical procedures involving the endocrine system:

- Thyroidectomy – Removal of all or part of the thyroid gland.
- Oophorectomy – Removal of an ovary.
- Orchiectomy – Removal of a testicle.
- Pituitary tumor resection – Removal of a tumor on the pituitary gland, which is located at the bottom of the skull.
- Thyroid excision – Removal of nodules and/or goiters (enlargements) on the thyroid.
- Adrenalectomy – Removal of one or both (bilateral adrenalectomy) adrenal glands.

Reproductive System

Everyone begins life as a single cell, formed when two other cells join together in a process called fertilization. The male sex cell is produced by the male reproductive system and is called **sperm**. The female sex cell (egg) is called **ovum** (plural: ova) and is produced by the female reproductive system. Both sperm and ovum contain rod-shaped structures called **chromosomes** that are responsible for inherited characteristics passed on from parent to child. Each sex cell contains 23 chromosomes; therefore, a fertilized egg consists of 46 chromosomes, receiving 23 from the sperm and 23 from the ovum.

The male reproductive system consists of two **testes**. These oval-shaped glands are located in a skin-covered, pouch-like structure called the **scrotum**. Two tube structures are also in the scrotum. The **epididymis** is a tube that carries sperm cells from the testes to the **vas deferens** (a thick-walled tube structure approximately 18 inches long) where they mature. The vas deferens then carries sperm to a hollow chamber, called the **seminal vesicle**, located behind the bladder.

The seminal vesicle joins with the vas deferens to form the ejaculatory duct. The secretions of the seminal vesicle are called **semen**, which bathes and nourishes the sperm cells. In the **ejaculatory duct**, the semen-containing sperm, upon ejaculation, enter the **urethra**, a membranous canal running through the **penis**, which transfers the sperm to the female's body.

Sperm The male sex cell.

Ovum The female sex cell.

Chromosomes Rod-shaped structures responsible for inherited characteristics passed on from parent to child.

Testes Male reproductive gland that forms and secretes sperm and several fluid elements in semen.

Scrotum Sac in which testes are suspended.

Epididymis A tube that carries sperm cells from the testes to the vas deferens.

Vas deferens A duct that transfers sperm from the epididymus to the seminal vesicle.

Seminal vesicle A gland that produces semen.

Semen Mixture of sperm cells and secretions from several male reproductive glands.

Ejaculatory duct A duct formed by the joining of the seminal vesicle with the vas deferens, through which semen moves during ejaculation.

Urethra A tube that discharges urine.

Penis Male organ of urination and intercourse.

Prostate gland Produces a fluid element in semen that stimulates the movement of sperm.

The **prostate gland** is a partly glandular and partly muscular gland surrounding the neck of the bladder. It secretes a fluid, which is part of the semen, and stimulates sperm motility (movement).

The female reproductive system consists of the **vagina**, a muscular canal approximately 4 1/2 inches long through which a baby passes during birth. It extends from an external opening to the **cervix** (neck of the uterus). The **uterus** is located between the rectum and urinary bladder, and is a hollow, pear-shaped organ. It is lined with a fluffy vascular layer of tissue called **endometrium**. The fertilized ovum embeds itself into the endometrium, which sloughs off (separates) during menstruation if the ovum is not fertilized.

The **fallopian tubes** (oviducts) extend from two openings on each side of the anterior portion of the uterus. The distal (farthest) ends of the fallopian tubes are funnel-shaped, and finger-like projections, called **fimbriae**, extend from them. They are located near, but not attached to, the **ovaries**. The fimbriae draw the ovum into the fallopian tube where it travels to the uterus.

Vagina The muscular canal in a female that extends from an external opening to the neck of the uterus.

Cervix Lower end (neck) of the uterus.

Uterus A female organ within which the fetus develops during pregnancy.

Endometrium Lining of the uterus.

Fallopian tubes Slender tubes that convey the ova (eggs) from the ovaries to the uterus.

Fimbriae Finger-like projections extending from the fallopian tubes that draw ova (eggs) into the fallopian tube.

Ovaries Female reproductive organs.

Examples of surgical procedures involving the reproductive system:

- Orchiopexy – Relocating a non-descended testicle to the correct location in the scrotum.
- Transurethral resection of the prostate (TURP) – Removal of part of the prostate gland through the insertion of instruments across the urethra to reach the prostate internally.
- Radical prostatectomy – Removal of the prostate gland using an incision in the abdomen, and also the urinary bladder. Frequently, additional tissue is biopsied for invasion of cancer cells.
- Hysterectomy – Removal of the uterus.
- Bilateral salpingo-oophorectomy (BSO) – Removal of fallopian tubes and ovaries.
- Endometrial ablation – Scarring or removal of the inner lining of the uterus to treat abnormal bleeding.
- Dilation and curettage (D&C) – Widening of the cervix (opening of the uterus) to permit evacuation of the contents or scraping of the lining of the uterus.
- Ectopic pregnancy – Removal of a fertilized ovum growing in the fallopian tube to prevent complications, such as hemorrhage, shock and scarring of the fallopian tube.
- Pelviscopy – Visualization of the pelvic cavity (lower abdomen) using an endoscope for medical diagnosis or treatment of female reproductive organs.
- Tubal ligation – Cutting, burning, tying or applying a clip on the fallopian tubes to prevent future pregnancies. (See **Figure 3.23**)

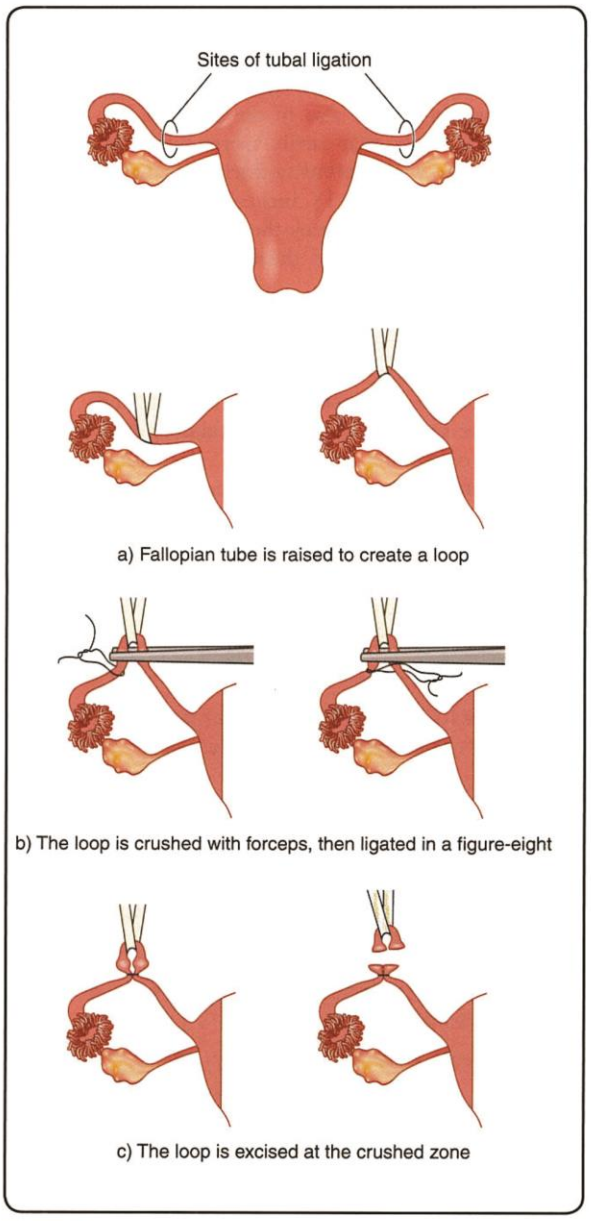


Figure 3.23

- Vasectomy – A surgical procedure for male sterilization and/or birth control. (See **Figure 3.24**)

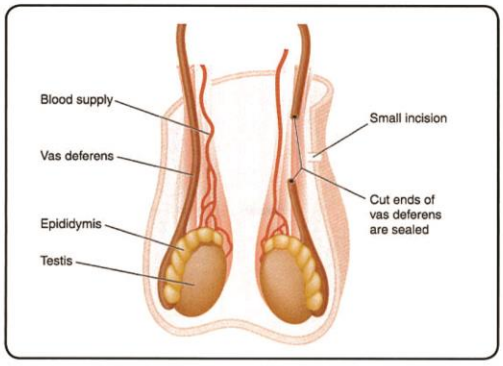


Figure 3.24

Urinary and Excretory Systems

The urinary system provides "pollution control" by eliminating body waste. This process takes place as blood is filtered by the urinary system. Urine is a water solution consisting of various waste substances that are products of metabolism. It obtains its color from excreted bile pigments and may be a shade of amber, pale or clear. Depending on the amount of liquid intake or loss through perspiration, an average adult may excrete between 1000cc to 1800cc of urine during a 24-hour period. In males, the urinary and reproductive systems are closely related and comprise the genitourinary system. In the female, however, the two systems are not interrelated.

Organs of the urinary system in both sexes include: (See **Figure 3.25)**

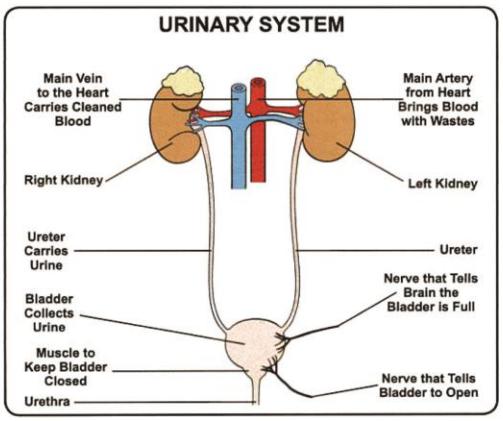


Figure 3.25

- **Kidneys** – Two bean-shaped organs containing a vast network of vessels and tubules, called nephron, that act as a filter to remove excess water and waste substances (including salts and minerals) from the blood to produce urine.

- **Ureters** – Two tube-like structures that extend from each kidney and connect them to the urinary bladder. The peristaltic (automatic constriction and relaxation) action of the ureters moves urine from the kidneys to the urinary bladder.

- **Urinary bladder** – Serves as a reservoir for urine. It is a muscular, membranous sack located in the pelvis just anterior (front) of the sigmoid colon and posterior to (behind) the pubis. The bladder is flexible and its size depends upon the amount of urine present. The average capacity ranges from between 300cc to 500cc in adults. As the amount of urine in the urinary bladder increases, it applies pressure on the bladder walls, sending an impulse to the central nervous system. As the bladder wall contracts, the sphincter muscle at the junction of the urethra relaxes and urine is released.

- Urethra – A membranous canal or tube that connects the urinary bladder to outside the body to eliminate urine. In the male the urethra is approximately 20cm long. It passes through the prostate gland and pelvic wall, and extends through the penis. The female urethra is about 4cm long. It runs from the bladder through the sphincter muscles to the external meatus (opening) located at the anterior (front) of the vagina.

Kidneys Organs that remove excess water and waste substances from the blood in a process that yields urine.

Ureters Tube-like structures extending from the kidneys to the urinary bladder that move urine between these organs.

Urinary bladder The reservoir for urine.

The excretory system removes toxic (poisonous) waste substances. The kidneys (urinary system) and lungs (respiratory system) also perform excretory functions, as do the **liver** and **skin**.

The liver is another filter for the blood. It removes amino acids and can neutralize some harmful toxins. It can also convert hemoglobin from worn-out blood cells into substances the body requires.

Skin contains sweat glands, oils, hair and nails. Dead skin cells form hair and nails. Sweat glands remove excess water, salt and other bodily wastes. These are located in the dermis (inner layer of skin) and consist of coiled tubes connected to pores in the skin's surface. The sweat glands, through the process of perspiration, produce and excrete sweat. Perspiration rids the body of waste and also helps to regulate the body's temperature by cooling its outside surface. The excretion of oil by the sebaceous glands keeps the skin soft and prevents hair from becoming too dry or brittle.

Liver An organ that filters the blood to remove amino acids and neutralize some harmful toxins.

Skin This organ contains sweat glands that, through the process of perspiration, produces and eliminates sweat.

Examples of surgical procedures involving the urinary system:

- Nephrectomy – Removal of the kidney.
- Lithotripsy (kidney stone shock wave treatment) – Serves to crush stones that form in the kidney and become stuck in an ureter. The procedure involves decreasing the size of the stones with a laser or shock waves or removing them using a long, flexible instrument called a stone basket. (See **Figure 3.26**)

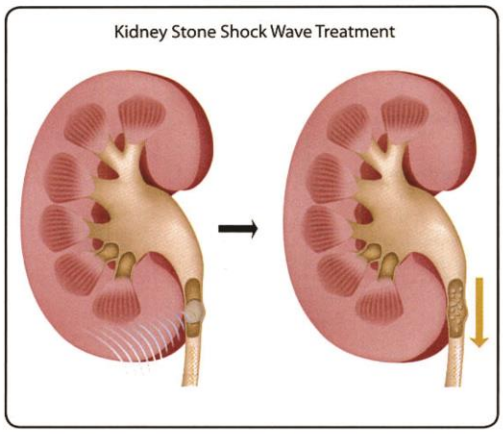


Figure 3.26

- Cystoscopy – Viewing the urinary bladder using an endoscope.

The Respiratory System

The respiratory system (See **Figure 3.27**) supplies the body with oxygen and removes carbon dioxide.

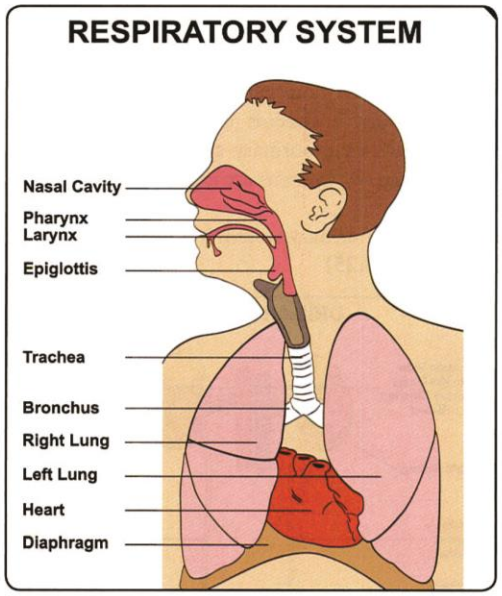


Figure 3.27

This exchange of gases is accomplished automatically as one breathes in a two-step process: inspiration (inhaling air into the lungs) and expiration (exhaling

air from the lungs). Air contains impurities, such as dirt, dust and microorganisms, and these are filtered out by the respiratory system.

The primary organs of the respiratory system are:

- **Nose** (nasal cavity) and **mouth** – During inspiration, air enters the nostrils (nasal openings) and mouth. Air in the nose is filtered, moistened and warmed.
- **Pharynx** – Air passes to the pharynx (throat), which is the crossroads of the nose, mouth, voice box, and **esophagus**. Food continues down the esophagus, while air passes through the **larynx** (voice box) to the **trachea**.
- Trachea (windpipe) – The trachea divides into two tube-like structures, the right and left **bronchi**, that extend into the **lungs**.
- Lungs – Air continues through the bronchi to the bronchioles, a series of many smaller tubes extending from each bronchus (somewhat like branches of a tree). At the end of each bronchiole are small clusters of air sacs, called alveoli, that comprise the lungs' tissue. Alveoli and each alveolus are covered by a thin wall surrounded by a vast network of capillaries (tiny blood vessels). There the blood picks up oxygen from the inspired air and releases the waste gas, carbon dioxide, during expiration.

Nose Organ of smell; also filters the air we breath.

Mouth Opening through which air, food and beverages enter the body; beginning of the alimentary canal.

Pharynx Throat.

Esophagus Connects the throat to the stomach.

Larynx Voice box.

Trachea Windpipe.

Bronchi The main passageway for air to travel from the trachea to the lungs.

Lungs Main organs of the respiratory system whose function is transporting oxygen into the blood and removing carbon dioxide from the blood.

The right lung consists of three lobes. The left lung consists of two lobes to allow space for the heart.

The lungs are located in the thoracic cavity (chest), where they are covered by thin membranes, called pleura, and protected by the skeletal rib cage and sternum. The pleura secrete a lubricating fluid that permits smooth movement of the lungs during the respiratory cycle.

The diaphragm is a muscle located below the lungs. It contracts and causes the chest cavity to expand to allow more space for air. During expiration, the diaphragm relaxes and air is forced out of the lungs.

Examples of surgical procedures involving the respiratory system:

- Thoracotomy – Making an opening into the thoracic cavity (chest) to give surgeons access to the lungs and heart.
- Thoracoscopy – Viewing the thoracic (chest) cavity with an endoscope for diagnosis or treatment.
- Pneumonectomy – Removal of a lung.
- Tracheotomy – Making an incision into the trachea. (See **Figure 3.28**)

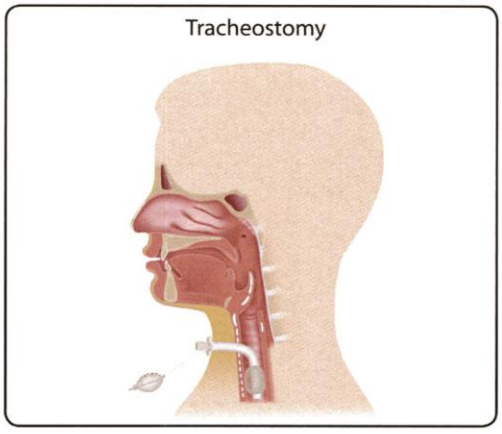


Figure 3.28

- Lobectomy - Removal of a lobe of an organ, usually referring to the brain, the lung or the liver.
- Laryngectomy – Removal of the larynx (voice box).
- Bronchoscopy – Visualizing the bronchus with an endoscope.
- Septoplasty – Straightening or removing cartilage and/or bone in the nose when the nasal septum is deformed, injured or fractured.
- Endoscopic sinus surgery (ESS) – Removal of bone defects or inflamed tissue of the paranasal sinuses to allow the sinuses to drain.

The Digestive System

The human body, like any other complex piece of machinery, requires a source of energy or fuel to keep it functioning. The body gets its fuel from the chemicals (nutrients) in food.

The function of the digestive system (See **Figure 3.29**) is to convert food into energy for the body. The human body requires six basic categories of nutrients: proteins, carbohydrates, fats, water, minerals and vitamins. A well-balanced diet is important to keep the body healthy and strong.

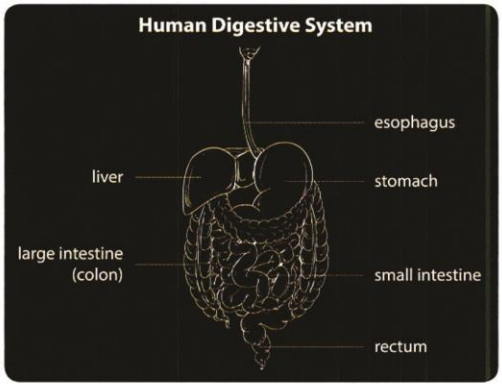


Figure 3.29

The process of digestion breaks food down mechanically and chemically so it can be absorbed by body cells or discharged as waste. The pathway that food takes through the digestive system is called the **alimentary canal** (digestive tract).

The alimentary canal is approximately 30 feet long, and consists of the mouth, esophagus, **stomach**, **small intestine**, **large intestine**, **rectum** and **anus**.

The liver, gallbladder and pancreas are accessory organs of the digestive system.

The salivary, gastric and intestinal glands are accessory structures to the digestive system that contribute to the process of digestion.

A review of the components of the alimentary canal allows us to study the digestive process.

- Mouth – The digestive process begins in the mouth. There, food is softened by saliva secreted by salivary glands located throughout the mouth. The teeth tear and grind the softened food into smaller particles that allow it to be easily swallowed. The food then passes through the esophagus.
- Esophagus – A somewhat flexible, muscular tube that produces peristaltic contractions, which move food into the stomach.
- Stomach – An elongated and muscular J-shaped pouch that serves as a reservoir for food as gastric gland secretions (mucin, hydrochloric acid, and enzymes) convert the food into a semi-liquid material, called chyme.
- Small intestine – From the stomach, the liquified food enters the small intestine (an organ approximately 20 to 23 feet long). This is where the greatest amount of digestion and absorption of nutrients into the body cells occurs. The small intestine is divided into three portions: duodenum, jejunum and ileum. Bile (produced by the liver and stored in the gallbladder), along with pancreatic and intestinal juices, facilitates digestion in the small intestine.

- Large intestine (colon) – Material that is not absorbed by the small intestine enters the large intestine (colon), which is approximately five to six feet long. The first few inches of the large intestine are called the cecum, from which the appendix extends. The large intestine consists of six portions: ascending colon, transverse colon, descending colon, sigmoid colon, rectum and anus. Peristaltic action moves food through the large intestine where the absorption of water and electrolytes or salt occurs.

- Rectum and anus – The rectum is the last several inches of the large intestine where the remaining waste (feces) becomes dehydrated and is eliminated through the anus.

Alimentary canal The pathway that food takes through the digestive system; also called digestive tract.

Stomach A pouch that serves as a reservoir for food that has been consumed.

Small intestine The organ in the digestive system where the greatest amount of digestion and absorption of nutrients into the body cells occurs.

Large intestine (colon) The digestive organ that dehydrates digestive residues (feces).

Rectum The last several inches of the large intestine.

Anus The lower opening of the alimentary canal.

Examples of surgical procedures involving the digestive system:

- Appendectomy – Removal of the appendix.

- Parotidectomy – Removal of a salivary gland (parotid) because of tumor formation.

- Gastrectomy – Removal of the stomach. Other procedures include removal of portions of the stomach [e.g., hemi (half) gastrectomy or gastric sleeve]. (See **Figure 3.30**)

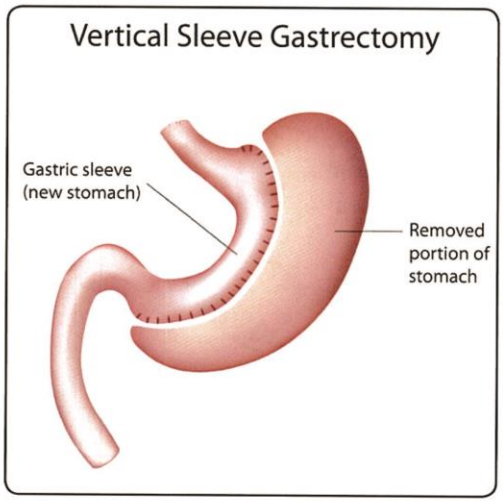


Figure 3.30

- Gastric bypass – Isolating a small portion of the stomach and suturing part of the small intestine to it to treat morbid obesity. Food intake is then limited to the small part of the stomach. (See **Figure 3.31**)

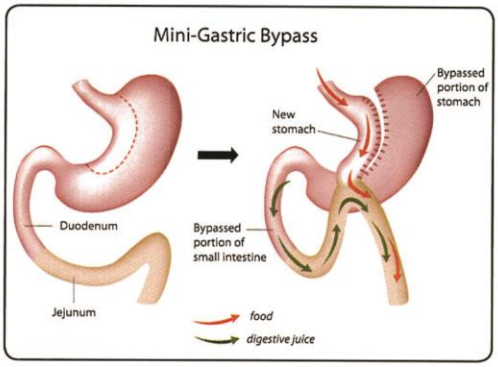


Figure 3.31

- Gastric banding – An inflatable silicone device placed around the top portion of the stomach to treat obesity. (See **Figure 3.32**)

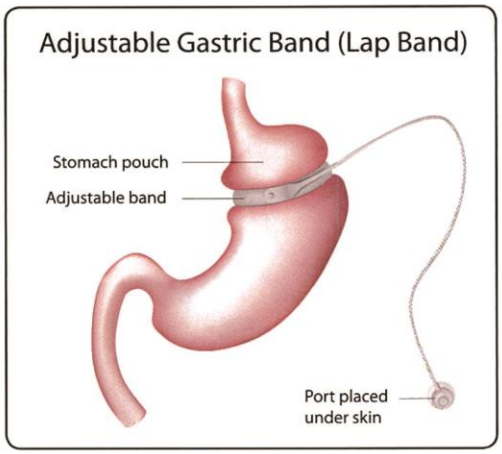


Figure 3.32

- Cholecystectomy – Removal of the gallbladder with a surgical incision or by endoscopic surgery, called laparoscopic cholecystectomy. (See **Figure 3.33**)

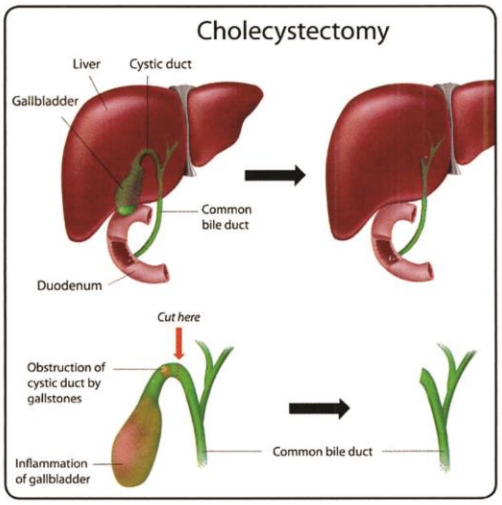


Figure 3.33

- Colectomy – Removal of all or part of the large intestine.
- Laparoscopic cholecystectomy– Removal of the gallbladder with endoscopic instrumentation.

The Circulatory System

The circulatory system (See **Figure 3.34**) is the body's primary transportation network. It delivers nutrients and oxygen to body cells, and carries away carbon dioxide and other harmful waste products from them. This is accomplished as blood is pumped through 60,000 miles of blood vessels in the body.

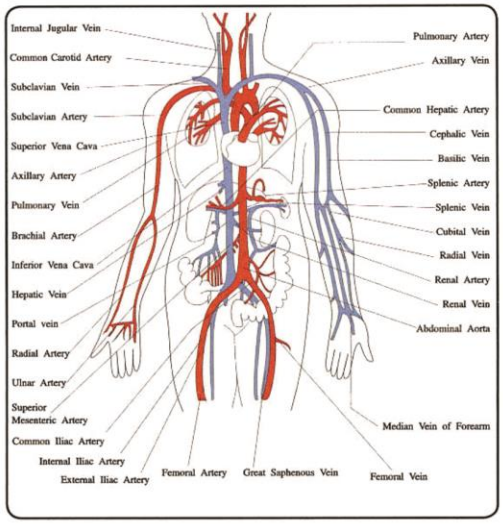


Figure 3.34

The lymphatic system (See **Figure 3.35**) is a subsidiary of the circulatory system and serves a vital role in the body's defense against disease.

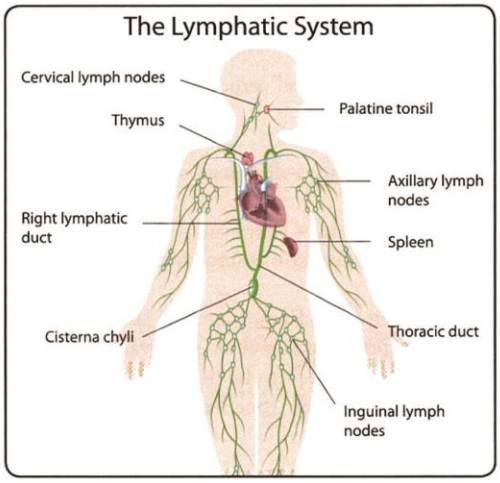


Figure 3.35

The lymphatic system consists of a series of tiny vessels located throughout the body that carry clear liquid fluid (lymph) that originates from blood plasma. Large numbers of lymph nodes (tissue masses containing special cells called lymphocytes) that filter bacteria and other harmful materials out of the lymph are located in the lymph and blood vessels. Lymph flows from the lymph vessels into two veins located in the neck region to return lost fluid back into the bloodstream.

Tonsils are one type of a lymph node, and they are located on both sides of the base of the tongue in the throat. (See **Figure 3.36**)

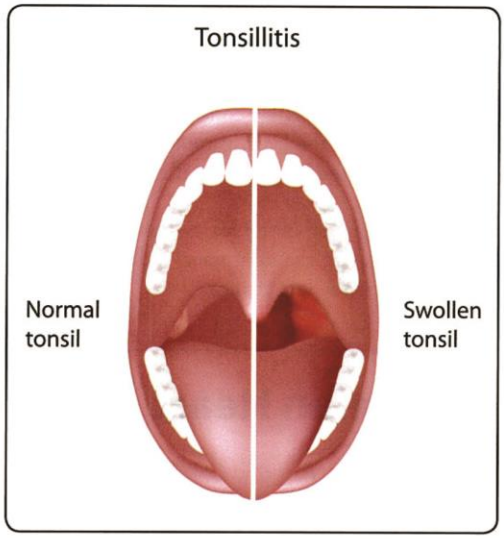


Figure 3.36

Sentinal lymph nodes are frequently identified during cancer surgery. The surgeon tries to find the first (sentinal) lymph node where the cancer cells have started to spread.

Blood is a type of connective tissue fluid that moves throughout the circulatory system and transports many important substances. The body contains an average of five to seven liters of blood. Blood is a mixture of plasma, red blood cells (erythrocytes), white blood cells (leukocytes) and platelets:

- **Plasma** – More than 55% of blood is made up of plasma, a yellowish liquid that is composed of water (92%) and proteins. Plasma serves as the vehicle of transportation for dissolved nutrients, enzymes, waste and other substances through the body.

- **Red blood cells** – These structures have thin centers that allow them to be pliable when moving through narrow capillaries. Red blood cells are rich in hemoglobin (an iron protein) that picks up oxygen in the lungs, transports it to all the body cells and then transports carbon dioxide back to the lungs. These cells are produced in the bone marrow and have a life span of approximately 120 days. Worn out or damaged red blood cells are broken down in the liver and destroyed by the spleen.

- **White blood cells** – Some white blood cells are twice as large as red blood cells, and their life span can range from hours to years. White blood cells are also produced by bone marrow and their purpose is to attack, destroy and digest disease-producing organisms that enter the body.

- **Platelets** – These tiny cell fragments detach from bone marrow and enter the bloodstream. They have no color or nucleus, and last for a maximum of 10 days. Enzymes released by the platelets act on other blood components to create fibrin. This chemical weaves across cells in blood vessels, and traps blood cells and plasma that will harden and clot.

Blood A type of connective tissue fluid that transports many substances throughout the circulatory system.

Plasma The largest component of the blood. Plasma transports nutrients throughout the body and helps remove wastes from the body.

Red blood cells Blood cells that carry oxygen throughout the body.

White blood cells Blood cells that circulate in the blood and help defend the body against infection or foreign invaders.

Platelets Blood cells whose function is to help the blood to clot.

Circulation in the body is a continuous process, traveling the same route throughout the body all the time. Blood moves from the heart to the lungs and then back to the **heart** where it is pumped to all the cells of the body through a system of vessels. Blood then returns back to the heart to be recurculated.

The vessels that carry blood away from the heart are called **arteries**. **Veins** are the vessels that carry blood back towards the heart. **Capillaries** are the tiny vessels abundant throughout the body that serve as connections between veins and arteries.

The heart (See **Figure 3.37**) is a muscular organ, about the size of a fist, that pumps five liters of blood through the body every minute, while resting only between beats. Located in its upper right side is a "pacemaker" that signals the heart muscle to contract; this controls the heartbeat. Here's how the heart works:

- The heart consists of four hollow chambers: two on each side.
- A thick tissue wall, called the septum, separates the right and left sides of the heart.
- The upper chambers of the heart are called **atria** and the lower chambers are called **ventricles**.
- Deoxygenated blood (blood that has had oxygen removed by the cells) returns to the heart and enters the right atrium.
- As the right atrium becomes full, a tissue flap (called a heart valve) opens. It allows blood to flow into the right ventricle.
- When the right ventricle is full, the valve closes to prevent backflow of blood.
- As the right ventricle contracts, blood is forced out of the heart through the pulmonary artery into the lungs where it is oxygenated.
- The oxygenated blood leaves the lungs through the pulmonary veins and enters the left atrium.

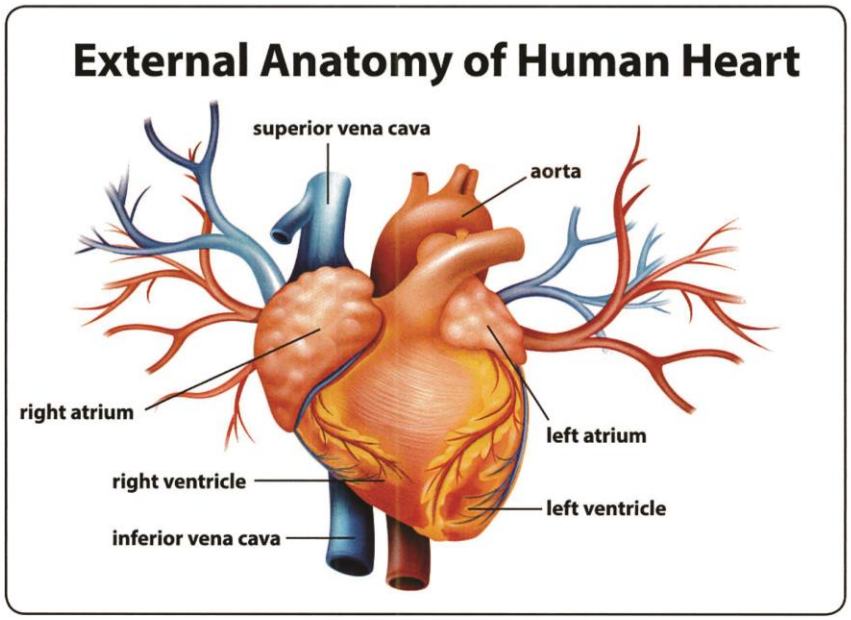


Figure 3.37

- As the left atrium becomes full, the left atrium heart valve opens and the blood flows into the left ventricle. As the left ventricle becomes full, the left atrium valve closes, the left ventricle contracts, and oxygenated blood leaves the heart.

As the heart contracts, blood is forced out of the left ventricle through the aortic valve into the **aorta**, the largest blood vessel in the body. The aorta is an artery that carries blood away from the heart, and it branches out into a vast network of smaller arteries throughout the body. The left ventricle pumps blood throughout the entire body, working about six times as hard as the right ventricle, which only pumps blood a short distance.

Heart The muscular organ that pumps blood throughout the body.

Arteries Vessels that carry blood away from the heart.

Veins Vessels that carry blood back to the heart.

Capillaries Vessels that serve as connections between veins and arteries.

Atria The two upper chambers of the heart.

Ventricles The two lower chambers of the heart.

Aorta The largest blood vessel in the body.

Examples of surgical procedures involving the circulatory system:

- Tonsillectomy – Removal of lymph tissue in the pharynx (throat).
- Adenoidectomy – Removal of tonsil tissue at the end of the soft palate (roof of the mouth).
- Arteriovenous (AV) fistula – Suturing the radial artery and cephalic vein together in the lower arm to allow the dilated (enlarged) vein to be used for large bore needle insertion for renal dialysis.
- Aneurysm repair – Abdominal aortic aneurysm (AAA) – Removing a weakened, balloon-like area in the aorta and replacing it with a synthetic product. (See **Figure 3.38**)

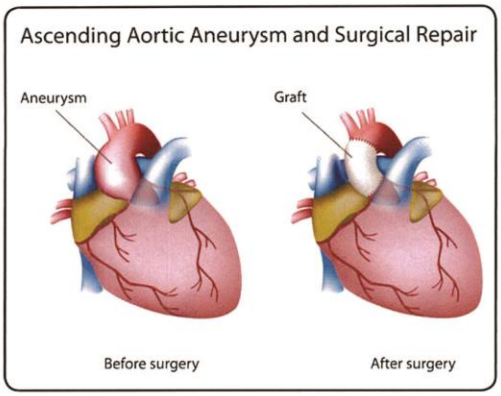


Figure 3.38

- Pacemaker insertion - A small electrical medical device implanted in a patient to make the heart beat regularly. (See **Figure 3.39**)

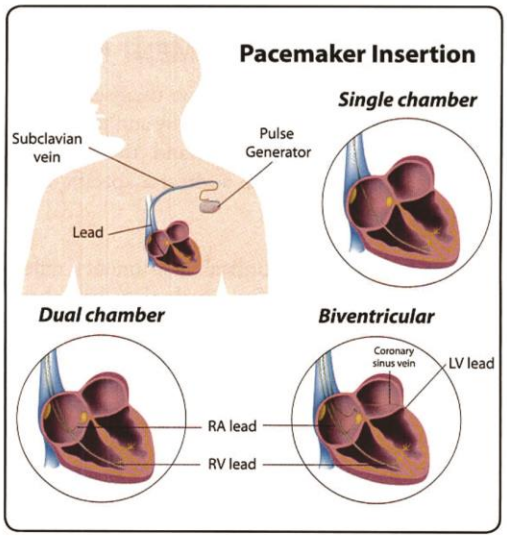


Figure 3.39

- Hemorrhoidectomy – Removal of swollen inflamed veins from the anus.
- Coronary artery bypass graft (CABG) – Removal of a vein, usually from a lower limb, to bypass the blocked section of the coronary arteries. (See **Figure 3.40**)

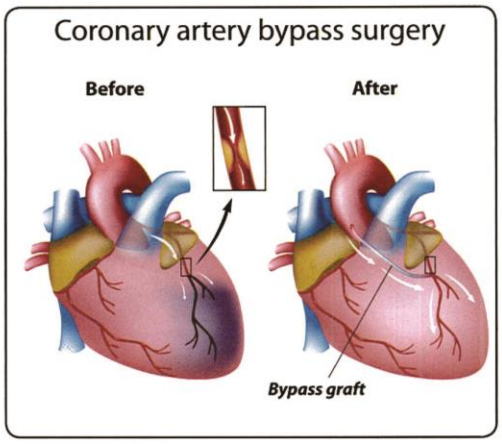


Figure 3.40

- Carotid endarterectomy – A procedure to reduce the risk of stroke by removing plaque from the carotid artery that causes lack of brain oxygenation.

ANATOMY AND INSTRUMENT NAMES

CS professionals who familiarize themselves with common aspects of human anatomy and physiology may find it easier to understand the need for specialized instruments to address a specific body system.

The names of many surgical instruments reflect the anatomical region for which they have been designed. For this reason, taking the time to learn how the body works will help CS professionals better understand the purpose of a particular instrument, and help them remember its name.

Here are just a few examples of the hundreds of instruments that reflect the anatomical area from which their names are derived:

- Aortic compressor
- Vaginal speculum
- Adenotome
- Eyelid retractor
- Urethratome
- Bowel forceps
- Anal retractor
- Lacrimal duct probes
- Hip skid
- Uterine sounds
- Brain spatula

CONCLUSION

While Central Service technicians do not provide direct patient care, an understanding of basic anatomy and common surgical procedures can help improve communication with surgery and other procedural units and, therefore, improve patient outcomes. A basic understanding of anatomical terms can also increase instrument knowledge. Both enhancements make it easier to function in the role of surgical support.

The human body is incredibly sophisticated. With its many parts, networks and functions, it is amazing to contemplate how these various systems must work together in a grand orchestral maneuver, and how disease or injury can disrupt the symphony. By gaining a basic understanding of how the body works and the common surgical procedures that are performed to treat certain conditions, CS technicians can become more knowledgeable about the instruments and devices in their care, and improve their ability to communicate with the surgical team.

RESOURCES

Brooks M. *Exploring Medical Language: A Student-Directed Approach. Fifth Edition.* Mosby Inc. 2002.

Davies J. *Essentials of Medical Terminology. Third Edition.* Delmar Publishers Inc. 2002.

Fremgen B. *Medical Terminology: An Anatomy and Physiology Systems Approach.* Prentice-Hall Inc. 1997.

Gylys B. *Medical Terminology Simplified: A Programmed Learning Approach by Body Systems.* F. A. Davis Company. 1995.

Gylys B, Wedding M. *Medical Terminology: A Systems Approach. Third Edition.* F. A. Davis Company. 1995.

Isler C. *The Patient's Guide to Medical Terminology. Third Edition.* Health Information Press. 1997.

Lillis C. *A Concise Introduction to Medical Terminology. Fourth Edition.* Appleton & Lange. 1997.

McCann Schilling J. *Medical Terminology Made Incredibly Easy.* Springhouse Corp. 2001.

CENTRAL SERVICE TERMS

Anatomy

Physiology

Cell

Cell membrane

Cytoplasm

Nucleus

Tissue

Organ

System

Tendon

Ligament

Cartilage

Ossification

Joint

Fascia

Central nervous system (CNS)

Peripheral nervous system (PNS)

Brain

Cerebrum

Cerebellum

Brain stem

Hormones

Metabolism

Insulin

Glucagon

Sperm

Ovum

Chromosomes

Testes

Scrotum

Epidilymis

Vas deferens

Seminal vesicle

Semen

Ejaculatory duct

Urethra

Penis

Prostate gland
Vagina
Cervix
Uterus
Endometrium
Fallopian tubes
Fimbriae
Ovaries
Kidneys
Ureters
Urinary bladder
Liver
Skin
Nose
Mouth
Pharynx
Esophagus
Larynx
Trachea
Bronchi
Lungs
Alimentary canal (digestive tract)
Stomach
Small intestine
Large intestine (colon)
Rectum
Anus
Blood
Plasma
Red blood cells
White blood cells
Platelets
Arteries
Veins
Capillaries
Heart
Atria
Ventricles
Aorta

Chapter 4

Microbiology for Central Service Technicians

Learning Objectives

As a result of successfully completing this chapter, readers will be able to:

1. Define the term "microbiology" and explain why it is important for Central Service professionals to have a basic understanding of its science
2. Restate basic facts about microorganisms
3. Identify common ways to identify and classify microorganisms by:
   - Shape
   - Color change
   - Need for oxygen
4. Explain environmental conditions necessary for bacterial growth and survival
5. Provide basic information about non-bacterial organisms:
   - Viruses
   - Protozoa
   - Fungi
   - Prions
6. Review basic procedures to control and eliminate microorganisms

INTRODUCTION

Central Service (CS) professionals are sometimes daunted by microbiology because much of its terminology is unfamiliar and because it deals with a world that cannot be seen without a microscope; however, we can see the effects that microorganisms have on us. For example, we have all become sick with infections like colds or the flu and, even though we didn't see the microorganisms that infected us, we felt their effects.

Microscopic invaders can enter our bodies and cause serious illness and even death. How can something so small have such massive power over the human body? Why can anyone, even the strongest and healthiest person, become infected by microorganisms? Why does the risk of infection increase in people whose immune systems or natural body defenses are compromised? CS technicians must have a clear understanding of basic information about microorganisms. This chapter will help answer these and related questions about how these unseen organisms impact everyone in the healthcare facility.

OVERVIEW OF MICROBIOLOGY

Most people have some understanding of microbiology. They know that it is not wise to eat food that falls on the floor, touch a sick person's soiled facial tissues or share eating utensils. They know they should wash their hands before eating and after using the restroom. They understand that taking these precautions helps to protect against germs. For the average person, this limited understanding of the world of microbes is typically enough; however, CS technicians must have a better understanding about **microbiology** for two reasons:

- They have the responsibility to protect patients from microorganisms in the healthcare environment.
- The nature of their job duties places them and their co-workers in harm's way for exposure to harmful microorganisms.

Microorganisms are tiny organisms that can only be seen with a microscope. Examples of how small they are can be seen in **Figures 4.1** and **4.2** that show magnified photos of a contaminated needle.

Microbiology The study of microorganisms. The scientific study of the nature, life and action of microorganisms.

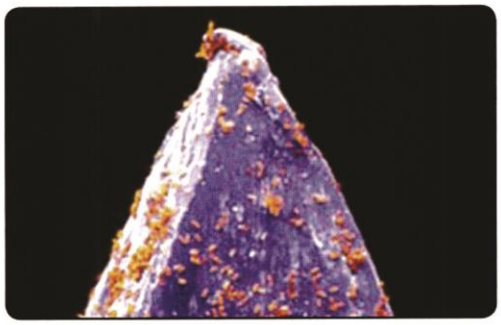


Figure 4.1

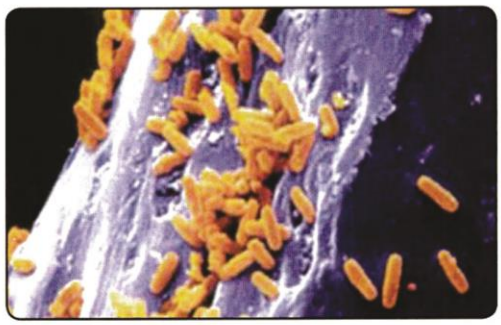


Figure 4.2

CS technicians should be able to recognize the conditions that favor the growth of microorganisms and recognize that even though we cannot see microorganisms with the naked eye, they are present in our environment. The surgical instruments, equipment and utensils processed by CS personnel every day are **contaminated** with microorganisms that pose a threat to patients, CS professionals and other facility personnel.

Contamination The state of being soiled by contact with infectious organisms or other material.

In this chapter, we will provide a broad overview of microbiology, including:

- Basic facts regarding microorganisms.
- Beneficial vs. dangerous microorganisms.
- How microorganisms are identified and classified.
- The conditions microorganisms need to grow and reproduce.
- How microorganisms are transmitted.
- How microorganisms can be controlled and eliminated.

Basic Facts Regarding Microorganisms

Cells are the basic units of all living organisms (plants, animals, protozoa and bacteria), and they are the smallest unit that can live, grow and reproduce. Cells differ in size and shape, but they all have: (See **Figure 4.3**)

- A nucleus (the controlling unit of the cell).
- Cytoplasm (the material that fills the cell).
- Cell membrane (the outer membrane that allows some liquids and gasses to seep in and out of the cell).

Bacterial cells differ from both plant and animal cells because they have no membrane to separate the nucleus (one strand of DNA) from the cytoplasm. Plants and animals have a nuclear membrane surrounding many strands of DNA.

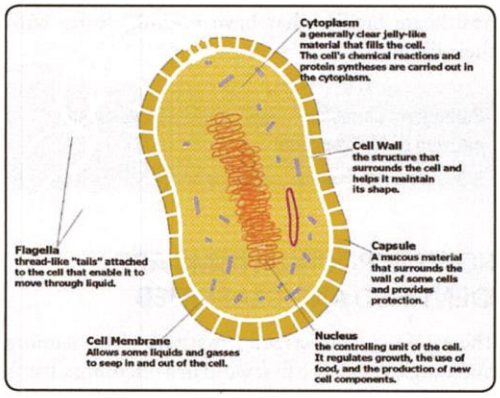


Figure 4.3

BENEFICIAL VS. DANGEROUS MICROORGANISMS

Many microorganisms, or microbes, are harmless. In fact, 95% of bacteria are beneficial and essential to our lives. They are everywhere in nature and are necessary for the existence of all plants and animals. For example, microorganisms maintain the balance of chemical elements in the natural environment by breaking down dead matter and recycling carbon, nitrogen, sulfur and other elements. Microorganisms are useful in sewage treatment to convert waste materials into soluble, odorless compounds for disposal. Harmless microorganisms are also found in people: on the skin and hair, in the intestinal tract and in some bodily discharges.

Microorganisms can cause infections when introduced into a body site where they are not normally found. Microorganisms that can cause illness are called **pathogens**. Pathogens cause disease by producing powerful toxins that interfere with how body systems work. Their uncontrolled reproduction can overwhelm body systems or cause tissues to degenerate.

Pathogens are a specific concern for CS professionals, as disease-causing organisms can reside on the instruments and devices used in patient care, leading to healthcare-associated infections (HAIs). It is estimated that two million patients every year acquire infections in the

healthcare facility that have nothing to do with their illness.

Pathogen Capable of causing disease (disease-causing microorganism).

HOW MICROORGANISMS ARE IDENTIFIED AND CLASSIFIED

There is a prescribed method for naming microorganisms. The first word in a microorganism's name (always capitalized) is the genus, or tribe, (family) of the microorganism; the second word is the specific name of the organism, also called the species. Microorganisms, like all living things, are identified and classified according to certain characteristics. We will break these organisms into two camps: bacteria and non-bacteria.

Bacteria

Characteristics

Bacteria are incredibly small; so small, in fact, that a microscope that can magnify at least 900 times is necessary to view them. Bacteria are measured by **microns** and most bacteria are one to two microns in size.

The most common ways to identify and classify bacteria are by shape, by color change and by need for oxygen (**aerobic** or **anaerobic**).

Micron 1/25,000 of an inch or 1/1,000 of a millimeter.

Aerobic Requiring the presence of air or free oxygen.

Anaerobic Bacteria that can live in the absence of atmospheric oxygen.

Shape

One of the properties used to identify and classify bacteria is by shape, which is determined by cell wall structure. The common shapes of bacteria are:

- Spherical – These bacteria are shaped like a circle or sphere (coccus) such as *Staphylococcus aureus* and *Streptococci*. (See **Figure 4.4**)
- Rod – These bacteria are shaped like rods or bricks (bacillus). Examples include *Pseudonomas aeruginosa* and *Enterobacteria*. (See **Figure 4.5**)
- Spiral – These bacteria are shaped like spirals (spirilla). *Helicobacter pylori* is a spiral bacteria. (See **Figure 4.6**)

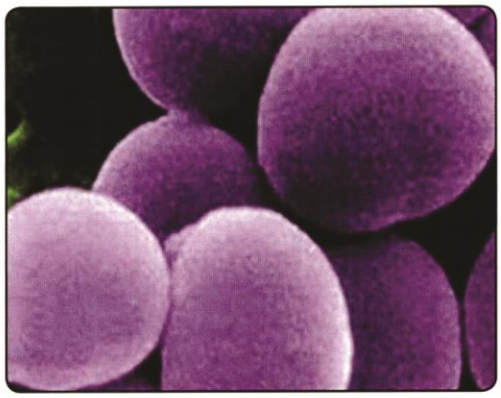


Figure 4.4

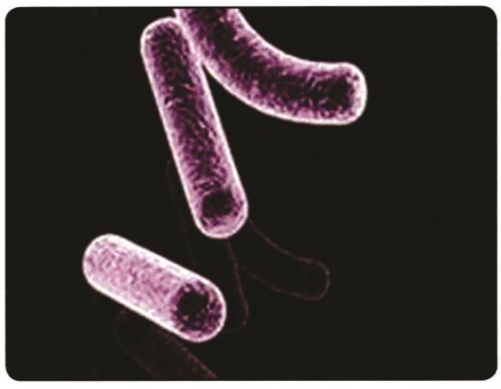


Figure 4.5

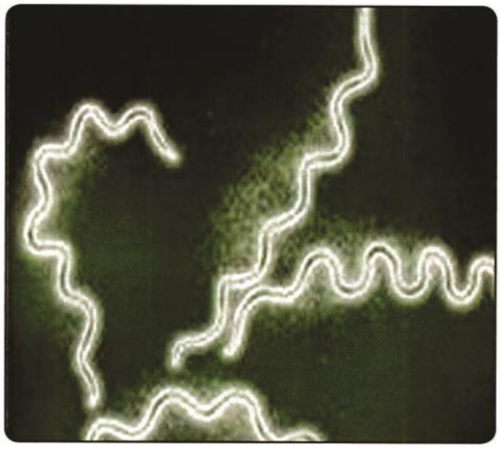


Figure 4.6

Certain bacteria can change into a different form called **endospores (spores)** by developing a thick coat around the cell's nucleus when conditions required for growth are not adequate. These spores can become infectious and produce toxins once inside the body. For example, some spores (such as *Bacillus anthracis* that causes anthrax and the *Clostridium* species that cause tetanus, botulism and severe diarrhea) are found in the soil, air and all over the body. (See **Figures 4.7** and **4.8**) Spores are very resistant to disinfection and other conditions, such as heat, making them very difficult to kill.

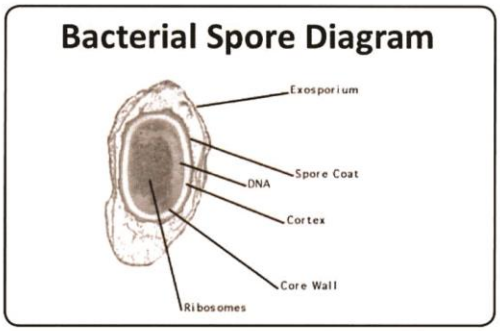


Figure 4.7

Endospores (spores) Microorganisms capable of forming a thick wall around themselves enabling them to survive in adverse conditions; a resistant form of bacterium.

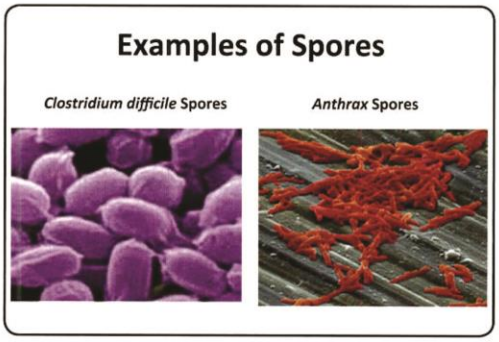


Figure 4.8

Color Change

Bacteria are normally clear and colorless organisms, and they cannot be seen, even when viewed under the microscope, unless they are dyed with a stain so the shape of each individual organism can be seen. There are two main types of staining processes used to identify the shapes and characteristics of bacteria.

Gram staining is used most frequently. Gram staining is a multi-step process using several stains and rinses. The specimen is affixed to a slide that is first stained purple, with crystal violet. It is then stained with iodine, discolored using alcohol or acetone, and, finally, stained with safranin.

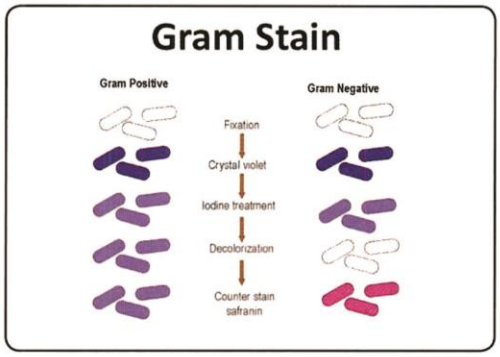


Figure 4.9

Gram-negative bacteria have an outer membrane that will not retain the purple stain after treatment with iodine; they will stain pink. Gram-negative bacteria include *Pseudonomas aeruginosa* that causes

urinary tract infections, *Escherichia coli (E. coli)* and *Salmonella* species that cause intestinal disease, and *Klebsiella* species that cause pneumonia. (See **Figure 4.10**)

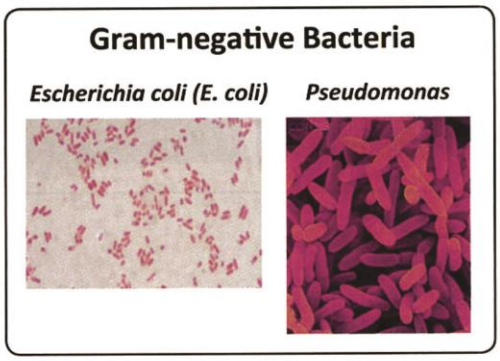


Figure 4.10

Gram-positive bacteria have no outer membrane and will retain the purple stain, even if a decolorizer is used. Gram-positive bacteria include *Staphylococcus aureus* that effects skin and mucous membranes, *Bacillus anthracis* that causes anthrax, and *Clostridium difficile* that causes diarrhea. (See **Figure 4.11**)

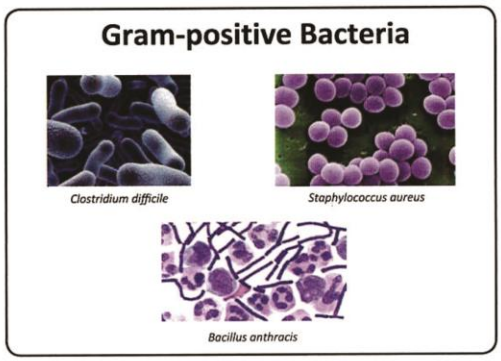


Figure 4.11

Gram Stain Chart

Gram Stain Classification		
Bacteria	**Shape**	**Gram stain**
Staphylococcus	Cocci	Gram-positive
Streptococcus	Cocci	Gram-positive
Enterococcus	Cocci	Gram-positive
Mycobacterium tuberculosis	Bacillus	Gram-positive
Mycobacterium leprae	Bacillus	Gram-positive
Clostridium tetani	Bacillus	Gram-positive
Clostridium botulinum	Bacillus	Gram-positive
Clostridium perfringes	Bacillus	Gram-positive
Bacillus anthracis	Bacillus	Gram-positive
Geobacillus species	Bacillus	Gram-positive
Neisseria meningitis	Cocci	Gram-negative
Neisseria gonorrheae	Cocci	Gram-negative
Acinetobacter	Cocci	Gram-negative
Escherichia coli (E. coli)	Bacillus	Gram-negative
Proteus	Bacillus	Gram-negative
Klebsiella	Bacillus	Gram-negative
Pseudomonis	Bacillus	Gram-negative
Salmonella typhi	Bacillus	Gram-negative
Shigilla dysenteriae	Bacillus	Gram-negative

Figure 4.12

Acid Fast (Ziehl-Neilson Stain)

Some acid-fast bacilli are rod-shaped and are very difficult to stain, but once stained and heat or other agents are used, the bacteria will resist decolorization with a dilute acid-alcohol solution. (See **Figure 4.13**) This group includes mycobacteria, such as *M. tuberculosis*, which causes tuberculosis (TB), and *M. leprae*, which causes leprosy. (See **Figure 4.14**)

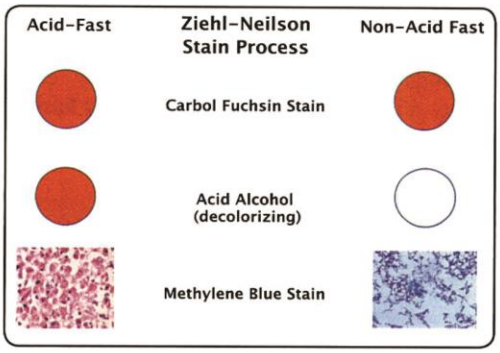


Figure 4.13

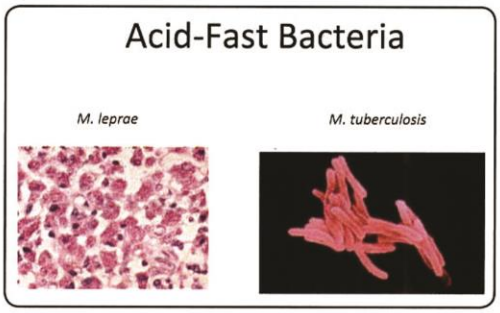


Figure 4.14

Need for Oxygen

Bacteria can also be classified according to whether they need oxygen to grow.

Aerobic bacteria require oxygen, just as humans do. They may grow in liquids; however, the liquid must have oxygen dissolved in it because oxygen is needed for respiration and metabolism.

On the other hand, anaerobic bacteria, such as *C. tetani*, which causes tetanus, and *C. botulinum*, which causes botulism, must have oxygen eliminated from the environment for them to grow. (See **Figure 4.15**) For example tetanus (lockjaw), bacteria are introduced deep into the flesh by a nail or similar object. Then, when it is removed, the tissue and tissue juices close the wound, oxygen is removed from the environment, and the anaerobic bacteria can grow.

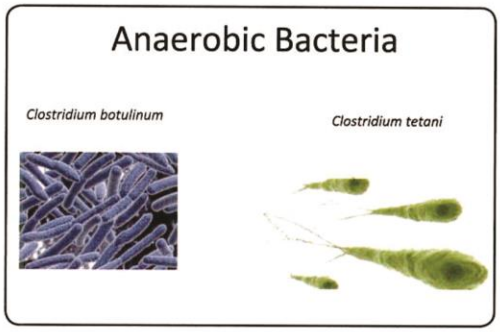


Figure 4.15

The Conditions Microorganisms Need to Grow and Reproduce

Groups of microbes have specific requirements for growth and survival. This tends to limit where they may be found. Suitable environments for bacteria are as diverse as the bacteria themselves. For example, a microbe that lives and thrives in the soil may not grow well in the vital organs of humans, and vice versa. The suitable environments for bacteria can be broken down into nutritional needs, temperature, moisture/humidity, **pH** and light.

Pathogenic bacteria are most likely to thrive where their specific nutritional needs can be met. Some, like *Staphylococci*, can grow on and in many areas of the body, skin, blood and hair follicles. Others, such as *Neisseria gonorrhoeae*, are more delicate and require a special environment, such as the mucous membranes of the reproductive system where they can live and invade deeper tissue.

Temperature requirements vary widely among bacteria, as well. **Psychrophile** bacteria like cold temperatures (59°F to 68°F); **mesophiles**, which are bacteria most pathogenic to humans, like moderate temperatures, such as 68°F to 113°F; and **thermophiles** like warm temperatures of 122°F to 158°F. (See **Figure 4.16**)

pH Measure of alkalinity or acidity on a scale of 0 to 14; pH of 7 is neutral (neither acid or alkaline); pH below 7 is acid; pH above 7 is alkaline.

Psychrophiles (bacteria) Bacteria whose optimum temperature for growth is 59°F to 68°F (15°C to 20°C) or below.

Mesophiles (bacteria) Bacteria that grow best at moderate temperatures: 68°F to 113°F (20°C to 45°C).

Thermophiles (bacteria) Bacteria which grow best at a temperature of 122°F to 158°F (50° to 70 °C).

Moisture and relative humidity play a major role in the growth and survival of microorganisms. Those which inhabit our skin, other bacteria that produce spores and the TB bacillus can survive for years in a dry state. Other species, like gonorrhea bacteria, cannot survive for more than 30 seconds when subjected to complete dryness.

Except for bacteria used in the fermentation process (such as vinegar and sauerkraut), most species will not grow in an acid pH of 4.4 or lower. Pathogenic microorganisms have an optimum pH range of 7 to 7.8, the same pH as blood.

Dark conditions are favorable to the growth of bacteria, while sunlight is lethal to organisms in their actively growing or **vegetative stage**. When spores of gram-positive bacilli are in a resting stage, they are most resistant to sunlight. The most lethal light is ultraviolet light in the range of 2537 **angstrom**, which can be used to disinfect air and purify the environments in the OR setting. Both ultraviolet light and sunlight kill bacteria by causing breaks in the nuclear DNA.

Bacteria are transmitted primarily by the droplet route (diphtheria and strep throat), by contaminated water or food (food poisoning by *Staphyloccocus* or *Salmonella* species), by direct contact (gonorrhea), through wounds (tetanus), by airborne mode (tuberculosis) and by disease-carrying animals (bubonic plague).

Vegetative stage State of active growth of microorganisms (as opposed to the resting or spore stages).

Angstrom A unit used to measure the length of light waves.

How Bacteria Grow

Under optimal conditions, most bacteria and other microorganisms reproduce approximately every twenty minutes in a process called **binary fission**, in which the original "mother" cell divides into two "daughter" cells.

Binary fission The typical method of bacterial reproduction in which a cell divides into two equal parts.

Temperature Requirements for Bacteria

Name	Description	Optimum Temperature for Growth
Psychrophiles	Cold Temperature	59° F to 68° F (15° C to 20° C)
Mesophiles	Moderate Temperature	68° F to 113° F (20° C to 45° C)
Thermophiles	Warm Temperature	122° F to 158° F (50° C to 70° C)

Mesophiles are the bacteria most pathogenic to humans

Figure 4.16

Multiple-Drug Resistant Organisms

In some cases, microorganisms adapt and change as a means of survival. For example, multiple drug-resistant organisms (MDRO) have become resistant to antibiotics used to treat bacterial infections. MDRO are increasingly found in hospitals, nursing homes and healthcare facilities of all sizes, and are eliminating the effectiveness of our best antibiotics, leaving us with more and more infections that cannot be treated. Resistant pathogens can produce many types of infection in almost any body site, including urinary tract, wound, blood infections and pneumonia. The most common drug-resistant bacteria today are:

- Methicillin-resistant *Staphylococcus aureus* (MRSA) lives on the skin and is known for causing severe infections, especially on the skin. Staph infections are spread by direct contact with someone with the infection or by touching contaminated surfaces. (See **Figure 4.17**)

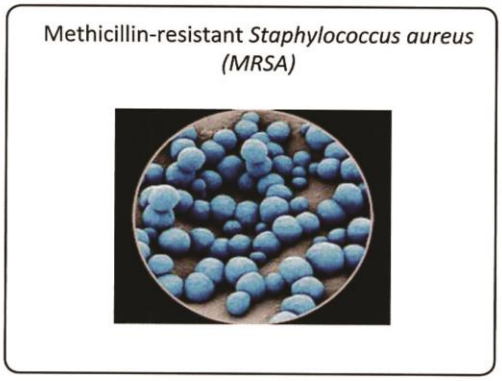


Figure 4.17

- Vancomycin-resistant *Enterococci* (VRE) lives in the bowels. This bacteria is transmitted when hands become contaminated from feces, urine or blood that is infected. It is also contracted by touching contaminated environmental surfaces. (See **Figure 4.18**)

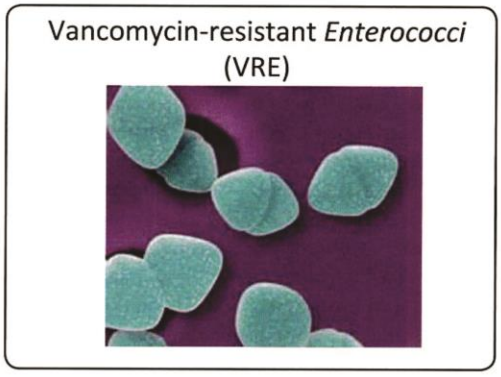


Figure 4.18

- Vancomycin-resistant *Streptococcus pneumoniae* lives asymptomatically in the nose and pharynx of healthy carriers. This bacteria causes pneumonia in susceptible humans. Strep is transmitted through direct contact with infected droplets from coughing or sneezing or from contact with other infected fluids. (See **Figure 4.19**)

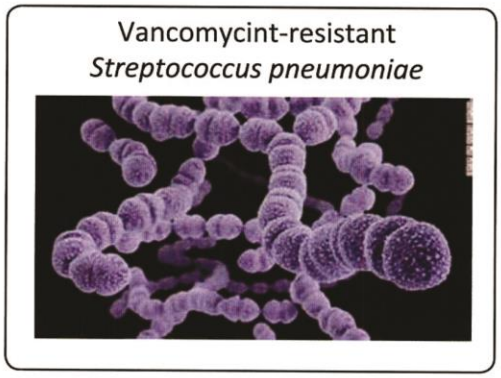


Figure 4.19

- *Klebsiella* is found on the hands and in the intestinal tract. This bacteria causes pneumonia, nasal infections, urinary tract, wound and bloodstream infections. *Klebsiella* is usually transferred from infected patients or surfaces through hand contact. (See **Figure 4.20**)

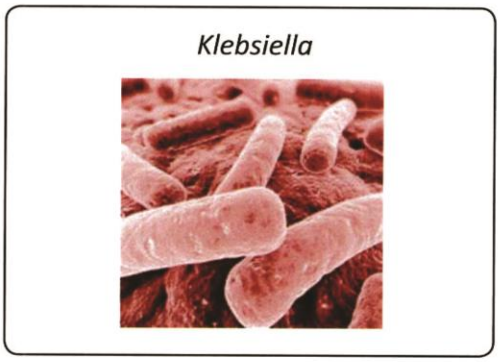


Figure 4.20

- *Acinetobacter* is found normally in soil. This bacteria can cause various illnesses ranging from pneumonia to serious blood or wound infections, and the symptoms vary depending on the disease. Acinetobacter can be resistant to many of today's antibiotics. It is transmitted by person-to-person contact or by contact with contaminated surfaces. (See **Figure 4.21**)

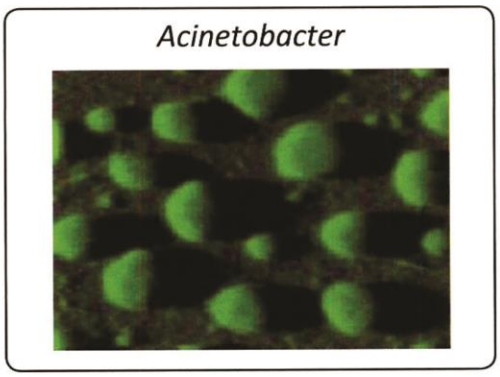


Figure 4.21

Figure 4.22

- *Carbapenem-resistant Enterobacteriaceae* are a family of germs that are difficult to treat because they have high levels of resistance to antibiotics. Klebsiella species and Escherichia coli (E. coli) are examples of Enterobacteriaceae, a normal part of the human gut bacteria that can become carbapenem resistant. CRE infections have been associated with devices, such as flexible endoscopes, ventilators, urinary catheters or intravenous catheters. Some CRE bacteria have become resistant to most available antibiotics. CRE infections are very difficult to treat and can contribute to death in up to 50% of patients who become infected.

- *Pseudomonas aeruginosa* is sometimes called the water bug because it is frequently found in water; however it is also found naturally in soil. *Pseudomonas* may not necessarily be drug-resistant, but is a pathogen commonly acquired in both hospitals and the community. *Pseudomonas* infections include urinary tract infections, respiratory system infections, dermatitis, soft tissue infections, bacteremia, bone and joint infections, gastrointestinal infections and a variety of systemic infections. These infections can occur particularly in patients with severe burns, and in cancer and AIDS patients who are immunocompromised. *Pseudomonas* is transmitted through hand to hand contact or contact with contaminated surfaces. (See **Figure 4.22**)

Even though the above bacteria are known to cause severe infections in humans and may be highly resistant to today's antibiotics, they require no special cleaning protocols. Following manufacturer's Instructions for Use (IFU), cleaning policies and procedures, and paying careful attention to the process is all that is required to clean items contaminated with these microbes.

Non-Bacterial Microorganisms

Viruses

Viruses are the smallest microorganisms and are about 1,000 times smaller than bacteria.

A virus enters a living plant or animal cell and reproduces itself within the cell. It usually destroys the cell, then enters another cell to survive. The virus itself has no means of movement and depends on air, water, insects, humans or other animals to carry it from one host to another. Some viruses contain envelopes: membrane structures that enclose the nuclear capsid (protein coat) that contain viral-specified proteins that make it unique. Herpes simplex, chickenpox and infectious mononucleosis are among the envelope viruses. (See **Figure 4.23**)

In the healthcare setting, there are several bloodborne viral pathogens of significance: human immunodeficiency virus (HIV), hepatitis B virus (HBV) and the most prevalent chronic bloodborne infection today, hepatitis C virus (HCV). (See **Figures 4.24** and **4.25**)

Viruses that are transmitted primarily by the airborne or droplet route include chickenpox (varicella), shingles (zoster), measles (rubeola), influenza and the common cold.

Ebola virus or Ebola hemorrhagic fever is a viral disease caused by the filovirus species. This virus is contracted by contact with blood or body fluids of an infected animal or human. The incubation period ranges from two to 21 days after exposure. The World Health Organization (WHO) states that ebola has a mortality rate of approximately 50%, as of April 2015. (See **Figure 4.26**)

Viruses transmitted by contaminated water or food include those that cause acute viral gastroenteritis such as rotavirus, Norovirus and noro-like virus. These often have symptoms similar to bacterial infections and spread through the four Fs: food, feces, fingers and flies. Another virus spread by food or water is hepatitis A that is contracted by eating raw or improperly cooked shellfish.

Viruses that spread primarily by direct contact include cold sores (herpes labialis), genital herpes, genital warts, infectious mononucleosis and rabies.

Like bacteria, some viruses can survive away from the host for many hours or days when in organic material, such as scabs, blood and bodily waste. Some viruses, like the herpes simplex virus (HSV), can survive in a dry state for 1½ to four hours on toilet seats, up to 72 hours on cotton gauze and 18 hours on plastic.

Standard cleaning protocols with careful attention to cleaning processes are usually sufficient to control these microorganisms.

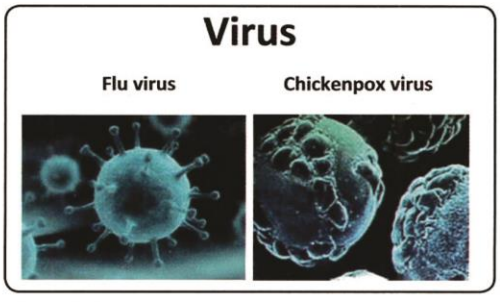


Figure 4.23

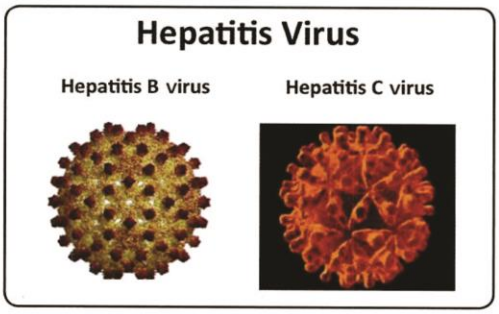


Figure 4.24

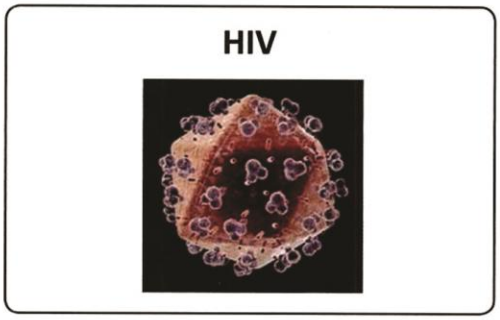


Figure 4.25

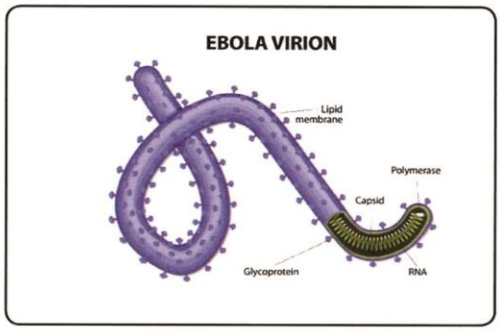


Figure 4.26

Protozoa

Protozoa are one-celled animal organisms that vary widely in size and shape and contain no cell walls.

Most protozoa live in moist habitats and are aerobic, but some species found in the human intestines are anaerobic. While most protozoa reproduce asexually, some species have sexual reproduction. They are known for their ability to move independently. The cells move by first

becoming longer and then retracting (called amoeboid movement) on false feet, called blunt pseudopodia. Protozoa consume food by flowing around a particle and taking it into itself. During their life cycle, all protozoa have a feeding stage, called trophozoite. Some protozoa can form cysts and become pathogenic. Some protozoa are spread by insects or by direct contact.

The most frequently encountered pathogenic protozoa is *Entamoeba histolytica*. It is found in feces, intestinal ulcers and liver abscesses of infected persons. *Cryptosporidium* is another protozoan that can cause diarrhea and abdominal pain. This organism causes severe, life-threatening diarrhea in AIDS or cancer patients, and organ transplant recipients. (See **Figure 4.27**)

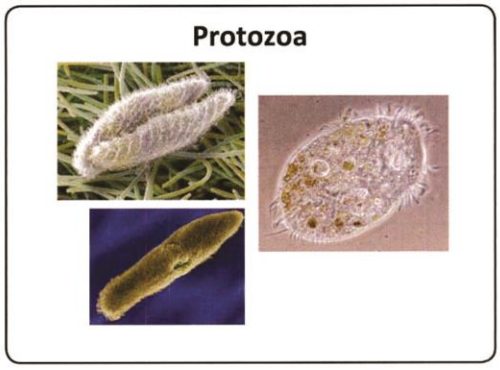


Figure 4.27

Fungi

Fungi are a large group of plant-like organisms that include molds, mushrooms and yeasts. Fungi and bacteria are often found together in nature. While some fungi, such as yeast, occur as single cells that require a microscope to see, others, such as mushrooms, are quite large.

The vegetative structure of a fungus (thallus) can vary widely in size, shape and complexity. Their shape and distribution of reproductive structures is how fungi are identified and classified (except for yeasts). Fungi can reproduce sexually, asexually or both. Fungi are mostly aerobic and require a carbohydrate or some reduced carbon source for carbon, electrons and energy.

Molds are composed of many-celled organisms that usually grow in compact masses of intertwining, branching and hair-like filaments. They reproduce in a variety of ways, including the formation of spores, fruiting bodies and binary fission.

Fungi have three major roles: to turn dead organic matter into usable substances through decay and mildew; to have a mutually symbiotic relationship with other organisms; and to be parasitic or pathogenic to plants or animals.

Fungi live by feeding on living or dead organisms and this process can be both beneficial and harmful. For instance, fermentation by fungi has been used for years to preserve food where refrigeration is unavailable. Fungi are necessary to produce bread, cheese, wine and beer, while other fungi, such as mushrooms, are used as food. Some fungi are used to produce pharmaceuticals, such as cortisone, the mold *Penicillium notatum* that produces penicillin, as well as the immunosuppressive agent cyclosporine. On the other hand, mold can produce toxins, such as aflatoxins, and can spoil food and create illness. (See **Figure 4.28**)

Several species of fungus can cause respiratory diseases in humans who acquire infections by inhaling spores from dust, bird droppings, soil and other sources, and these pathogenic fungi can be isolated to certain regions or widespread. For example, histoplasmosis, caused by the *Histoplasma capsulatum* fungus, occurs around the world, but has a relatively high incidence in certain countries. Histoplasmosis is generally mild, may affect more than one organ and can be difficult to diagnose since symptoms can vary from mild to severe disease; it can also cause chronic pulmonary diseases.

Some fungi target the skin, hair, nails and mucosal surfaces, and are called superficial fungi. Common examples are ringworm of the scalp (*Tinea capitis*), athlete's foot (*Tinea pedis*) and candida, such as thrush and vulvovaginitis.

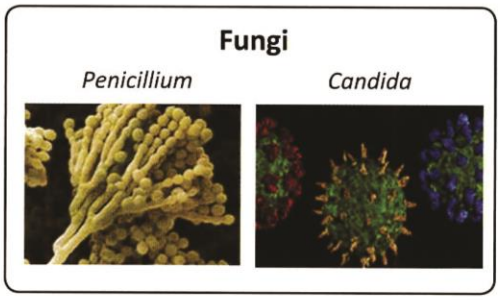


Figure 4.28

Prions

Prions are abnormal, pathogenic agents that are transmissible and able to induce abnormal folding of specific normal cellular proteins, called prion proteins (found most abundantly in the brain). (See **Figure 4.29**) The abnormal folding of the prion proteins leads to brain damage and the characteristic signs and symptoms of prion disease.

Prion diseases or transmissible spongiform encephalopathies (TSEs) are a family of rare progressive neurodegenerative disorders that affect both humans and animals. They are distinguished by long incubation periods, characteristic spongiform changes associated with neuronal loss and a failure to induce inflammatory response. Prion diseases are rapidly progressive and always fatal.

Creutzfeldt-Jakob Disease (CJD) is a specific type of prion disease. It is rare that CS professionals in the U.S. receive instrumentation exposed to CJD, but when they do, they must know and apply proper processing procedures.

This section considers processing concerns for instruments and medical devices that have been exposed to patients known or suspected to have CJD. The processing of this instrumentation requires a shift from the use of standard precautions where all items are processed in the same manner.

CJD is a neurological disease believed to be caused by prions, pathogenic agents that are smaller than viruses, and are extremely resistant to inactivation by heat and disinfecting agents. The incubation period can be many years long and death is almost certain within a year after initial onset of symptoms.

Prion An infectious protein particle: an infectious particle of protein that, unlike a virus, contains no nucleic acid, does not trigger an immune response, and is not destroyed by extreme heat or cold.

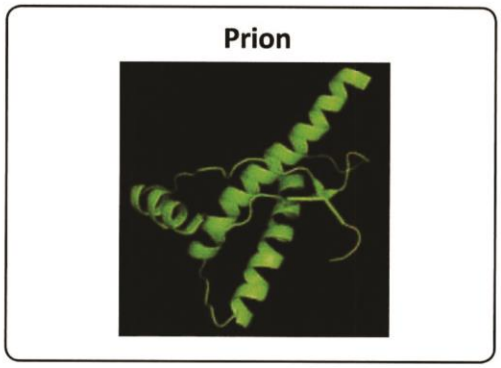


Figure 4.29

CJD is named after the German psychiatrists who first described the disease in the 1920s. It, along with other similar diseases, is classified as a TSE. Under a microscope, infected tissue, generally the brain, has a sponge-like appearance.

The CJD affects about one person per million worldwide with approximately 200 cases seen in the U.S. each year.

CJD has a relatively long incubation time (up to 30 years) during which the disease is unnoticed. Therefore, patients with CJD who have brain or spinal surgery may contaminate instruments with the infectious agents. This makes plans and policies for control of CJD very important.

In infected patients, prions are most frequently found in the brain, dura mater (the tough membrane that encases the nerves of the spinal cord), and eyes. They are also detected less frequently in cerebrospinal fluid, spleen, lymph nodes, kidney and liver. Seldomly, they are located in blood, urine, skin, muscle, bone, adrenal gland, heart, feces, peripheral nerves, nasal mucous, gingival, saliva, sputum and tears. When a suspected CJD patient undergoes a procedure, all healthcare professionals involved with that patient must be notified and

the facility's CJD policies and procedures must be followed.

Cleaning and sterilization of items contaminated with prions is a challenge as prions are difficult to remove or deactivate and standard cleaning/sterilization procedures are ineffective against prions. Whenever a suspected CJD case is scheduled for an invasive procedure the following actions should be taken:

Information:

- Inform department manager as soon as notification of a prion or potential prion procedure is received.
- Immediately contact Infection Prevention and Control to determine which cleaning and sterilization guidelines will be followed at your facility. Currently recommended guidelines are published by the WHO, the Centers for Disease Control and Prevention (CDC), and the Society for Healthcare Epidemiology of America (SHEA). Current guidelines are reviewed and updated as new knowledge regarding prions is gained.
- Ensure the most current cleaning and sterilization information is available in the facility.

Instrumentation:

- Due to the difficulty in cleaning and sterilization, disposable instruments should be used whenever possible. All current guidelines suggest disposing of reusable instruments that have become contaminated with high-risk tissue (brain tissue, dura mater, spine and eye tissue). Reusable instruments will likely be damaged or completely destroyed during the stringent cleaning and sterilization protocols.
- Heat- and moisture-sensitive items should not be used as they would probably be destroyed during cleaning and sterilization.
- Some facilities will quarantine instruments used on suspected CJD cases. This is done as a precaution while awaiting a diagnosis.

Environmental surfaces:

- Surfaces, such as countertops, that have become contaminated with prion material should be cleaned following the most current published protocols.
- Contaminated non-critical equipment should be cleaned following the most current published guidelines.

Prion-contaminated instruments pose a special challenge to CS professionals. Careful attention to the most current published guidelines for cleaning and sterilization is the most important factor for your safety, and the safety of patients and co-workers.

Note: Additional information about CJD can be found on the WHO and SHEA websites, in AAMI ST79, Annex C, and from the CDC website (www.cdc.gov/ncidod/dvrd/cjd/qa_cjd_infection_control.htm#reprocessed).

CONTROLLING AND ELIMINATING MICROORGANISMS

To prevent the spread of the microorganisms that can cause disease, healthcare settings must practice microbial control. The departments of Infection Prevention and Control and CS, in particular, are vital to microbial control and patient safety. Every time an instrument or device enters a patient's body during an invasive or minimally invasive procedure, there is a risk of infection. This risk is increased because many items used in patient care and treatment are processable: they are used on one patient, processed and then are used on another patient. It is up to the CS department to control the spread of microorganisms from one patient to another through proper instrument cleaning, disinfection and sterilization.

It is important to remember that even if you cannot see these microorganisms they can pose a significant

threat to humans. Let's compare microorganisms to seeds and draw some comparisons. There are many varieties of seeds, and each produces a different plant. Seeds must have the right conditions to grow and continue living. Those in a paper envelope at the store will not germinate and grow (See **Figure 4.30**); however, when they are placed in the right conditions with proper soil, water, fertilizer, warmth and sunlight, they grow and develop. In the same manner, there are many varieties of microorganisms, and each can produce a specific effect (an infection or disease) when they have the right conditions for growth and reproduction.

Like microorganisms, seeds need the right conditions to grow.

Figure 4.30

CS professionals should be able to recognize the conditions that favor the growth of microorganisms, and learn to "see" microorganisms in the workplace. For example, the decontamination work station in the left-side image in **Figure 4.31** looks safe to the untrained eye; however, if microorganisms were as easy to see as plants, that same workstation might look like the photo on the right.

What if we could "see" what was growing on work surfaces?

Figure 4.31

Microbial control is a complicated endeavor. Just as microorganisms differ in their needs for growth and reproduction, they also die at different rates. The type of microbial control used against an organism varies according to how susceptible the microbes are. Some pathogens are more difficult to kill than others and that is one reason why disinfection and sterilization processes are so complex. Microbial control can also depend on whether the goal is to kill a pathogen-causing infection through antibiotics, inactivate or kill microorganisms on the skin through antisepsis, or in the case of CS, kill pathogens on medical instruments or devices that will be used on patients. In addition to microbial susceptibility, the vast array of items that must be processed is another reason why no single disinfection or sterilization process can kill all microorganisms.

A Common Question:

You receive a case cart from the OR to the decontamination area with a note stating instruments are contaminated with hepatitis B or MRSA. How will you handle the instruments?

Answer:

All instruments, except those contaminated with prions, are to be cleaned following the manufacturer's instructions and the facility's cleaning procedures. Items contaminated with prions have special cleaning and handling requirements.

CONCLUSION

Having a basic understanding of the principles of microbiology and learning about bacterial and non-bacterial organisms and how they can be transmitted helps Central Service professionals understand the important role they play in preventing disease.

RESOURCES

Needham C, Hoagland M, McPherson K, Dodson B. *Intimate Strangers: Unseen Life on Earth.* ASM Press. 2000.

Huys J. *Sterilization of Medical Supplies by Steam.* Vier-Turme GmbH Benedict Press. 2004.

Tierno P. *The Secret Life of Germs.* Pocket Books. 2003.

Centers for Disease Control and Prevention. *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings.* 2007.

Alcamo E. *Cliffs Quick Review: Microbiology.* Hungry Minds Inc. 1996.

McCall D, Stock D, Achey P. *Introduction to Microbiology.* Blackwell Science Inc. *2001.*

Association for the Advancement of Medical Instrumentation ANSI/ AAMI ST79, Annex C. Comprehensive guide to steam sterilization and sterility assurance in health care facilities. 2013.

Chess B. *Foundations in Microbiology: Basic Principles, 9th Edition.* 2014.

CENTRAL SERVICE TERMS

Microbiology

Contamination

Pathogen

Micron

Aerobic

Anaerobic

Endospores (spores)

pH

Psychrophiles (bacteria)

Mesophiles (bacteria)

Thermophiles (bacteria)

Vegetative stage

Angstrom

Binary fission

Prion

Chapter 6

Infection Prevention

Learning Objectives

As a result of successfully completing this chapter, readers will be able to:

1. Explain the role of Central Service in the prevention of healthcare-associated surgical infections
2. Explain the principles, practice and importance of personal hygiene and attire, including personal protective equipment
3. Identify the hazards of bloodborne pathogens and how the Occupational Safety and Health Administration's requirements impact personal safety
4. Explain the rationale for the separation of clean and dirty, and the environmental requirements for maintaining that separation
5. Discuss the chain of infection and the technician's role in breaking that chain

INTRODUCTION

The Central Service (CS) professional plays a significant role in the prevention of surgical site and healthcare-associated infections (HAIs). When the importance of this role is understood, technicians recognize that their work practices can mean the difference between a patient's successful surgery or hospital stay, and a negative outcome that could lead to infection or possibly death.

CENTRAL SERVICE PROCESSES

Every step or process in the CS department is carefully designed to prevent poor patient outcomes. Poor outcomes can be traced to many factors; including the condition of instruments, trays and other medical devices that are processed in CS.

In the most simplistic terms, CS supports infection prevention by:

- Cleaning contaminated medical devices to make them safe for handling and prepare them for a **biocidal** process.
- Inspecting instruments to help ensure they are safe and functional.
- Assembling and packaging instruments in a manner that facilitates the method of sterilization chosen and provides a barrier after sterilization.
- Selecting and properly using the sterilization or high-level disinfection (HLD) method for each medical device.
- Safely storing items until they are needed and delivering them using methods that protect the integrity of the sterile packages.

While those tasks may appear easy, there are several steps to each process. Each requires attention to detail, understanding of specific protocols and process parameters, an understanding of each medical device's manufacturer Instructions for Use (IFU) and dedication to processing each item exactly as stated in the IFU. Every medical device not processed according to the manufacturer's IFU has the potential to cause infection in both the patient and healthcare worker.

Cause for Concern

In 2011, the Centers for Disease Control and Prevention (CDC) reported that approximately one of every 25 hospitalized patients, or 722,000, contracted an HAI. Of those approximate 722,000, about 75,000 patients died during their hospitalizations. Many of these infections may have been preventable. A **surgical site infection (SSI)** is an infection that occurs after surgery in the part of the body where the surgery took place. As many as three of every 100 surgical patients develop these infections per year, according to the CDC.

Approximately 51.4 million surgical procedures are performed in the U.S. annually, the CDC reports. Each involves the use of medical devices or instruments that have contact with a patient's sterile tissues or mucous membranes. Infection is a major risk in all of these procedures. Additionally, a growing number of microorganisms are becoming resistant to antibiotics or are naturally difficult to control. Many of these microorganisms may be easily transferred to other surfaces and people. Controlling these microorganisms and preventing their transmission is the number one responsibility of the CS department.

Infection prevention principles and practices are based on knowledge of the nature and characteristics of disease-producing microorganisms. This includes an understanding about how they are transmitted in the healthcare environment, and their place in the **chain of infection**. The more CS technicians know about microorganisms, the better equipped they are to prevent the spread of these organisms. **Figure 6.1** identifies the top HAI-causing pathogens, as identified by the CDC.

Biocidal Process or ability to kill or control the growth of living organisms.

CDC Top HAI Causing Pathogens	
Acinetobacter	*Burkholderia cepacia*
Clostridium difficile	*Clostridium sordellii*
Enterobacteriaceae (Carbapenem-resistance)	Hepatitis
Human immunodeficiency virus *(HIV)*	Influenza
Methicillin-resistant *Staphylococcus aureus*	*Klebsiella*
Norovirus	*Mycobacterium abscessus*
Staphlococcus aureus	*Pseudomonas aeruginosa*
Vancomycin-intermediate *Staphylococcus aureus*	Tuberculosis (TB)
Vancomycin-resistant *Enterococci (VRE)*	Vancomycin-resistant *Staphlococcus aureus*

Source: http://www.cdc.gov/HAI/organisms/organisms.html

Figure 6.1

Surgical site infection (SSI) An infection that occurs after surgery in the part of the body where the surgery took place.

Chain of infection A way of gathering the information needed to interrupt or prevent an infection. Each of the links in the chain must be favorable to the organism for the infection to continue. Breaking any link in the chain can disrupt the infection. Which link is most effective to target will depend on the organism.

Protection from Pathogens

The origins of isolation precautions date back to the days of quarantine, a control measure used in infectious disease epidemics of earlier times. In the early 1970s, the CDC established the first practical recommendations for the isolation technique. The new recommendations categorized infections and communicable diseases based upon the likely mode of transmission. To protect healthcare staff and patients from infectious diseases, Standard Precautions were adopted; the basis of this is to treat all human blood, bodily fluids and other potentially infectious materials as infectious.

Standard precautions drive the infection prevention and control procedures that CS technicians must use because they are exposed to contaminated instrumentation and equipment. Failure to wear the appropriate personal protective equipment (PPE) increases the individual's risk of acquiring an infection.

The primary purpose of the CS department is to stop the spread of disease-producing microorganisms to patients from instruments and other medical devices. CS technicians must ensure that items used in patient care, including instruments, utensils, supplies and equipment, are made safe by either disinfection or sterilization. Chapter 4 addressed microorganisms: how they live, grow and are transmitted from person to person and place to place. This chapter addresses how CS professionals control the spread of microorganisms and prevent infection. Understanding **asepsis** in healthcare is an important piece of the basic knowledge required to work in CS.

PRINCIPLES OF ASEPSIS

Asepsis can be defined as the absence of microorganisms that cause disease. **Aseptic technique** includes any activity or procedure that prevents infection or breaks the chain of infection.

There are two types of aseptic techniques:

- **Medical asepsis** (clean technique) - Procedures performed to reduce the number of microorganisms to minimize their spread. Examples include handwashing and decontamination of equipment.
- **Surgical asepsis** (sterile technique) – Procedures to eliminate the presence of all microorganisms, and/or prevent the

introduction of microorganisms to an area [e.g., sterilization of instrumentation and techniques performed in the Operating Room (OR) prevent contamination of sterile instruments and supplies].

Asepsis The absence of microorganisms that cause disease.

Aseptic technique Any activity or procedure that prevents infection or breaks the chain of infection.

Asepsis (medical) Clean technique; procedures performed to reduce the number of microorganisms and minimize their spread.

Asepsis (surgical) Surgical technique; procedures performed to eliminate the presence of all microorganisms, and/or prevent the introduction of microorganisms to an area.

There are five basic principles of asepsis:

- Principle one: know what is dirty. Items that have been used for patient care are considered contaminated. An item is considered to be either contaminated or not contaminated. For the CS technician, the terms "dirty" and "contaminated" mean the same thing. Microbial contamination cannot be seen with the naked eye; however it can be present even when it is not seen. Examples of contaminated items include opened surgical instrument trays, IV pumps and suction machines.

- Principle two: know what is clean. Cleanliness is the basis of aseptic technique. Mechanical cleaning removes soil and most microorganisms. Any item that has been properly cleaned via manual or mechanical means is considered clean. If that item has been cleaned with a detergent disinfectant or a thermal decontamination process, it is considered clean and decontaminated. The physical task of washing/cleaning removes soil and most microorganisms.

- Principle three: know what is sterile. Sterility is defined as the absence of all microbes. Sterility is impossible to see with the naked eye; one cannot look at a specific item and determine its sterility. Absence of microbes can only be achieved by use of steam, ethylene oxide (EtO) or other sterilization methods.

- Principle four: keep the three conditions separate. There must be separation between dirty, clean and sterile areas to allow a margin of safety. Clean or decontaminated items must not come in contact with dirty items. If they do, they must again be considered dirty. If sterile items come in contact with non-sterile items, they must also be considered non-sterile. Sterile items should not be stored near sinks or in any location where there is a risk that they will become wet or soiled. The presence of moisture allows the passage of microorganisms through wrappers, resulting in contamination of sterile supplies.

- Principle five: remedy contamination immediately. When dirty, clean and sterile areas or items have not been separated, the situation must be corrected immediately. One who observes a procedure has as much responsibility for maintaining proper aseptic technique as the person who performs the procedure. There are times when only a CS technician will know or suspect that something may be contaminated (e.g., when something is dropped on the floor). Even though processing the item may result in more work, this must be done to protect the patient.

A careless attitude may lead to an increased risk of infection, so CS professionals must always be aware of their actions. By adhering to the principles of asepsis, the risk of infection will be reduced for patients and the facility's employees. The responsibility of CS technicians to provide safe items for use should never be compromised.

CS professionals must assume several important responsibilities in their facility's infection prevention and control efforts. The infection prevention and control goals of the CS department are to:

- Eliminate and/or destroy all potentially infectious contaminants present on reusable instruments and equipment.
- Safely distribute reusable and single-use items required for the delivery of patient care.
- Establish and enforce standards for decontamination, disinfection and sterilization in various healthcare settings.

The importance of these responsibilities is clear. The use of medical devices that have not been properly handled, disinfected or sterilized can cause infections in patients and staff. CS professionals are responsible for providing safe items that support good patient outcomes.

PERSONAL HYGIENE AND ATTIRE

Preventing the spread of microorganisms and maintaining appropriate environments for clean and sterile items requires good self management skills. Hygiene and adherence to dress code protocols are critical components of infection prevention in the CS department.

Personal Hygiene

Hand hygiene is a term that means either handwashing, or using an approved antiseptic hand rub (such as an alcohol-based product). Hand hygiene is considered the single most important factor in reducing infections.

Handwashing refers to the use of soap, water and friction to wash one's hands. Effective handwashing consists of wetting, soaping, lathering and vigorously rubbing one's hands together, making certain to lather between fingers and around nails for at least 20 seconds. Washing should be followed by rinsing with running water and thoroughly drying with a disposable towel. (See **Figure 6.2**)

Hand sanitizing refers to the use of an alcohol-based gel or foam. Alcohol does not kill some highly-infectious bacteria, like *C. difficile*, and some food borne pathogens; therefore, handwashing is critical before and after any meal, and before and after using the restroom.

Hand hygiene The act of washing one's hands with soap and water or using an alcohol-based hand rub.

Handwashing should be done prior to starting work, upon entering or leaving the work area, before and after eating or using the restroom or whenever hands become soiled or contaminated. Infection control and prevention experts recommend that hands be washed immediately and thoroughly if they become soiled with blood, bodily fluids, secretions or excretions. After coming in contact with contaminated items without visible soil or after gloves are removed), an alcohol-based hand rub should be used according to the manufacturer's recommendations. Approved hand lotions may be used after handwashing to keep the skin healthy, and to minimize skin irritation and excessive drying.

CS departments are equipped with handwashing sinks conveniently located for easy access. CS technicians should wash their hands only in dedicated handwashing sinks (not in those used for decontamination purposes).

Because fingernails harbor microorganisms, they should be kept clean and not extend beyond the fingertips. Long nails also increase the risk of tearing gloves. Fingernail polish should not be worn in the CS department because nail polish may chip and fall onto an instrument set. Artificial nails should not be worn in CS because they also harbor microorganisms and may detach and fall into a tray unnoticed.

Infection prevention begins at home. Personal hygiene is important for the prevention of

infections. Bathing and shampooing regularly, wearing clean clothing and practicing good hand hygiene prepares CS professionals to continue this practice in the healthcare facility.

Personnel with open or weeping wounds or excessive skin irritations should refrain from handling any patient care equipment until the condition is resolved or medically evaluated.

Attire

CS professionals must wear attire specific for the area in which they work. This protects the employee and other staff members, patients and the public.

Attire should be clean, provided by the facility, and not worn outside the facility. Technicians should change out of their street clothing (clothing worn at home) and shoes, and into scrubs and shoes kept at the facility. Usually, there will be a locker space for personal belongings. At the end of the workday, scrubs will be left behind in the facility's laundry, protecting employees from infecting anyone at home or in the community. Necklaces, rings or other jewelry should not be worn because they can harbor microorganisms.

Lanyards, if used, should be left at the facility and cleaned on a regular basis.

Basic attire should be worn in every area of the department and by everyone working in or visiting the department. (See **Figure 6.3**)

- Scrub attire should be changed daily, anytime it becomes soiled or as soon as it may have become contaminated. Scrub attire should consist of at least clean pants and a top. Some facilities provide long-sleeve jackets. T-shirts, if worn, should be completely covered by the scrub top. No part of the T-shirt should be visible outside the scrub attire. *Note: Some facilities allow outside visitors to wear disposable cover clothing, such as jump suits, instead of scrub attire.*

Handwashing Procedure
1. Remove all jewelry
2. Turn on faucet using a paper towel
3. Wet hands and apply liquid soap
4. Work soap into a lather and scrub hands for at least 20 seconds*
5. Keep hands at a lower angle than elbows to prevent dirty water from running back onto arms
6. Interlace fingers to clean between them
7. Dry hands with clean disposable towels
8. Turn off the faucet using a clean disposable towel

*** Source: Centers for Disease Control & Prevention**

Figure 6.2

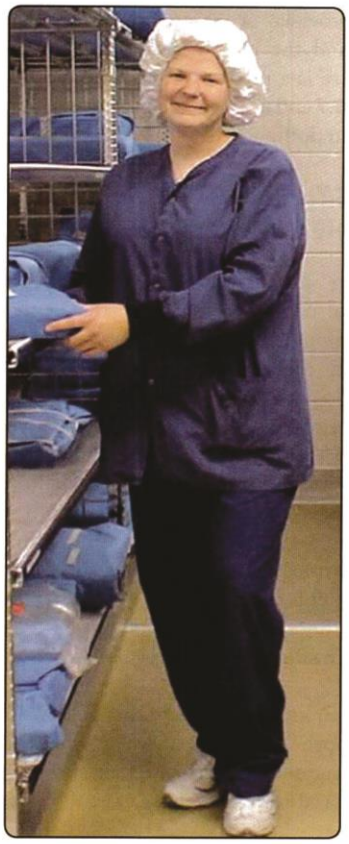


Figure 6.3

Scrub attire should always be donned (put on) just prior to starting work and doffed (removed) before leaving work.

- A disposable bouffant-type head covering should be worn in all areas of the department. Head covers should cover all head hair, except eyelashes and eyebrows. Reusable head covers, if allowed in the facility, should be covered with a bouffant cover to keep from contaminating the area with outside bacteria or with bacteria that may have multiplied on the caps due to improper cleaning. Skull-type caps are no longer suggested for use because they do not always cover all head hair. Beards and mustaches should be covered with an approved cover to prevent facial hair from shedding onto the items being processed.

- Sturdy shoes with non-skid soles should be worn in the department. Shoes should be able to protect the feet from items that may inadvertently fall from work areas. It is good practice to have shoes dedicated to the area and not worn out of the facility.

- A cover gown/lab coat may be used to protect the scrub attire when leaving the department for another area of the same facility (this depends on facility policy). *Note: Cover gown/lab coats are not meant to protect departmental attire while outside the building.*

Decontamination attire: All individuals working in the decontamination area must comply with dress code requirements for PPE. This is required by the Occupational Safety and Health Administration (OSHA), and was established to help ensure workers are protected from potential pathogens.

Risk of exposure to pathogenic microorganisms can be reduced by diligently following dress codes in decontamination areas. For example, fluid-resistant gowns provide protection from splashes that may soak into and contaminate regular scrub attire. (See **Figure 6.4**)

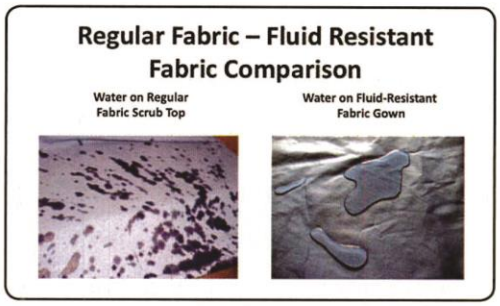


Figure 6.4

All of the basic attire outlined previously, except the cover gown, should be worn in the decontamination area. Because of the nature of the work in the decontamination area (soiled and contaminated devices, water and chemicals) additional attire is required. **Figure 6.5** provides examples of PPE worn in the decontamination area. Decontamination PPE includes:

- Gloves approved for the decontamination area. These gloves are thicker than examination gloves to protect the hands. They also have longer cuffs (some are elbow length), so they can be placed over the gown cuff to keep fluids from flowing into the glove or up the gown sleeve.

- Mask that fits around the ear or ties on the head to protect the nose and mouth.

- Fluid-resistant gown or jumpsuit to protect clothes and skin. Fluid-resistant materials will keep fluids away from the skin, while standard fabrics will absorb fluids allowing the skin beneath the fabric to become wet and contaminated.

- Goggles or face shield to protect the eyes (face shield will also protect the face, mouth and nose). *Note: Wearing a face shield does not replace the need to also wear a face mask.*

- Shoe covers protect the shoes from contamination. Shoe covers should be worn even if the shoes are dedicated to department use only. Using boot length covers (not required) will help protect the leg area, as well.

Figure 6.6 provides a recap of basic PPE requirements and the reason each component is important. There is a proper way to don and doff PPE. **Figures 6.7** and **6.8** give the proper sequence for donning and doffing PPE.

MANAGING THE ENVIRONMENT TO PREVENT THE SPREAD OF BACTERIA

The first step in maintaining environmental integrity is to control the traffic that enters and passes through the CS department. The aforementioned dress codes apply to all who enter the CS department. Department dress standards for visitors (e.g., sales representatives, maintenance personnel and clinical engineering staff) vary between facilities. In some facilities, they must change into surgical scrubs; in others, coveralls (worn over street clothes) are required. CS technicians must protect the integrity of the environment by enforcing traffic control guidelines. This may sometimes mean educating visitors about dress code and traffic control protocols.

Dress code requirements may change as CS technicians move from one area to another. For example, surgical scrubs and hair coverings may be appropriate for the clean assembly area,

Examples of PPE

Figure 6.5

Types of PPE

Type of PPE	Protects	Why
Fluid-resistant gown, apron, jumpsuit	Protects skin and scrubs	Provides a barrier against splash or spray
Mask	Protects mouth, nose, chin	Protects respiratory tract from airborne infectious aerosols
Goggles	Protect the eyes	Protects eyes from infectious aerosols
Face shield-full length	Protects eyes, nose, mouth, face	Protects eye, nose, mouth, face from spray and infectious aerosols
Shoe covers	Protect shoes (boot length will protect calf to knee)	Protects the shoes (lower leg) from spray
Gloves	Protect hands	Protects hands from contaminated instruments

Figure 6.6

How to Don (Put on) on PPE

*	Before beginning	Don surgical scrubs, a head cover and appropriate shoes.
1.	Gown or jumpsuit	Don the impervious gown or jumpsuit. Tie, snap or zip completely
2.	Mask	Secure the ear pieces around the ears or tie the strings on the head area. Fit the mask over the nose area, ensure the nose and mouth areas are completely covered.
3.	Goggles or face shield	Don goggles or face shield and adjust to fit properly (goggles should wrap around the side of the face).
4.	Shoe covers	Don shoe covers and ensure shoes are completely covered.
5.	Gloves	Don gloves and ensure gloves are over the gown cuff.

Figure 6.7

CDC Recommendations for Doffing (Removing) PPE

1.	Remove shoe covers
2.	Remove gloves
3.	Remove goggles or face shield
4.	Remove gown
5.	Remove mask
6.	Remove head cover
7.	Wash hands

Figure 6.8

but OSHA-required PPE is necessary for the decontamination area. (See **Figure 6.9**) Dress codes are an important part of traffic control; therefore, CS technicians must understand what attire is appropriate in different areas. *Note: If in an unfamiliar area and unsure of the attire requirements, ask before entering.*

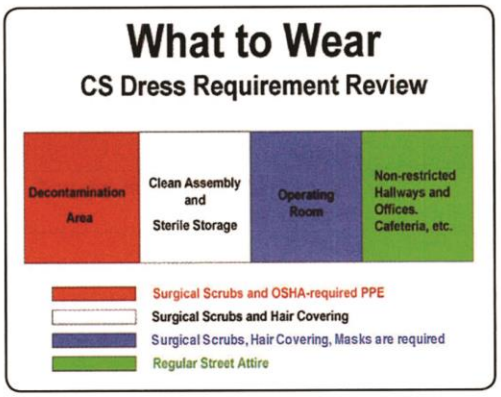


Figure 6.9

Areas that CS technicians routinely travel through may have three separate traffic control/dress code requirements:

- Restricted – Areas where sterile surgical procedures are performed. Surgical scrub attire, hair coverings and masks are required in restricted areas. Those working within the sterile field (including surgeons, surgical technologists and nurses) are also required to wear a sterile surgical gown and gloves. *Note: Semi-restricted areas in the OR, such as access corridors to surgical suites, must follow restricted dress code.*

- Semi-restricted – These areas include peripheral support areas to the OR, CS clean assembly, and sterile storage areas. Surgical scrub attire and hair coverings are required in these areas.

- Unrestricted – These areas include normal traffic areas, such as hospital corridors, most offices, locker rooms and general public areas (e.g., cafeteria and waiting rooms). Street clothes may be worn in unrestricted areas.

CS departments use signage to assist in traffic control. All restricted and semi-restricted areas also have signage that informs people entering the area about the need for specific dress codes. (See **Figure 6.10**)

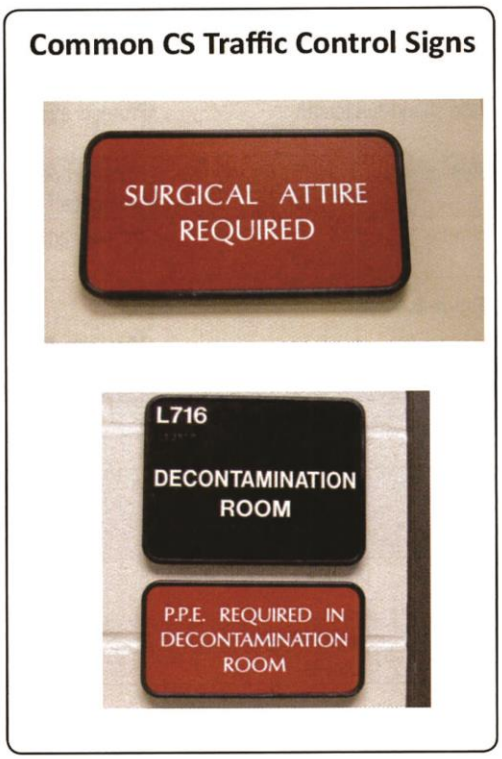


Figure 6.10

OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION 29 CFR 1910.1030

OSHA is the primary federal agency charged with the enforcement of occupational safety and health legislation. In response to concerns, OSHA published the Bloodborne Pathogens Standard, recognizing the potential for occupational exposure to bloodborne diseases (hepatitis B and C and HIV). The standard places the responsibility for providing a safe work environment on the employer, and contains several key elements:

- A written exposure control plan (ECP) that summarizes the employer's program for the protection of workers from occupational exposure to bloodborne diseases. The ECP must be reviewed annually and updated whenever new tasks or procedures affecting occupational exposures are instituted. An ECP contains the following provisions:

  › Determination of employee exposure.

  › Implementation of various methods of exposure control, including:

  - Standard precautions (also known as universal precautions).

  - Engineering and work practice controls: The use of engineering controls to physically remove the hazard, and development of work practice controls (policies and procedures) to prevent occupational exposure and transmission of bloodborne pathogens.

  - Use of PPE.

  - Housekeeping: Provision of a clean and sanitary working environment including scheduled cleaning using hospital germicides (disinfectants) approved by the U.S. Environmental Protection Agency (EPA).

  - Hepatitis B vaccination: The facility must offer the hepatitis B vaccine at no cost. Employees who choose not to take the vaccine must sign a declination (refusal) form, and they may reconsider at any time during their employment.

  - Post-exposure evaluation and follow-up: Provision for medical evaluation and treatment when an employee experiences an exposure incident.

  - Communication of hazards to employees and training regarding those hazards.

  - Recordkeeping: Proof of training upon initial hire and annually thereafter. If significant changes are made to the ECP, additional training is required to address the changes. Medical records regarding any exposure must be maintained.

  - Procedures for evaluating circumstances surrounding an exposure incident.

  › The use of fluorescent orange or orange red "BIOHAZARD" labels to identify contaminated items or regulated waste that may be stored or transported in refrigerators, freezers or other containers. (See **Figure 6.11**) Labels are not required when using red bags or marked containers. (See **Figure 6.12**)

Figure 6.11

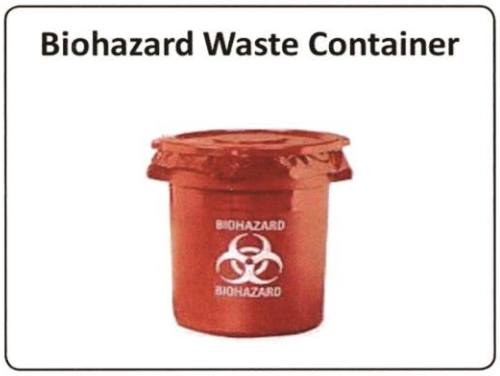


Figure 6.12

› Disposal of all sharp items in rigid, puncture-proof containers that are covered, properly labeled or color-coded. (See **Figure 6.13**)

Figure 6.13

Reusable sharps should be transported in enclosed carts or hard-sided containers to prevent injury. (See **Figure 6.14**)

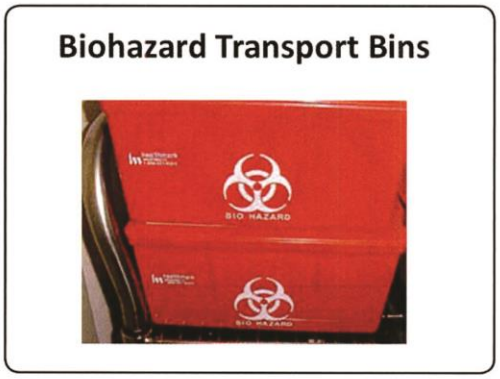


Figure 6.14

ENVIRONMENTAL CONCERNS IN CENTRAL SERVICE AREAS

In addition to specific guidelines for dress codes and standard precautions, there are environmental tools designed to help CS technicians promote infection prevention. Some tools are evident. Others, while not as evident, still play an important role in maintaining an environment that is safe for patients and employees.

Physical Design

CS departments' physical design should incorporate a clear separation of clean and dirty, and workflow patterns should be designed that create a one-way flow of goods from dirty to clean.

In addition to walls separating the decontamination area from the rest of the department, the area is designed to reduce the likelihood that airborne bacteria can be transmitted from the decontamination area to the clean area. This is accomplished with use of positive and negative air pressure. The decontamination area has negative (lesser) air pressure. This means that when a door or window is opened between the separate work areas, air flows from the clean (positive pressure) area to the dirty (negative pressure) area. This minimizes the risk of airborne bacteria in the decontamination area being carried to the clean area. **Figure 6.15** illustrates the airflow created by the use of positive and negative air pressure. To maintain the balance necessary for air pressure systems to function correctly, windows and doors between the decontamination and clean areas must remain closed when not in use.

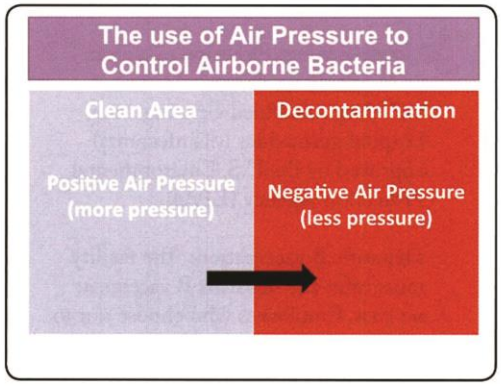


Figure 6.15

In addition to the air pressure requirements, CS areas must meet specific temperature, humidity and air exchange requirements. These vary by work area and CS technicians must be familiar with the requirements for each specific area, and ensure that policies designed to manage airflow, temperature and humidity are followed at all times. In many departments, CS technicians may be responsible

CS Department Temperature, Humidity, and Air Exchange Requirements

Central Service Department Temperature, Humidity, and Air Exchanges			
Work Area	**Temperature**	**Humidity***	**Air Exchanges**
Decontamination	60°F to 65°F (16°C to 18°C)	30% to 60%	10
General work areas	68°F to 73°F (20°C to 23°C)	30% to 60%	10
Sterile storage	75°F or lower	Not to exceed 70%	4
Sterilization equipment room	75°F to 85°F (24°C to 29°C)	30% to 60%	10

Figure 6.16

**Some facilities may choose to use 20% for the lower humidity level. CS departments should check with their supply and equipment manufacturers to ensure that the lower humidity is acceptable for items stored in the area.*

for collecting data, such as temperatures and humidity, and recording that data as part of their department's formal documentation system. **Figure 6.16** provides temperature, humidity and air exchange requirements for CS work areas.

Use of fans should not be permitted in any CS work area. Fans create highly turbulent air flow, which recirculates dust and microorganisms from the floor and work surfaces, and interferes with air flow.

Work Area Cleanliness

The cleaner the work area, the more likely that the products prepared in CS will be safe for use in a sterile environment. Dust and lint particles not only carry bacteria, but, in some cases, lint remaining in a sterile set may enter the patient's body during surgery and cause infection. CS technicians must minimize the amount of contaminants, such as dust, lint and bacteria in these work areas.

Bacteria can be transmitted by contact with contaminated items. Items in the decontamination and clean assembly areas can also be contaminated, which may be transmitted to other objects. Inanimate objects that can transmit bacteria are called **fomites**. Common fomites that become contaminated in CS areas include door handles, computer pads and keyboards, telephones, work surfaces and other items routinely handled by multiple people. CS technicians should know that by routinely cleaning these items and their general work areas (workstations), they can control the unwanted spread of bacteria within their workplace.

Fomite An inanimate object that can transmit bacteria.

Food and beverages should not be allowed in CS work areas. This standard is well understood for decontamination areas; however, this rule is also necessary in clean areas of the department for the following reasons:

- Beverages should not be allowed because they may spill and contaminate sterile items, or they may spill onto items that need to be sterilized and impact sterilization outcomes. Spilling may also contaminate items being assembled for sterilization or damage count sheets, reference books and other items on the work station.

- Foods should not be allowed because it may also contaminate items. CS technicians should not eat food in their work areas because their hands may become soiled and they could transmit bacteria. Snack foods leave oily residue on hands that can adhere to instruments being packaged for sterilization. This oil may impede the contact of the sterilant with the entire surface of the instrument. Food and beverages also attract insects and may increase the chance of insects invading the work area.

Environmental cleaning (housekeeping) is a vital component in the department's overall infection prevention and control process. CS departments are routinely cleaned to ensure that the microbial population is minimized. Basic housekeeping

procedures used in CS should be the same as those used in the OR and delivery rooms. Cleaning guidelines include:

- Floors should be cleaned (wet mopped) at least daily. Floors should never be swept or dust mopped because dust will rise and fall on items, such as instruments, in the area. When sterile packages are opened, the dust that has accumulated on them may fall onto the package contents.
- The decontamination area should have separate and dedicated cleaning equipment, such as mops and buckets. Items used to clean the decontamination area should not be used elsewhere.
- Horizontal work surfaces, such as counters and work tables should be cleaned at least daily and, preferably, every shift.
- Light fixtures or their covers, and air vents should be cleaned at least every six months or as necessary. This function is usually performed by another department such as Environmental Services or Plant Maintenance.
- Other surfaces (including walls, cabinets and racks) should be cleaned on a regularly scheduled basis.

Many CS housekeeping functions are performed by Environmental Services personnel; however, routine cleaning of sterile storage cabinets, carts and racks is usually the responsibility of CS technicians who have been trained to properly handle sterile items, and who know specific product names and locations.

Other Environmental Cleaning Requirements

Fixtures and furniture in CS departments must be constructed of materials that can be washed, and they must be cleaned on a regularly scheduled basis.

The area designated for sterile storage may consist of either open (rack) or closed (cabinet) storage units. The decision about the type of storage used is based on the types of items to be stored, and the amount of traffic in the area. For example, closed cabinets may be used in high traffic areas, and open shelving (racks) may be used in more controlled, low traffic areas. Open rack systems should have a solid bottom, so items stored on the lower shelves are protected from contamination during housekeeping tasks. *Note: Specific information about sterile storage will be covered in Chapter 16.*

CS technicians work with items at all stages of the decontamination, sterilization, storage and distribution processes, so they must be well versed in basic infection control principles. To ensure the workflow is maintained, and items are handled appropriately at each stage in the processing cycle, staff must understand and practice the principles of asepsis.

An Important Concern

As discussed in Chapter 4, some microorganisms are becoming resistant to antibiotics or are naturally very hard to control. Many of these resistant microorganisms can be transferred to other surfaces and people very easily. Controlling these microorganisms and preventing their transmission is the number one responsibility of the CS department.

Understanding the way microorganisms can be transmitted is the key to helping stop cross-contamination.

ELEMENTS OF TRANSMISSION AND THE CHAIN OF INFECTION

Infection transmission is a complicated process that involves many factors in order for a pathogenic microorganism to result in disease or illness. According to the CDC *Guideline for Isolation Precautions: Preventing Transmission of Infectious Agents in Healthcare Settings, 2007*, the transmission of infectious agents in a healthcare setting requires six elements: a **causative agent**, a **reservoir**, a **portal of exit**, a **mode of transmission**, a **portal of entry** and a **susceptible host**. This infectious disease process is better known as the chain of infection. (See **Figure 6.17**)

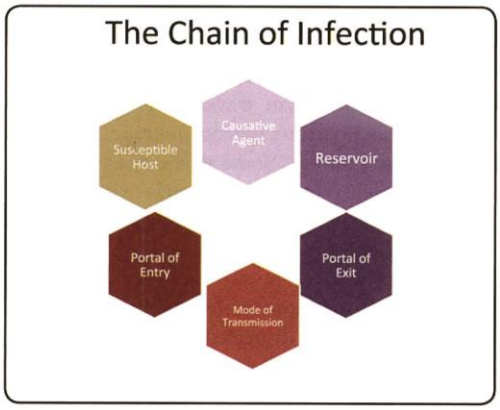


Figure 6.17

Causative agent (chain of infection) The microorganism that causes an infectious disease.

Reservoir (chain of infection) The place where an infectious agent (microorganism) can survive.

Portal of exit (chain of infection) The path by which an infectious agent leaves the reservoir.

Mode of transmission (chain of infection) The method of transfer of an infectious agent from the reservoir to a susceptible host.

Portal of entry (chain of infection) The path used by an infectious agent to enter a susceptible host.

Susceptible host (chain of infection) A person or animal that lacks the ability to resist infection by an infectious agent.

Causative Agent

The first link is the causative agent, meaning the pathogenic microorganism: bacteria, virus, fungi, protozoa or prions. The characteristics that make the organism capable of causing disease include:

- Invasiveness – the ability of an organism to invade the host and cause damage.
- Pathogenicity – the ability of an organism to gain entry into the host and cause disease.
-
- Virulence – the degree of pathogenicity.
- Infectious dose – the quantity of organisms required to cause disease.
- Viability in a free state – the ability of the organism to survive outside the host.
- Ability to develop resistance to antimicrobial agents.

The only way to interrupt the transmission of a causative agent is to eliminate it. This can be done by promptly initiating the appropriate processes, such as using aseptic technique to avoid cross contamination, physically removing the contaminated substances through cleaning, and using effective disinfection and sterilization processes.

Reservoir/Source

The second link is the reservoir or source of the agent, a place in which an infectious agent can survive. In the healthcare setting, the most common reservoirs are human sources, such as patients, healthcare personnel, family, and visitors. However, inanimate objects, such as environmental surfaces, surgical instruments and devices, have also been implicated, as have contaminated food, water or intravenous fluids.

Those with active infections, but without obvious symptoms, and those who are **carriers**, represent the greatest risk to other patients and healthcare workers because the presence of disease-producing organisms may go undetected.

Carrier A person or organism infected with an infectious disease agent, but displays no symptoms. Although unaffected by the disease themselves, carriers can transmit it to others.

Good personal hygiene and health habits, the use of appropriate housekeeping measures, and the proper cleaning, decontamination, disinfection and

sterilization of hospital equipment can eliminate reservoirs.

Portal of Exit

The third link is the portal of exit, or the path by which an infectious agent leaves the reservoir. Portals of exit associated with humans and animal reservoirs include:

- Respiratory tract (coughing and sneezing).
- Genitourinary tract (urine, vaginal secretions or semen).
- Gastrointestinal tract (vomit or stools).
- Skin/mucous membrane (mucous or wound drainage).
- Blood (blood transfusions or contact with blood).
- Transplacental (through the placenta from mother to baby).

Common ways CS technicians can block the portal of exit include covering nose/mouth when sneezing/coughing, disposing facial tissues immediately after use, performing proper hand hygiene, disposing of trash and effectively using PPE.

Mode of Transmission

The fourth link is the mode of transmission, or how a pathogenic organism is spread. This can vary by the type of organism, and by its route.

Direct contact occurs when microorganisms are transferred directly from one infected person to another via blood or other blood-containing bodily fluids. Indirect contact occurs through a contaminated object or person such as through inadequately cleaned or sterilized instruments, the hands of healthcare personnel, or contaminated PPE. Some infections transmitted by contact include herpes simplex virus (HSV), *Staphylococcus aureus*, respiratory syncytial virus and *Clostridium difficile*.

Droplet transmission occurs when an infected person coughs, sneezes or talks during procedures, such as endotracheal intubation or suctioning. Infectious droplets can travel short distances to the susceptible person's mucous membranes of the eyes, nose and mouth. Some of the diseases spread in this manner include influenza virus, group A Streptococcus, adenovirus and some types of meningitis.

Airborne transmission occurs when very small droplet particles are dispersed in the air over long distances by air currents and are then inhaled by susceptible individuals. Infectious agents transmitted by this route include Mycobacterium tuberculosis (TB), spores of Aspergillus spp, and varicella-zoster virus (chickenpox).

Common vehicle transmission occurs when infectious agents are present in a vehicle, such as food (salmonella), blood (HIV) or water (pseudomonas).

Vector-borne transmission rarely occurs in U.S. hospitals. Agents can be carried on insects (e.g., on the feet or wings of flies) or by the bites of insect or arthropods (mosquitoes, ticks and fleas).

Pathogenic transmission can be interrupted through proper hand hygiene, cleaning, decontamination, disinfection and sterilization, Standard and Isolation Precautions, as well as proper food handling, proper water treatment, and proper maintenance of heating and air conditioning systems.

Portal of Entry

The fifth link is the portal of entry, or the path used by an infectious agent to enter a susceptible host.

Patients are particularly vulnerable to transmission in areas where the usual defense mechanisms are bypassed. Portals of entry associated with a human host include:

- Respiratory tract
- Genitourinary tract
- Gastrointestinal tract

- Skin/mucous membranes
- Transplacental
- **Parenteral**

Parenteral Something that is put inside the body, but not by swallowing (e.g., an injection administered into the muscle).

Safe protocols include maintaining clean or sterile techniques during patient care procedures. Proper hand hygiene can alter access of an infectious agent to a susceptible host. Other practices involve using only properly disinfected/sterilized equipment for invasive procedures, and safe handling and disposing of sharps. *Note: Caregivers and their patients rely on CS to provide medical devices that are safe from infectious microorganisms.*

Susceptible Host

Most of the factors that influence whether a person gets an infection are related to the sixth and final link: whether the individual is a susceptible host and lacks the ability to resist infection Some who are exposed to an infectious agent will become severely ill and die, while others never develop symptoms at all. Some may progress from **colonization** to symptomatic disease right after exposure to the pathogen, while others will become temporarily or chronically colonized and never have symptoms.

Colonization Occurs when microorganisms live on or in a host organism, but do not invade tissues or cause damage.

Whether or not an individual becomes susceptible to a microorganism can be influenced by various factors:

- Age (very young or very old).
- Disease history/underlying disease, such as cancer, diabetes and heart disease.
- Medications and treatments that can compromise immune systems, including chemotherapy, radiation and steroids.
- Trauma (the injury itself and the treatment of the injury can increase the risk of infection).

Some measures to boost the ability to fight disease include treating the primary disease (e.g., keeping blood sugar under control in diabetics), administering vaccines (such as pneumonia and influenza) and recognizing that patients are at high risk for infection.

From a CS perspective, there are many opportunities to interrupt the chain of infection and play an active and important role in preventing and controlling infectious diseases. **Figure 16.18** provides an example of how the chain of infection can be impacted by the CS department.

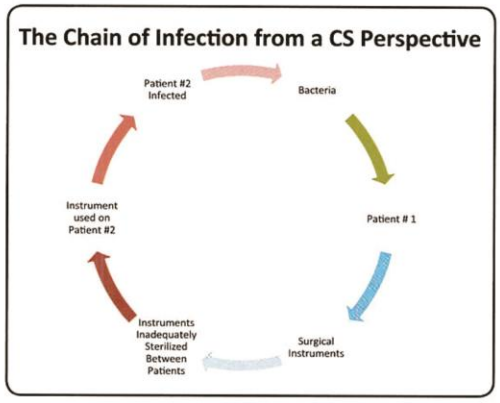


Figure 6.18

CONCLUSION

Central Service technicians face the ongoing challenge of ensuring that the instruments and equipment they process are safe for patient use. Advances in technology and the emergence of new microbiological challenges have increased the difficulty in meeting this challenge. Every CS professional must appreciate the importance of infection control and prevention, and thoroughly understand their role in the process.

RESOURCES

Centers for Disease Control and Prevention. www.cdc.gov/nchs/fastats/insurg.htm.

Centers for Disease Control and Prevention. http://www.cdc.gov/HAI/organisms/organisms.html.

Association of periOperative Registered Nurses. *AORN Perioperative Standards and Recommended Practices 2013, Recommended Practice: Surgical Attire.*

Association for the Advancement of Medical Instrumentation. *NSI/AAMI ST79:2013, Section 3.*

Occupational Safety & Health Administration. *Bloodborne Pathogens (29 CFR 1910.1030).*

CENTRAL SERVICE TERMS

Biocidal

Surgical site infection (SSI)

Chain of infection

Asepsis

Aseptic technique

Asepsis (medical)

Asepsis (surgical)

Hand hygiene

Fomite

Causative agent

Reservoir

Portal of exit

Mode of transmission

Portal of entry

Susceptible host

Carrier

Parenteral

Colonization

Chapter 8

Cleaning and Decontamination

Learning Objectives

As a result of successfully completing this chapter, readers will be able to:

1. Define cleaning and identify challenges to cleaning medical devices
2. Discuss the purpose and set up of the decontamination area
3. Identify the importance of personal protective equipment and standard precautions
4. Explain the role of common cleaning tools
5. Discuss mechanical cleaners
6. Discuss the use of chemicals in the decontamination area
7. List steps in the cleaning process
8. Explain manual cleaning processes

INTRODUCTION

Cleaning is the cornerstone of instrument processing. Items that have not been cleaned properly cannot be sterilized or made safe for patient use. The cleaning processes performed in Central Service (CS) are very different than the cleaning processes carried out in other situations. When cleaning is performed outside the healthcare facility (for example, in home settings), the definition of clean can vary with the individual. When cleaning is performed in the healthcare facility, it must be performed to the highest level and it must be performed with consistency. Improper cleaning can cause infections and even death. This chapter will examine the cleaning process—from the tools required to perform cleaning to the basic steps necessary to carry out a successful process.

WHAT IS CLEAN?

Cleaning is defined as the removal of all visible and non-visible soil and other foreign material from medical devices being reprocessed. When faced with the complex configurations of today's medical devices, the cleaning process becomes quite challenging. Some soils are easy to see and remove; others are not. The goal of every cleaning process in the decontamination area is to remove all soils, not just the ones that are easy to see and remove.

Proper cleaning requires the right tools, the right technique, and attention to detail. A medical device may appear clean at first glance, but may harbor soils that are not readily visible. The following photos (**Figures 8.1** through **8.4**) provide some examples of the challenges associated with cleaning medical devices. **Figure 8.1** provides a look at the inside of a bulb syringe that was mistakenly assumed to have been cleaned. It is extremely difficult, if not impossible, to properly clean any area that cannot be seen. Lumens and other areas that do not provide good access for cleaning pose a significant challenge to CS technicians. **Figure 8.2** provides a look inside an arthroscopic shaver using a flexible inspection scope. The configuration of this instrument makes it impossible to see all areas for cleaning.

Dried soil inside a bulb syringe

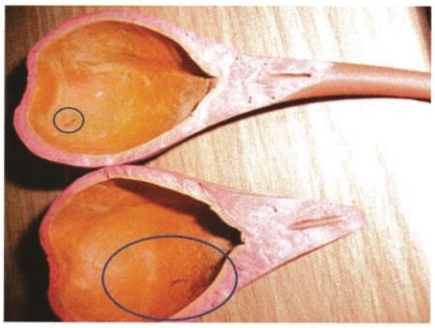


Figure 8.1

Soil inside an arthroscopic shaver as viewed through a flexible inspection scope.

Figure 8.2

Even when item surfaces are clearly visible, inadequate cleaning can occur. **Figure 8.3** provides a look at a common clamp that has undergone fluorescence-based protein detection testing to

detect residual protein soils. Although the clamp appeared visibly clean, several areas of concern were identified. The yellow and orange areas indicate residual soil.

Residual protein soils detected by fluorescence-based protein detection testing

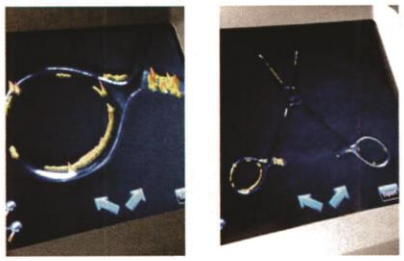


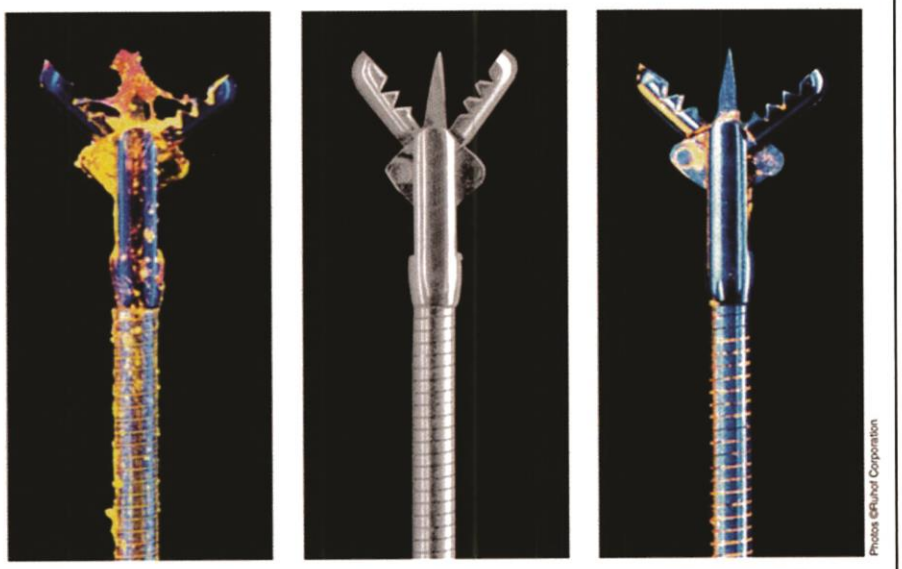
Figure 8.3

Figure 8.4 provides a look at common biopsy forceps that have undergone fluorescence-based protein testing to detect residual protein soil.

These examples illustrate that even simple instruments can pose a significant cleaning challenge. Every item that passes through the decontamination process has the potential to harm a patient or present a danger to healthcare workers. That is why CS technicians assigned to the **decontamination area** must have the proper cleaning tools, must understand the correct cleaning technique for every item, and must always pay close attention to detail as they perform their duties.

Cleaning The removal of all visible and non-visible soil, and any other foreign material from medical devices being processed.

Decontamination area The location within a healthcare facility designated for the collection, retention and cleaning of soiled and/or contaminated items.



Biopsy forceps prior to reprocessing. Bioburden can clearly be seen in this laboratory photo.

After reprocessing, this same instrument appears to be clean to the naked eye.

In some cases residual bioburden still remains after reprocessing, as seen in this laboratory photo.

Photos ©Ruhof Corporation

Figure 8.4

INTRODUCTION TO THE DECONTAMINATION WORK AREA

This section provides an overview of the decontamination area, and the equipment and processes needed to accomplish thorough cleaning.

Design and Location of the Decontamination Area

The process of cleaning and decontamination begins long before even one soiled instrument arrives in the decontamination area. A great deal of planning and preparation goes into the design and set up of the work area and the acquisition of cleaning equipment, tools and supplies. CS technicians assigned to the decontamination area should be aware of the processes and safeguards used to facilitate the cleaning of soiled items, reduce the spread of microorganisms and ensure the safety of patients and employees.

Decontamination areas are unique because of their purpose and design. Soiled instruments should only be cleaned in a designated decontamination area. The decontamination area serves as a receiving area for soiled instruments and, in many cases, other medical devices and equipment from surgery and other areas of the healthcare facility. Several design-related factors must be considered as the decontamination area is planned. It is more cost effective to centralize the decontamination function to one area of the healthcare facility. If the decontamination area is not centralized, additional expenses will be incurred for duplicate equipment and space.

The location of the decontamination area should consider the need to transport contaminated devices from the point of use. Proper transportation of contaminated devices is necessary to reduce the risk of cross contamination and exposure to bloodborne pathogens. (See **Figure 8.5**) In many cases, the decontamination area is located near the Operating Room (OR) because the majority of soiled instruments are generated there.

Floors and walls in the decontamination area should be constructed with materials that can tolerate cleaning chemicals. Walls should not be constructed of particulate or fiber-shedding materials. Spills and splashes are a common occurrence in the decontamination area and can create a need for frequent cleaning/disinfecting of surfaces.

Figure 8.5

The ventilation system should allow for no less than 10 air exchanges per hour, and the area should be under negative pressure in relation to other areas adjacent to the decontamination area. Temperature should be regulated between 60°F and 65°F (16°C and 18°C). The low temperature is needed because CS technicians working in the decontamination area must wear fluid-resistant attire that, when worn for extended periods of time, can become uncomfortable and hot. A low temperature also helps inhibit the growth of microorganisms. **Relative humidity** is also important and should range from 30% to 60%.

Relative humidity Amount of water vapor in the atmosphere; expressed as a percentage of the total amount of vapor the atmosphere could hold without condensation.

Lighting is essential to a safe work environment, and is a key element in the cleaning process. Instrument cleaning requires attention to detail, and lighting must enable technicians to perform inspections associated with the cleaning process.

Traffic should be restricted to personnel working in the area, and access to the area should be controlled. (See **Figure 8.6**)

Figure 8.6

Emergency eyewash/shower equipment should be placed so these safety stations are accessible within 10 seconds or 30 meters of areas of potential chemical exposure. (See **Figure 8.7**)

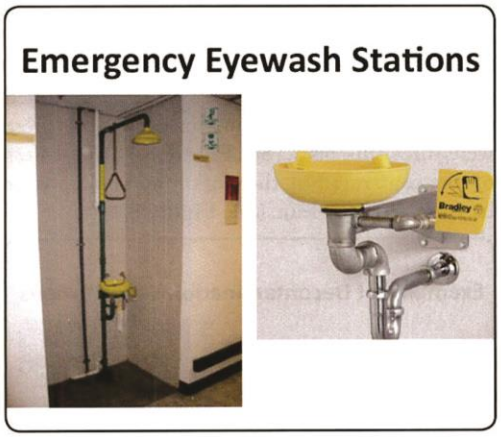


Figure 8.7

The decontamination area is the central point for handling contaminated devices, and a high microbial count will be present in the environment. The first line of defense for reducing contaminates is maintaining as clean a work area as possible. Special attention should be given to the cleaning procedures in the work area. For example:

Cleaning and Decontamination

- Horizontal work surfaces should be cleaned and disinfected at least at the beginning and end of each shift.
- Spills should be spot-cleaned immediately.
- Floors should be cleaned and disinfected daily.
- **Biohazardous waste** should be removed at frequent intervals.

Adequate storage for equipment used to clean the decontamination area should be available and tools, such as mops, used in this area should not be used in other areas of the department.

Biohazardous waste Waste containing infectious agents that present a risk or potential risk to human health, either directly through infections or indirectly through the environment.

Dress Code and Personal Behaviors

Employee safety is an important concern at all times during instrument cleaning and decontamination. Since CS technicians do not know the origin of the contamination, they must assume that every item received in the decontamination area can pose a potential risk to them. For these reasons, following personal protective equipment (PPE) requirements is essential. (See **Figure 8.6**)

Developing and adhering to good work practices and personal safety habits can reduce the risk of potential exposure to pathogens.

Handwashing and frequent use of appropriate hand germicidal agents is required. Whenever CS technicians remove PPE, they should properly wash their hands. A sink dedicated to hand hygiene should be provided within the decontamination area, and it should be separated from sinks used to sort and prepare instruments for processing.

Personal protective equipment (PPE)

- Hair covering.
- Eye protection, such as goggles or eyeglasses with solid side shields, or a chin-length face shield.
- Fluid-resistant face mask.
- A gown with reinforced cuffs and a front that acts as a barrier to fluids.
- Strong general-purpose utility gloves that cover the cuffs of the reinforced gown and can resist cuts and tears.
- Skid-resistant decontamination shoe covers.
- Employer-provided cloth scrub attire that is changed at the end of each shift, or when wet or soiled.

Figure 8.8

Effective, ongoing education and training is critical to the safe processing of medical devices. Safety training is the ongoing responsibility of both the employer and the CS technician.

Before any new staff member is assigned to the decontamination area, he/she must receive a thorough and comprehensive orientation.

Traffic Control and Environmental Management

Technicians assigned to the decontamination area should be constantly vigilant of their surroundings. Traffic control is imperative due to the potential for exposure to bloodborne pathogens and hazardous chemicals.

Work Area Set Up

Preparation of the work area is an essential first step in promoting safety and efficacy in the decontamination area.

Sinks - Ideally, each workstation will have three sink bays for washing, intermediate rinsing and final rinsing. If three bays are not available, the cleaning process must be modified to accomplish the cleaning process as if there were three sink bays. (See **Figure 8.9**) Regardless of the configuration, the workflow should always be from dirty to clean. (See **Figure 8.10**)

Examples of Decontamination Workstations

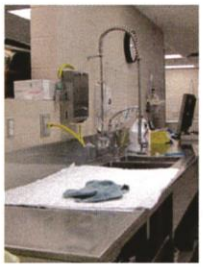


Figure 8.9

Figure 8.10

A three-sink arrangement used for manual cleaning should consist of:

- A wash sink with water and detergent or enzymatic solution. This sink should be filled with warm water with a temperature range of 80°F to 110°F [27°C to 44°C]. The temperature of the solution should be monitored. (See **Figure 8.11**) Water hardness, pH, temperature and the type of soil present on instrumentation impact the effectiveness of enzyme cleaners and detergents. *Note: The detergent manufacturer's Instructions for Use (IFU) must be consulted for specific instructions.*

  All cleaning chemicals must be mixed per manufacturer's instructions. Marking the sink to indicate gallon levels can help ensure that solutions are mixed to the proper dilution. (See **Figure 8.12**) Cleaning solutions should be changed frequently for maximum cleaning.

- A second sink (intermediate rinse) that contains plain or softened water. After cleaning, devices should be thoroughly rinsed to further assist in removing debris and detergent residues. This rinse water should be changed frequently, so the cleaning chemicals do not build up and reattach to the instruments being rinsed.

- A third sink (final rinse) with **distilled, deionized** or **reverse osmosis (RO)** water. This helps prevent instrument spotting, rinse off cleaning chemical residues and **pyrogens**, and prevent the redeposit of minerals, microbes and pyrogens.

Deionized (DI) water Water that has had all minerals removed through an ion exchange process.

Distilled water Water that is heated to steam, then allowed to cool and condense. Distillation removes impurities, like gases and organic material; it also removes some bacteria.

Reverse osmosis (RO) A water purification process by which a solvent, such as water, is removed of impurities after being forced through a semipermeable membrane.

Pyrogen A substance, typically produced by a bacterium, that produces fever when introduced/released into the blood.

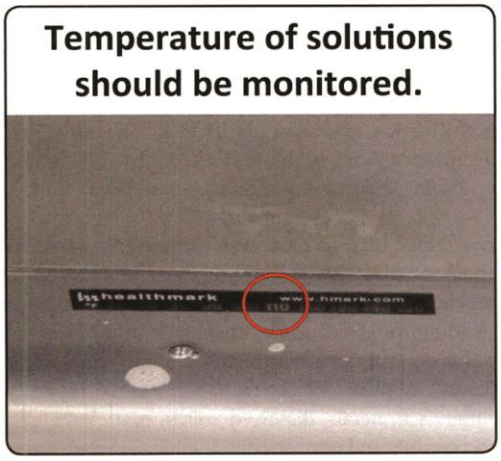


Figure 8.11

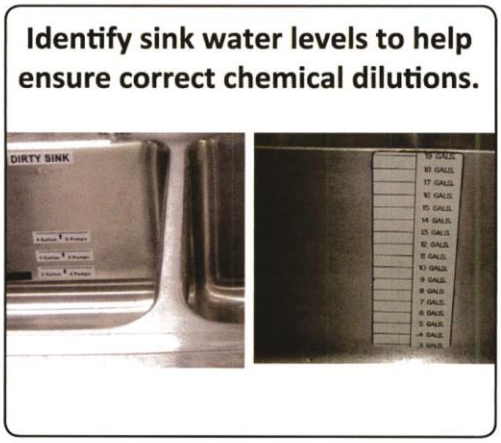


Figure 8.12

Adequate cleaning and rinsing should result in low bioburden, which is essential to the effectiveness of terminal sterilization.

Cleaning Tools

Water

Although it is often taken for granted, and not often considered to be a tool, water quality makes a big difference in instrument/equipment cleaning outcomes. Poor water quality can impact the performance of chemicals used for cleaning and disinfection, and it can also affect the rinse phase by leaving deposits on items that have been cleaned.

Regardless of where the water originates, a natural aquifer, or in surface water, it must be purified to provide the proper quality for the instrument cleaning process. There are many impurities in water, even in tap water treated at a municipal water treatment plant. Water from any source typically contains minerals, dissolved solids, particles, gases, and organic and non-organic chemicals. Some water sources also contain bacteria, algae and parasites. These contaminants may impede cleaning and biocidal processes and, in some cases, contaminates may shorten the life of instruments by harming their finish.

Water used as a final rinse in any cleaning process should be purified to reduce or eliminate these elements. Water sample tests should be made at each site where it is used as a final rinse in manual and mechanical (ultrasonic, cart washer and washer-disinfector) processes. Tests can be performed by facility personnel. Alternatively, manufacturers and distributors of cleaning products, cleaning machines and water treatment products often provide these tests free of charge. Knowing the pH and what is in the water used to process instruments allows facilities to make wise choices in the selection of cleaning and disinfecting chemicals used, and the type of water purification system needed. Many chemicals used in the decontamination process require specific pH ranges, and final rinse water must be free of impurities. **Figure 8.13** provides a comparison of pH levels to common household items.

CS departments must ensure that the water used for the cleaning process meets the requirements for the specific use.

Manual Cleaning Tools

Decontamination requires a combination of manual and mechanical cleaning processes; therefore, the area will have equipment for both types of cleaning.

The following section provides information about manual cleaning tools.

Brushes

Brushes are available in many diameters and lengths. Some must be rigid and others must be flexible to properly clean the many different lumens, channels and crevices in instruments. (See **Figure 8.14**) Brushes used for cleaning usually have nylon bristles; however, metal varieties, brushes with plastic wands and sponge tips are also available. Some brushes are impregnated with enzymatic detergents that can help with the cleaning process.

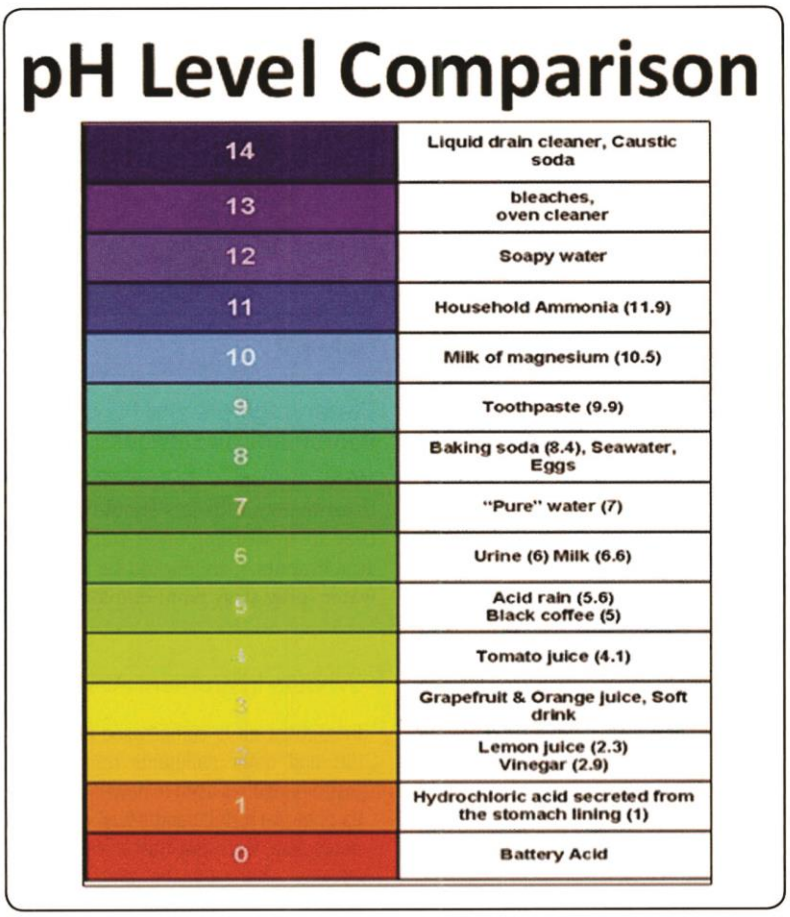


Figure 8.13

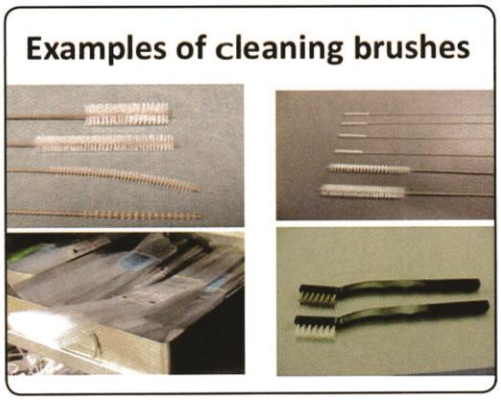


Figure 8.14

Ideally, disposable brushes should be used. If reusable brushes are used, they should be decontaminated at least daily and when visibly soiled to ensure they are not a source of contamination. Abrasive brushes should never be used because they can scratch the surface of the instrument and accelerate corrosion. Metal or wire brushes should only be used if indicated in the instrument's IFU.

Correct brush size is also critical. Consider lumen cleaning, for example. If the brush is too large, it will not fit into the lumen. If the brush is too small, it will not have complete contact with the lumen walls, and will not thoroughly clean them. The brush must also be long enough to extend through

the lumen. (See **Figure 8.15**) Brushes that are worn should be discarded. (See **Figure 8.16**)

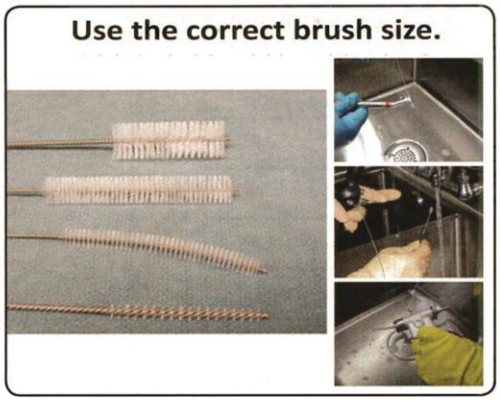


Figure 8.15

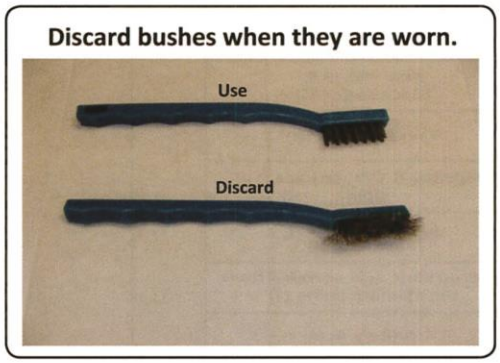


Figure 8.16

Cleaning Cloths

Most cleaning cloths are made of textiles. Some have lint and others are low-lint or lint-free. Use of a lint-free or low-lint cloth reduces the risk of fibers being left on instruments. Cloths should be changed regularly, or when visibly soiled or stained.

Sponges

Sponges can be used to clean some medical devices. Some sponges are impregnated with detergents and should be used according to the manufacturer's IFU. Unfortunately, the sponge's structure makes them virtually impossible to completely clean and sterilize for reuse, so they must be discarded and replaced at least daily or after each use, according to the manufacturer's IFU. (See **Figure 8.17**)

Figure 8.17

Water Irrigators and Forced Instrument Air Devices

Water irrigation devices (See **Figure 8.18**) and instrument air devices should be checked to ensure they are in working order and have all the necessary attachments. Care should be used to direct air and water spray away from employees.

What Is Instrument Air?

Instrument air is compressed air that has had dust, dirt and other pollutants removed. In healthcare, instrument air is used to power medical devices, such as pneumatic drills and saws, and calibrate medical equipment. Instrument air is also used to dry medical devices after cleaning and decontamination. To qualify as instrument, air must be free of oil, water, hydrocarbons and other contaminates that could cause infection.

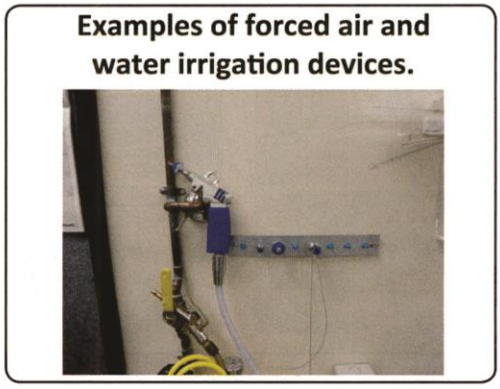


Figure 8.18

Floor Drains and Spray Nozzles

Many decontamination areas are equipped with a spray nozzle and floor drain/grate that provides drainage when manually cleaning bulkier items that do not fit in the cleaning sinks. The spray nozzle system is also used for cleaning the wheels of mobile equipment that cannot be sent through an automatic process. (See **Figure 8.19**)

Example of a spray nozzle system for cleaning mobile equipment and cart wheels.

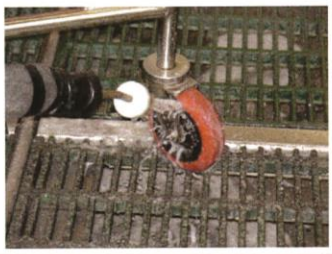


Figure 8.19

Additional Tools

Specific instruments may require specific tools to perform cleaning and decontamination. For example, flexible endoscopes may require leak testing devices. Specific cleaning tools should be purchased at the same time as the instrument(s) and replaced, as necessary. All CS technicians assigned to the decontamination area should be trained in the proper use of special cleaning tools.

MECHANICAL CLEANERS

Several mechanical options are available to assist with decontamination. Mechanical cleaning facilitates the decontamination process by removing soil and microorganisms using an automated cleaning process. When functioning correctly, these machines function consistently and reduce time and labor for CS professionals. *Note: The use of mechanical cleaners does not completely replace the need for manual cleaning.*

Some units reduce microbial contamination through a multi-step approach using a combination of cleaning solutions, hot water, rinsing, lubrication and drying, while others provide a cleaning function only. Mechanical devices commonly found in the decontamination area include ultrasonic cleaners, irrigating sonics, washer-disinfectors, cart washers, pasteurizers and automated endoscope reprocessors (AER).

CS technicians should not use any type of mechanical equipment without receiving proper training and competency review.

The following is an overview of common equipment found in the decontamination area.

Ultrasonic Cleaners (Sonics)

Ultrasonic cleaners are used for fine cleaning, not for disinfection or sterilization. They are used to remove soil from joints, crevices, lumens and other areas that are difficult to clean by other methods.

The term "ultrasonic" is an appropriate name for this type of mechanical cleaner. "Ultra" means beyond and "sonic" means sound. When an ultrasonic wave passes through a liquid, it makes the liquid vibrate. Hospital sonic cleaners produce from 20,000 to 38,000 vibrations per second. The vibrations are transmitted through the detergent bath and create **cavitation**. With this process, ultrasonic waves pass through a cleaning solution, the molecules of the solution are set in very rapid motion, and small gas bubbles develop. As the bubbles grow larger, they become unstable until they implode (not explode). (See **Figure 8.20**) This creates a vacuum in the solution that draws minute bits of foreign matter (including microorganisms) from cracks and crevices, such as hinges and serrations on instruments. This vacuum action results in cleaning of hard-to-reach areas.

After cavitation, rinsing is necessary to remove any residue, including detergents that remain on the instruments. Since the ultrasonic cleaning process lifts proteins, starches and lipids from instruments, it is important to routinely clean the tank according to the manufacturer's instructions.

Cavitation The process used by an ultrasonic cleaner in which low-pressure bubbles in a cleaning solution burst inward and dislodge soil from instruments.

Magnified cavitation bubble imploding

Figure 8.20

Instruments to be processed must be pre cleaned to remove gross soil, such as blood and tissue debris. In addition, protein absorbs sound and reduces the cleaning action in the sonic cleaner. Bath temperatures for cleaning instruments should be between 80°F and 109°F (27°C and 43°C), unless otherwise specified by the equipment or detergent manufacturer. Temperatures above 140°F (60°C) will coagulate protein, making it more difficult to remove. Water should be changed when it is visually soiled, or at regularly scheduled intervals, to prevent soiled particles from redepositing on instruments. The unit's tank should be cleaned and the drain should be checked for debris at each water change.

An ultrasonic unit may have one, two or three chambers. The first chamber is for the detergent bath, the second is for rinsing and the third is for drying. (See **Figure 8.21**) Some single-chamber sonics may only provide a cleaning process, while other single- chamber units perform both cleaning and rinsing functions. When using a single-chamber unit, it is necessary to know if the rinsing function is automatic. If the unit does not have a rinse cycle, it is important to manually rinse instruments after removing them from the sonic cleaner.

Examples of ultrasonic cleaners

Figure 8.21

Water must be degassed each time it is changed in the sonic cleaner. Excess bubbles in the water are formed during filling, and these gas bubbles reduce the energy released during implosion. To de-gas a unit, fill the sonic cleaner, close the lid and run it for five to 10 minutes. Degassing should only be done after the tank is filled (not while it is being filled) to avoid damaging the equipment. Some ultrasonic cleaners will automatically de-gas the solution when the chamber is filled. The lid of the sonic cleaner should be closed at all times when the unit is operating to prevent aerosols from being dispersed.

When using ultrasonic cleaners there are some important factors to remember:

- Instruments must be precleaned prior to placing them in a sonic.
- Instruments should be placed in trays designed for use in the machine. They are typically of small wire construction with at least eight openings per inch to allow transmission of sonic energy.
- All lumens must be completely filled with fluid, so the cavitation process can be effective inside the lumen.
- All instruments must be completely submerged in the solution, so they are exposed to the cavitation process.
- Hinged instruments placed in the sonic cleaner should be opened.

- Trays must not be overloaded. Check the ultrasonic IFU for load limitations. (See **Figure 8.22**)

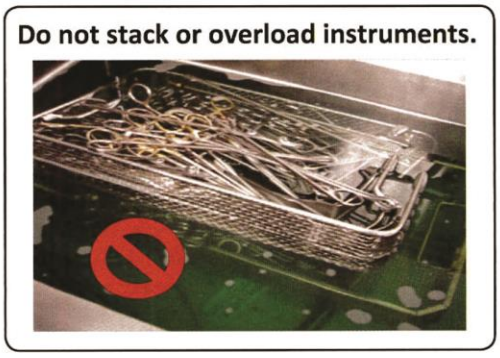


Figure 8.22

Ultrasonic energy can loosen the tiny screws of delicate instruments and degrade the glues or amalgam in other devices. Items that should not be placed in a sonic cleaner include:

- Chrome-plated and ebonized instruments, and those made of plastic, cork, glass, wood, chrome and rubber.
- Needles, unless approved for the process by the needle manufacturer's IFU.
- Instruments that contain fiber optic components.

Stainless steel instruments should not be mixed with aluminum, brass or copper instruments in a sonic cycle. Users should be aware that some sonic detergents may change or dull the color of anodized aluminum.

Irrigating Sonics

Some sonics are equipped with irrigating ports or connections to help facilitate cleaning of long lumened devices, such as laparoscopic or robotic instrumentation. (See **Figure 8.23**) It is important to check the flow of the solution through these connections to ensure they are not clogged.

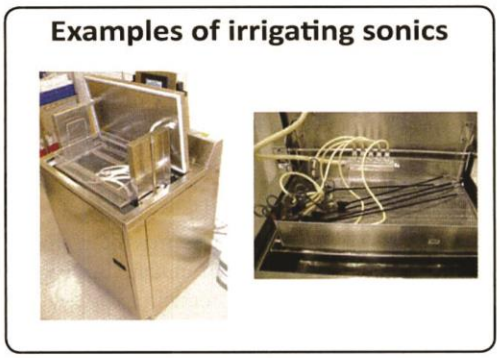


Figure 8.23

As with all processing equipment, the sonic cleaning equipment manufacturer's operating and maintenance recommendations should always be carefully followed.

Detergents for Ultrasonic Cleaners

Only detergents that have been specially formulated for ultrasonic cleaners should be used. Detergents must be low-foaming to prevent interference with the cleaning process.

Washer Disinfector

Washers have been used for many years in CS departments, and they are effective to clean instrumentation, instrument containers, basins and graduates. Most are designed to perform multiple cleaning functions automatically. *Note: Automated mechanical washers are not appropriate for washing electrical, battery or pneumatic devices, unless otherwise stated in the device's IFU.*

Washers work on the principle of **impingement**. They are an effective means for cleaning and disinfecting instruments because of their spray force and thermal action.

Impingement The spray-force action of pressurized water against instruments being processed to physically remove bioburden.

In some ways, impingement washers work like a dishwasher; they rely on a combination of water temperature, special detergent and a spray force action to remove soil from devices being processed. To clean effectively, items must be properly prepared and positioned in a manner that facilitates the mechanical cleaning process.

Mechanical washer disinfectors may be a single-chamber model or an indexed model. (See **Figure 8.24**) In single-chamber models, all cleaning functions are performed in a single chamber while the index model moves the instrument trays into separate chambers for each function. Many washer models have multiple types of cycles, including gentle, orthopedic instrument and glass, as well as the regular instrument cycle. Mechanical impingement washers typically use several successive steps during the wash cycle.

- The first step is a cool prerinse to wet the instruments and prepare them for the detergent cycle. The prerinse may be cool water or an enzymatic solution. The cool temperatures helps prevent coagulation of proteins.
- The second step is a detergent cycle with water at a higher temperature to maximize the effectiveness of the detergent action.
- The third step is rinsing, followed by a pure rinse cycle to remove any remaining detergents and debris. *Note: Some washers also provide a lubrication cycle during the rinse cycles.*

Examples of washer disinfectors

Figure 8.24

Washers are only effective when used and serviced according to the manufacturer's recommendations. Operator manuals and detailed instructions about the basic operation and loading of instrument racks should be provided. CS technicians should understand and comply with these instructions. Important factors to remember when using a washer-disinfector:

- Washer racks should never be overloaded, and spray arms should move freely during operation. Instruments that are sticking up and/or out of their perforated baskets must be relocated away from the spray arms travel paths.
- Instruments should be disassembled, and their small parts placed inside an approved containment device (part holder) for processing in the washer. (See **Figure 8.25**)

Examples of small part holders

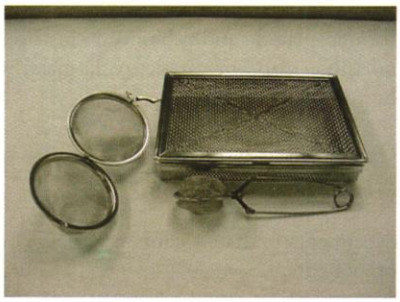


Figure 8.25

- Hinged instruments should be opened to permit direct contact of the water and detergent. (See **Figure 8.26**)

Figure 8.26

- Trays or sets with multiple levels should be opened, and each tray should be placed separately on the washer's rack. Failure to separate multi-level trays can cause the wash process to fail because tray layers impede contact between the spray action and the items within the tray. (See **Figure 8.27**)
- Trays with lids/covers should be opened so contents may be exposed to the washer spray.
- Delicate instruments may be dislodged from the racks due to the blunt force of the spray action. These instruments should be confined in small perforated baskets with approved lids.

Figure 8.27

Instrument washer racks and conveyor systems should be inspected daily. Routine cleaning of washers should include inspection and cleaning of spray arms and washer jets. Mineral build up will hinder spray action and disrupt cleaning efficacy. Washer traps/screens need special attention and should be inspected for debris at least daily (See **Figure 8.28**), and cleared of any obstructions. Washer detergent levels should be frequently monitored. If detergent drums are allowed to run dry, a column of air may enter the detergent feed lines and impact the delivery of replacement detergent.

Figure 8.28

It is important to keep the chamber walls clean, so the washer can perform at maximum efficiency. If a white scale is seen in the chamber, it should be removed immediately with an approved descaler because scale can fall on instruments and clog pumps, motors and spray arms. (See **Figure 8.29**)

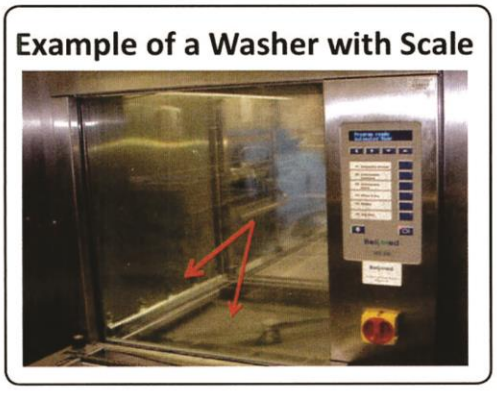


Figure 8.29

Automated washers have preset, factory-installed cycles for use with different cleaning situations. Instrument cycles generally are the longest cycle because they have multiple rinse, wash, lubrication and drying times to meet the instruments' cleaning needs. Basins and containers are generally run on a utensil cycle. Some washer manufacturers offer special cycles for delicate instruments. When running a mixed load of containers and instruments, the instrument cycle should normally be utilized for maximum cleaning. CS technicians should be familiar with different washer cycles, and should be able to select the appropriate cleaning cycle for the items to be processed.

Some washer racks (manifolds) are equipped with irrigation lines that can be connected to certain complex instruments to add a channel flush to the mechanical cleaning process. (See **Figure 8.30**)

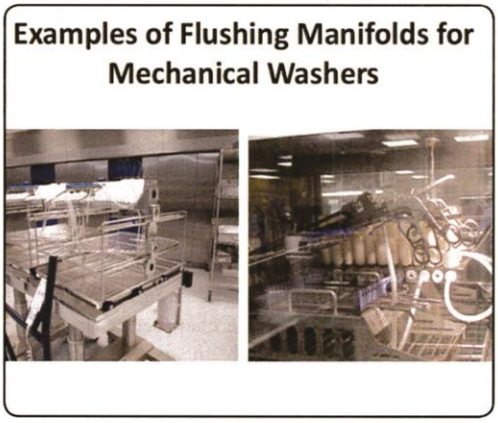


Figure 8.30

Automated Cart Washers

Cart washers were originally designed to clean carts used for transport of various supplies and instruments. (See **Figure 8.31**) Some cart washers are designed to process rigid containers and other miscellaneous items. Some models have programmed instrument cycles. Several manufacturers offer cart washers with design features and special washer racks to facilitate the processing of basins, pans, bedside commodes and surgical stainless steel tables. Processing rigid containers, basins and other transport containers in a cart washer can yield operational speed and efficiency. (See **Figure 8.32**)

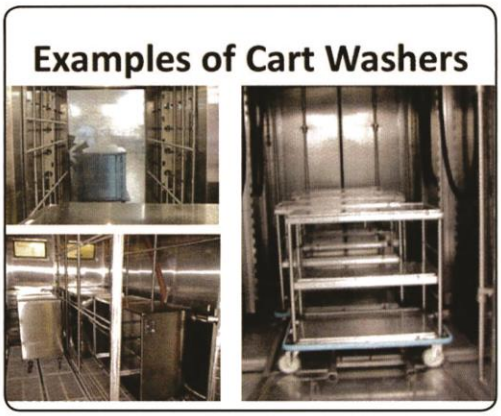


Figure 8.31

Figure 8.32

Cart washers operate in a manner similar to automated instrument washers, but on a larger scale. Spray arms deliver high-temperature water and detergent, and successive steps provide rinse water and hot air drying cycles. Cart washers resemble automated car washes in their cleaning process. Most cart washers do not have multiple phase cycles like washer disinfectors, but include a high-temperature process to reduce bacteria and facilitate drying. Detergents selected for cart washing should be formulated for use in cart washers. Important factors to remember when using a cart washer include:

- When cleaning enclosed carts, ensure they are approved to be cleaned by a cart washer. Older enclosed carts are not designed to allow water to drain from the interior, so the cart may be damaged by the lingering moisture.

- Do not process instruments in a cart washer that is not designed for that purpose.

- Do not process items inside carts. The walls of the cart will keep cleaning solution and rinse water from reaching the items inside.

As with the other equipment, it is important to test the cleaning ability of cart washers on a regular basis. Commercial testing products are available.

Automated Endoscope Reprocessors

Some AERs have cleaning cycles, as well as a disinfection process. This equipment will be discussed in depth in Chapter 9. It is important to note the following when using the cleaning cycles:

- Only process items approved for processing in this type of equipment.

- All items must be manually cleaned prior to placing them in these units.

- Only use cleaning chemicals that have been approved by the equipment manufacturer.

- The equipment must be tested on a regular basis.

EQUIPMENT TESTING

ANSI/AAMI ST79, 10.2, recommends a quality assurance program to ensure that the mechanical equipment is working properly. Commercially-prepared products can be obtained to verify the cleaning effectiveness of the equipment. (See **Figure 8.33**)

If the mechanical cleaner has a printout, the printout should be reviewed and initialed after each cycle to ensure the cycle reached the expected parameters.

Mechanical cleaners can save time and labor, while producing a consistent process; however, remember that human factors play a significant role in mechanical cleaning. In other words, mechanical cleaners are only as good as their operators. CS technicians must understand how to properly prepare items for cleaning and use each piece of equipment according to instructions.

Figure 8.33

CLEANING CHEMICALS AND LUBRICANTS

Many types of soil can be present on reusable devices. When soil, especially blood, is allowed to dry prior to cleaning, it becomes difficult to remove. (See **Figure 8.34**) Blood flows into instrument joints, hinges, grooves and other difficult to clean locations. It then coagulates and dries to create a significant challenge to cleaning. Soil adheres to microscopic irregularities in the surface of instruments and has to be manually and mechanically scrubbed away, or chemically treated, otherwise it could result in the formation of biofilm. Using proper chemicals in the correct concentrations rehydrates and loosens the soil, and helps to properly clean the devices.

Figure 8.34

Each chemical used should be compatible with both the medical device and the equipment used for cleaning.

Different types of chemicals are used in the cleaning process, including enzymatic products, detergents and presoaks (precleaning agents). Each has a specific purpose in efficiently processing reusable items.

Enzyme Products

Enzymatic cleaners are biodegradable, non-toxic cleaning agents used to break down soils, stains and other debris on heavily-soiled instruments. They are very helpful for processing difficult-to-clean devices, such as instruments with lumens. They are also used to keep instruments moist and begin breaking down the soil on instruments immediately after a procedure. Enzymes are very specific in their action. For example, a protein enzyme will not affect fat molecules.

There are different types of enzymatic products available. Some can be used at the point of use to moisten and loosen soil on instruments, and others are used in manual or automatic washing processes. Popular enzymes used in CS departments include:

- Protease enzymes (protein) – Break down blood, mucous, feces and albumin.
- Lipase (fat) – Break down fatty deposits, such as bone marrow and adipose tissue.
- Amylase – Catalyzes (changes) starch.

Elements in soil can gradually degrade enzymes during use and reduce their cleaning efficacy. Dried soil on a device must be rehydrated before enzymes that facilitate its removal can be effective. Point-of-use precleaning (keeping the instruments free of gross soil) can reduce these problems. After precleaning, the instrument should remain moist to keep soil from drying and maintain hydration needed to optimize the enzyme's efficacy.

Many enzyme products used in the decontamination area are single enzyme products, so it is important to know the type of soil being cleaned. Multi-enzymatic products contain protease (for soils), lipase (for fats) and amylase (for starches). Detergents take longer to clean if they are not used in conjunction with enzyme products.

Proper temperature is critical when dealing with enzyme-based products. Temperatures should not exceed 140°F (60°C), unless otherwise stated by the enzyme manufacturer.

Detergents

Since water is not an effective cleaning agent, detergents are used to enhance its cleaning ability.

Detergents contain **emulsifiers, surfactants** and **chelating agents** to increase their cleaning efficacy. Chelating agents have an ionic charge that allows soils with the opposite charge to break away and attach to the chelating agent. An emulsifier surrounds these particles to prevent them from reattaching, and they also help break bonds that oils can create to trap soil.

Emulsifier Any ingredient used to bind together substances that normally do not combine, such as oil and water.

Surfactant A substance that lowers the surface tension of the water and increases the solubility of organic compounds.

Chelating agents Chemicals that hold hard water minerals in solution and prevent soaps or detergents from reacting with the minerals.

When used properly, detergents penetrate and remove soil from instruments and keep soil in suspension, so it does not reattach to the instrument. Remember that detergents do not kill microorganisms (unless they contain a germicide). They help to clean the instrument by removing bacteria-laden soil.

Detergents are designed to perform specific tasks. In the home setting, there are different detergents for washing dishes, washing laundry and cleaning floors. In a similar manner, detergents for decontamination in the healthcare facility are formulated for different applications. Some detergents work in hard water, some are low-foaming, so they do not hinder the operation of the mechanical cleaning equipment, and others are developed specifically for a certain type of equipment, like those formulated for ultrasonic cleaners.

Detergents also come in several forms. Liquid detergents can be purchased in small quantities for use at a sink, or large quantities for use in mechanical washers. Solid forms (blocks) of detergents that mix with water as they are dispensed are also available. (See **Figure 8.35**)

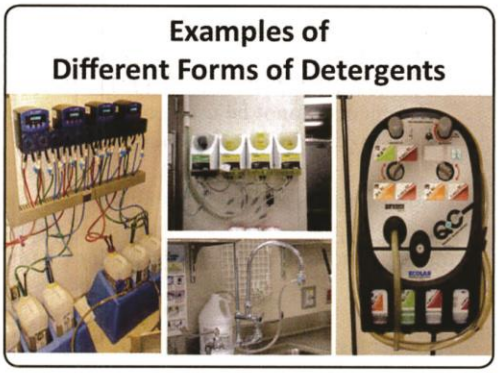


Figure 8.35

Detergents are selected at each facility, based on the item's and facility's specific cleaning needs, the quality of their water, and the types of soils present. There are several types of detergents that can be used for cleaning surgical instruments. Each has its advantages and disadvantages, so it is important to know how each type of detergent functions and how to properly use them.

- Neutral detergents are the most commonly-used type in the U.S. Neutral detergents have a pH value of 6 to 8.
  - › Advantages - Neutral-pH detergents are effective on organic and inorganic soils, and are safe to use on aluminum products.
  - › Disadvantages - Neutral pH detergents are not very effective in hard water, produce more foam and are more difficult to rinse than other types of detergents.
- Alkaline detergents are highly effective at removing organic soils (blood, fat and oils). Alkaline detergents range in pH from 8 to more than 11. Prior to using an alkaline detergent, refer to the manufacturer's IFU.
  - › Advantages - They remove a wider range of soil than any other type of detergent; they are economical to use and low foaming.

  - Disadvantages - Alkaline detergents require thorough rinsing as they can leave a powdery residue on the instrument surface. Alkaline detergents cannot be used on devices made of bronze, copper or aluminum.

- Acid detergents are primarily used to remove mineral deposits, such as hard water, urine, minerals and scale. Acid detergents have a pH of 1.6 to 3.

  - Advantages - Excellent for removing mineral deposits and urine. Acid detergents work well on inorganic soils, neutralize alkaline residues and make stainless steel shine.

  - Disadvantages - Can damage the surfaces of stainless steel and aluminum, bronze and glass. Disposal into drains and sewer lines may be restricted in some states.

Review of Common Chemicals Used in the Decontamination Area

During the course of any shift, CS technicians must select and properly use several different chemicals. While initial selection of chemicals to be used in the department is done by managers, the technician must select the proper chemical for the job from the chemicals available in the decontamination area. *Note: Each chemical is different and cannot be substituted for another.* (See **Figure 8.36**) Read labels carefully and ask questions if any information is not understood.

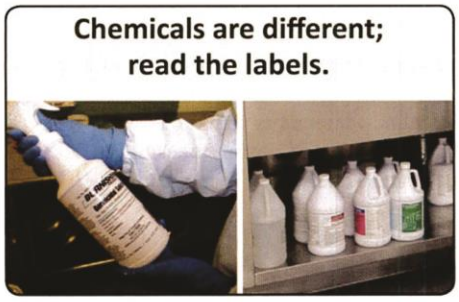


Figure 8.36

The following is a review of chemicals commonly found in the decontamination area.

- Precleaning chemicals are used in the first step in the decontamination process. Some commonly-used precleaning agents are detergent solutions, enzymatic detergents and combination enzyme-germicide detergents.

  Precleaning should begin immediately after the completion of any invasive procedure. Blood and other visible debris, if left on an instrument, serve as a reservoir for microbial growth, and may damage an instrument's finish. If not removed, the corrosive agents in blood and body tissue can penetrate the protective outer layer of an instrument and cause rusting or pitting of the stainless steel. The manufacturer's directions must be followed when using these precleaning products. Exceeding the time allowed for the instruments to be immersed in the solution can damage and corrode instruments.

  Precleaning chemicals are applied at point of use, but they may also be used in the decontamination area to keep soil moist and loosen dried soil.

- Manual cleaning chemicals – These products, when mixed properly, penetrate under the soil and break the bond that attaches the soil to the instruments. Their main function is to remove soil, not kill microorganisms. Low-foaming and free-rinsing manual cleaners should be used. The manufacturer's IFU should be followed for proper dilution and to determine the proper water temperature for their use. Manual cleaners are usually neutral or alkaline products.

- Mechanical cleaners are specially designed for use in mechanical cleaning processes. They are low foaming and designed to work with the specific mechanical cleaning process (for example, an ultrasonic cleaner), so careful attention must be paid to the manufacturer's IFU.

- Descalers are not typically required if the water quality and detergent mixtures are correct, and the equipment is operating properly. Still, problems can go unnoticed until a chalky-powdery, hard to remove substance appears on the walls of equipment and sinks. When this occurs, an acidic detergent or a descaler is needed to remove the scale. It is important to use a descaling product when scale is detected in the cleaning equipment because scale can interfere with the cleaning ability of the equipment.

- Lubricants (often called "instrument milk" because of its milky appearance) are an important part of the instrument maintenance program because they help maintain the integrity of instruments and keep them in good working order. Lubrication is performed after cleaning, as one of the final steps in the mechanical wash process, or it can be applied manually in the clean assembly area using a spray bottle. In the past, instrument baths (pans filled with instrument lubricating solution) were commonly used. This process has been discontinued because of increased risk of contamination. Always use lubrication according to the manufacturer's instructions to ensure the proper contact time and dilution concentration. Ensure the lubricant is designed for use with the instruments to be cleaned and compatible with specific sterilization processes that will follow.

- Stain and rust removers are used when the normal cleaning process does not remove stains on an instrument. Stains and rust usually result from improper care, such as soaking the instruments in saline. Stain and rust remover can be used after instrument cleaning to restore the luster to stainless steel instruments. These chemicals remove hard water deposits, rust scale and discoloration from instrumentation and processing equipment. Most stain and rust removers are acid-based compounds (0 to 6.9 pH) that react with minerals and iron on the instruments. They remove mineral and detergent build up, leaving the surfaces bright and shiny, and the instruments moving freely. Because these chemicals are acid-based, the IFU must be carefully followed to prevent instrument damage. After using a stain remover, the instruments should be recleaned.

When using any cleaning chemical, temperature is an important factor. Most cleaning chemicals deactivate if the temperature is higher than 180°F (82°C). Unless specified by the manufacturer, cleaning chemicals should never be combined with other chemicals.

To prevent instrument damage, the following chemicals should not be used (unless recommended by the device manufacturer) to clean instruments:

- Abrasive cleaning compounds.
- Saline.
- Buffered iodine, such as Betadine.
- Hydrogen peroxide.
- Any chemical not specifically recommended by the medical device manufacturer.

INSTRUCTIONS FOR USE

Knowing and following the manufacturer's IFU is a critical component of the decontamination process. CS technicians must understand how to follow the medical device's IFU, as well as clearly understand the IFU for any equipment and any chemical they use. Failure to follow an IFU can result in a failed decontamination process and damage to instruments and equipment.

The remainder of this chapter will examine basic cleaning and decontamination processes.

STEPS IN THE PROCESS OF DECONTAMINATION

Point of Use

The process of decontamination begins with the end user, at the point of use. OR staff should take the time to ensure that the initial steps of decontamination are performed. The Association for the Advancement of Medical Instrumentation (AAMI) and the Association of periOperative Registered Nurses (AORN) recommend that instrument users take the time to properly prepare instrumentation for transport to the decontamination area.

Soiled Receiving

If soiled items are hand delivered to the decontamination area, the person delivering the items should place them on a cart or counter top designated for receipt of items into the decontamination area. (See **Figure 8.37**)

Figure 8.37

When carts loaded with soiled items are received, proper body mechanics must be used when handling the heavy carts. When loading and unloading carts from dumbwaiters or elevators, check the weight of the cart. Ensure that the wheels are aligned, and that they will roll over door spaces or uneven edges. Unload some items to lighten the cart if it is too heavy to move easily.

If items are in a closed cart or transport container, open the lid or doors carefully, as items may have shifted during transport. (See **Figure 8.38**) Carefully remove items from the cart or container and place them on a flat surface near a sink.

Figure 8.38

Use the following guidelines during the unloading process:

- Fluids should be disposed of or contained at the point of use. If transported, fluids should be in a leak-proof container. Dispose of any fluids, per facility policy.

- If possible, disposable items and reusable textiles should be removed at the point of use. If this is not feasible, these items should be bagged and sent to the decontamination area. They should not be transported unless contained. (See **Figure 8.39**)

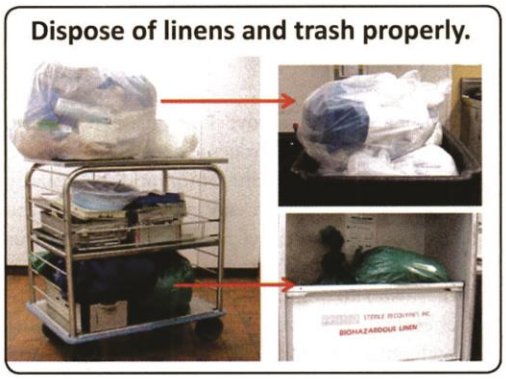


Figure 8.39

- Reusable sharps, including scissors and chisels, should be separated and safely contained at the point of use. Disposable sharps, such as

scalpel blades and trocars, should be removed and discarded at the point of use. If disposable sharps are found in the transport device or in any tray, they should be removed and discarded in an approved sharps container. (See **Figure 8.40**)

Carefully remove all tray liners, indicators, filters and other disposable items left inside instrument trays.

- Rigid containers:
  - Remove filter retention plates from rigid containers. Containers and lids should be cleaned without the retention plate or reusable filter in place. Discard disposable filters and clean reusable filters per manufacturer's instructions. (See **Figure 8.41**)
  - If the container system has valve-type closures, the valves should be inspected and cleaned following manufacturer's instructions. Improper cleaning of container valves can inhibit the sterilant from reaching the instruments to be sterilized. Improperly cleaned valves may also lead to contamination of the instruments after sterilization.

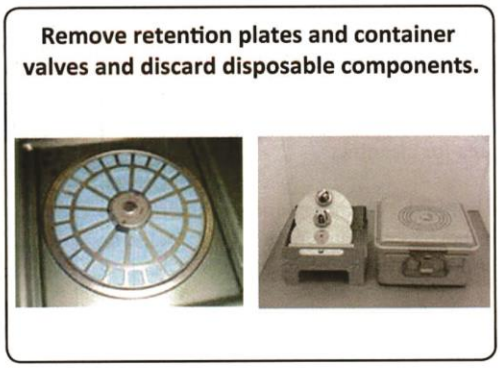


Figure 8.41

- Interior baskets should be removed from inside the container. Instruments may be mechanically cleaned inside the interior tray after manual preparation.
- Ensure the transport container or the case cart is completely empty, then clean per the manufacturer's IFU.

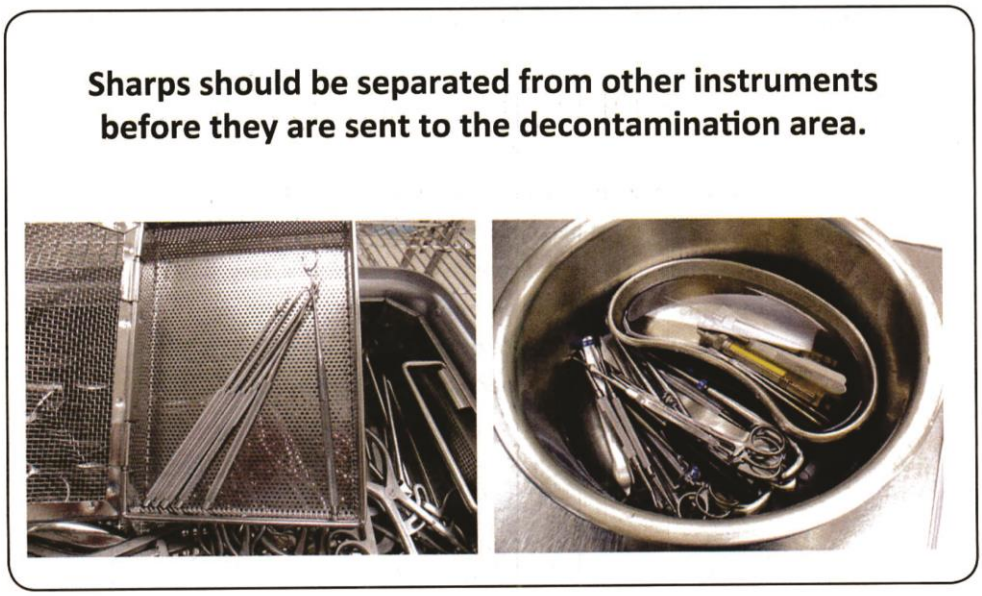


Figure 8.40

Cleaning

The cleaning of instruments and other medical devices is the primary function of the decontamination area. It is obvious that instruments should be cleaned after use; however, there are also other times when instruments should be cleaned. **Figure 8.42** lists some circumstances when instruments should be sent to the decontamination area for cleaning.

Thorough cleaning and adherence to IFU is important because failure of the cleaning process puts patients and staff at risk.

There are several types of cleaning methods:

- Precleaning (this process should occur at the point of use).
- Manual cleaning (also known as cleaning by hand).
- Mechanical cleaning (cleaning items using specialized cleaning equipment).

The method of cleaning selected should follow the device manufacturer's IFU.

Manual Cleaning

Manual cleaning is done to remove soil that was not removed, or was only softened during the precleaning process; this is achieved by the use of friction and appropriate cleaning chemicals.

Manual cleaning may be performed:

- Before the item is mechanically cleaned to ensure blood protein and other soil is removed.
- When the decontamination area does not have a mechanical method of cleaning.
- To clean items that cannot be immersed in water.
- For instruments with lumens.
- For delicate or complex medical devices, such as microsurgical and robotic instruments.

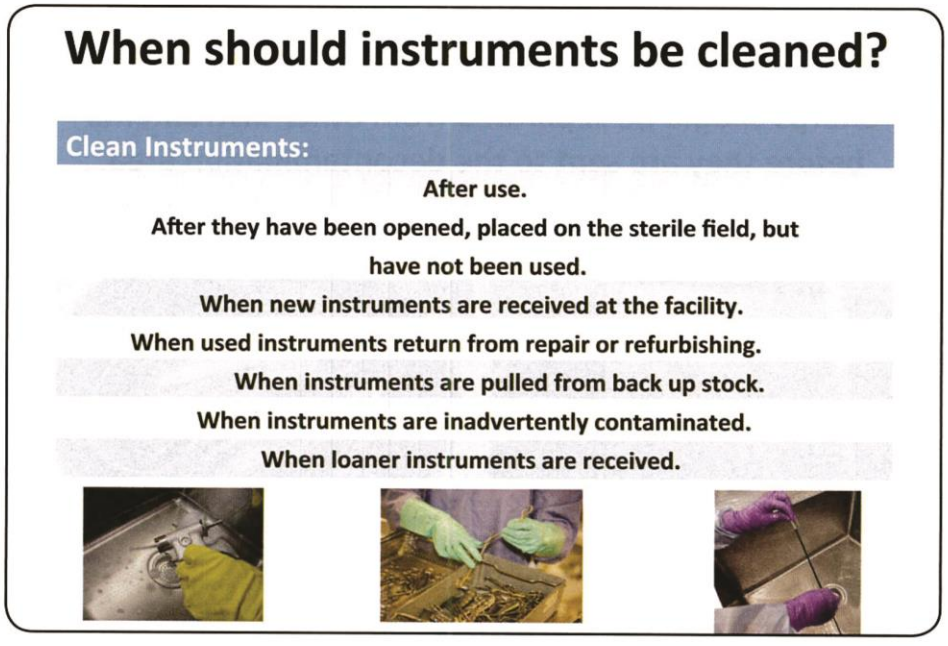


Figure 8.42

- For all items that require manual cleaning as part of their IFU.

Manual Preparation and Cleaning Processes

Set up the work area to accommodate the type of items to be cleaned. For example, for instruments that can be immersed, fill the sink with the appropriate cleaning solution. Place heavier instruments in the sink first, followed by lighter, more delicate items. Gently place the items into the sink. Do not pour them into the sink because instruments can damage easily.

The items should be placed in the sink in the following manner:

- Hinged instruments should be placed in the sink, fully opened.
- Multi-part instruments should be disassembled, following manufacturer's instructions, so all parts of the instrument can be exposed to the cleaning solution. (See **Figure 8.43**) Keep all parts near each other during the cleaning process.

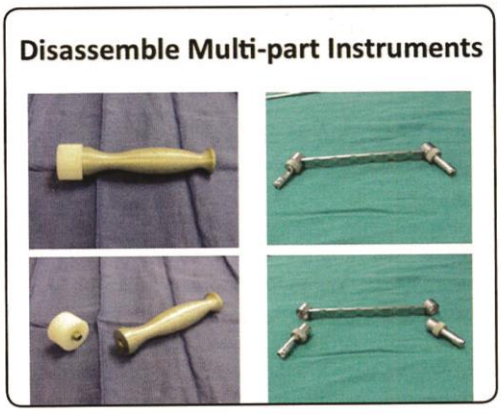


Figure 8.43

- Lumen/cannulated items should be fully submerged then flushed with cleaning solution; this will force the air bubbles out of the lumen and ensure all the inner surfaces are in contact with the cleaning solution. If available, placing lumened items in a vertical soaking cylinder also helps ensure air bubbles are not inside the lumens.

Ensure detergent can reach every part of the device being cleaned. If the detergent cannot reach every part of the instrument, the instrument cannot be thoroughly cleaned.

Items that cannot be immersed, like power equipment and many cables and cords, should be set aside to process separately. Many CS departments have a sink area designated for cleaning these non-immersable items. Cleaning procedures for these items will be discussed later in this chapter.

Carefully clean all instrument surfaces. Cleaning efforts must be focused and done consistently. Instruments should be brushed in a "to and fro" motion under the surface of the water. Brushing under the surface of the water prevents aerosolization. Aerosolization occurs when ultramicroscopic particles are released into the air. (See **Figure 8.44**) This is a concern because the cleaning solution contains contaminates from the instruments being cleaned. When cleaning, pay special attention to hinges and the tips of the instruments because these areas harbor the most soil. All serrated, toothed and crevice areas should be brushed to ensure the instrument is properly cleaned.

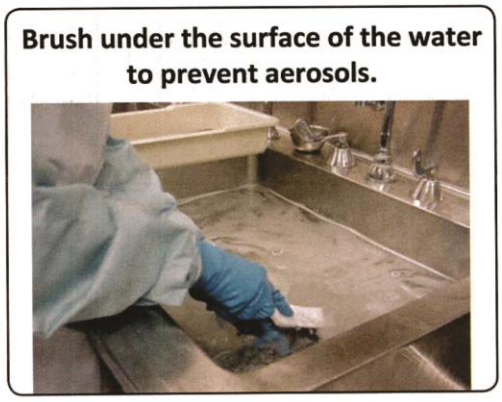


Figure 8.44

Lumened instruments (See **Figure 8.45**) should be carefully cleaned with a brush after soaking in the cleaning solution. Select a brush that fits into the lumen and touches all inner surfaces. (See **Figure 8.46**) With the lumened instrument under the surface of the water, gently push the brush through the lumen several times. Check the lumen for cleanliness by using a clean brush or an approved, non-linting pipe cleaner type product.

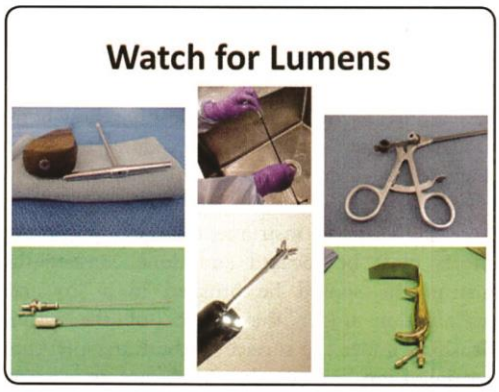


Figure 8.45

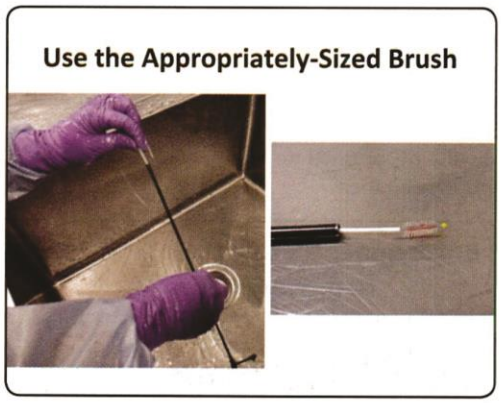


Figure 8.46

Because curettes, kerrisons, ronguers and other orthopedic instruments can conceal bone and other bioburden, removing material with bristle brushes should be an initial step in the cleaning process. Check all crevices carefully as blood and bone may be in other areas of the instrument besides the biting or cutting section. (See **Figure 8.47**)

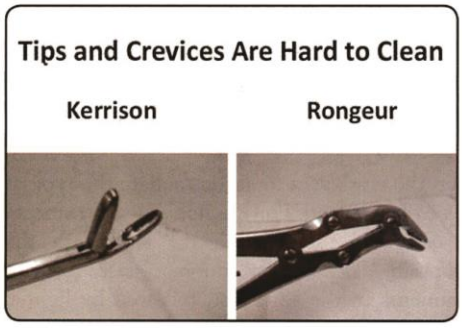


Figure 8.47

Instruments tagged for repair must still be cleaned and decontaminated. When instruments are returned from repair, they must be considered contaminated. (See **Figure 8.48**) They must be cleaned, decontaminated and inspected before being returned to their respective sets.

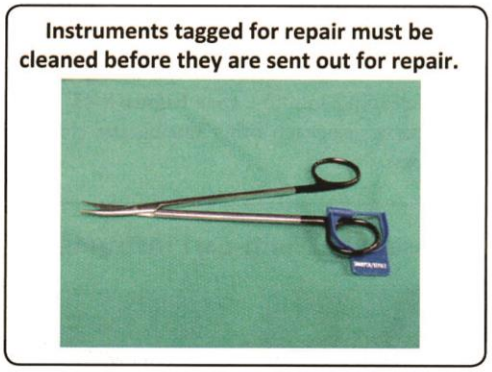


Figure 8.48

Delicate instruments are a cleaning challenge; they must be separated from regular or heavy instruments during cleaning. Devices used for delicate surgical procedures are generally lightweight, with fine points and tips. Mixing them with heavy instruments or placing heavy devices on top of them can cause damage and misalignment. Delicate instruments, such as skin hooks, can slip through perforated baskets and become entangled. Check the IFU to ensure the proper cleaning chemical is being used. Unless otherwise stated by the manufacturer, clean these instruments as one would other surgical instruments, but with more

care in handling. Always check the IFU to see if the instrument can be mechanically processed after manual cleaning. If processing in a washer-disinfector, a delicate cycle will probably need to be selected.

Ophthalmic instruments have special cleaning protocols because of the increasing incidents of **toxic anterior segment syndrome (TASS).** Manufacturer cleaning instructions must be carefully followed. It is recommended that facilities have sufficient instrumentation to allow adequate time for processing between patients.

Toxic anterior segment syndrome (TASS) Acute postoperative inflammatory reaction in which a noninfectious substance enters the anterior segment and induces toxic damage to the intraocular tissues.

TASS Precautions in the Decontamination Area

TASS occurs when contaminants enter the eye during eye surgery. Those contaminants can be the result of inadequate instrument processing. The risk of TASS can be reduced in the decontamination area by:

- Carefully following all manufacturer IFU for cleaning.
- Taking actions to prevent the formation of biofilm on instruments.
- Using only enzymes and detergents recommended by the manufacturer.
- Keeping cleaning tools, such as brushes and syringes, clean.
- Flushing lumens.
- Copious rinsing with the recommended rinse water.

Note: Be sure to follow the facility's specific protocols for processing eye instruments. Pay attention to detail and do not take shortcuts at any step in the process.

Figure 8.49

There are thousands of instruments on the market and cleaning each one requires specific knowledge. Instruments that are designed to perform the same function, but are made by different manufacturers, may need different cleaning processes. Consult the medical device manufacturer for special considerations, and to determine if these devices can withstand automated washers.

Orthopedic and neurologic surgery has many instrument sets that require extended preparation and inspection prior to and during cleaning. Joint replacement cutting guides, rasps, reamers and broaches hide gross amounts of blood, bone and tissue. (See **Figure 8.49**) This can occur even with the best point-of-use care in the OR, and these instruments must be cleaned with brushes and extensive hand detailing. Presoaking with enzymatic detergents can help remove much of the bioburden from the crevices. Some washer manufacturers have designed special washer racks to hold and flush out these devices.

Laparoscopic and robotic instrumentation can be difficult and time consuming to clean. The instrument manufacturers provide extensive cleaning instructions; these instructions must be carefully followed to ensure the instruments are clean. Always use properly-sized brushes in the lumened areas and carefully follow any flushing instructions provided by the manufacturer. For example, these instruments, especially robotic instruments, can be damaged if too much air and water pressure is used. Some types of mechanical cleaning equipment have special baskets, manifolds or connections to flush these items during mechanical cleaning. These items must still be manually cleaned and flushed, even when using a mechanical method.

Flexible and rigid endoscopes also pose special cleaning concerns. Endoscope cleaning and decontamination is discussed separately in Chapter 11.

New or repaired instruments received in the CS department must be cleaned prior to disinfection or sterilization. Although these instruments may look clean, their surfaces are covered in fine metal dust, oils and other debris from the manufacturing and repair processes. These instruments have also been handled and exposed to outside elements during shipping.

Instruments from back-up stock should be cleaned prior to use because they have been hanging on walls or stored in drawers for some time. These instruments could have been handled multiple times and most likely contain dust and other environmental contaminants. (See **Figure 8.50**)

Back up instruments contain dust and other contaminants from storage.

Figure 8.50

Cleaning Instruments That Cannot Be Immersed

Instruments such as power equipment and cameras cannot be immersed in water. The device manufacturer's IFU should be reviewed to ensure proper cleaning chemistries and cleaning methods are used.

Hoses and cords should be carefully wiped down using the approved solution and a clean, soft cloth. Special care should be taken at the ends of the hoses and cords because water will damage these items. Many of these types of instruments are a dark color, which makes it difficult to see dried blood, so meticulous attention must be paid to cleaning these items. (See **Figure 8.51**) Unless approved by the manufacturer, do not rinse these items under running water. Carefully check these items to ensure there are no nicks, breaks or tears in the outer cover. If any damage is noted, mark the item for repair prior to sending it to the assembly area.

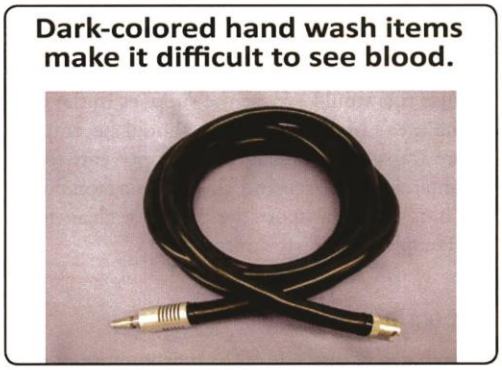


Figure 8.51

Power equipment presents challenges to CS technicians. These devices are powered by batteries, pneumatic air or electricity. Care should be taken to prevent exposure of the connection points and battery contacts to moisture or chemicals. These connection areas can react with chemicals and cause damage and loss of electrical contact with the power source. The use of a battery, hose or cable designated for the decontamination area will help keep these connections dry. (See **Figure 8.52**) *Note: Chapter 11 provides a more detailed discussion on cleaning power instrumentation.*

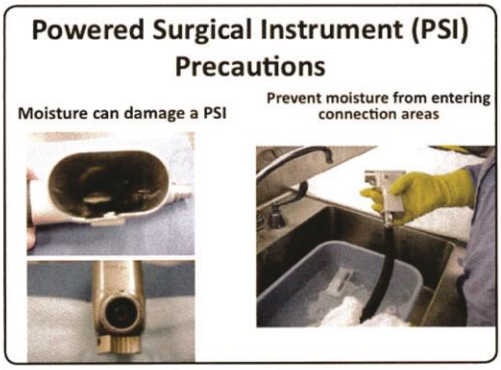


Figure 8.52

Cannulated drills may have their lumens cleaned with running tap water, if approved by the manufacturer, and they should be brushed with a soft brush. (See **Figure 8.53**) A plastic syringe filled with water and enzymatic detergent can assist in delivering cleaning agents to hard-to-reach areas. If the instrument cannot be cleaned under running water, use a clean soft cloth, appropriately-sized brushes, and syringes filled with cleaning and rinsing solutions.

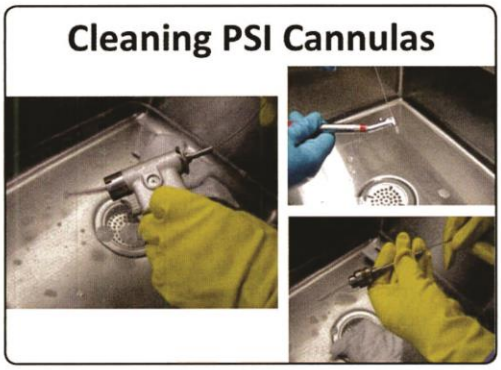


Figure 8.53

Orthopedic saws frequently have residual bone chips and impacted bioburden in their working parts. They must be flushed and brushed clean under running water, if approved by the manufacturer.

Power accessories, such as chucks, can usually be immersed in the cleaning solution; however, some may need to be hand processed without immersion. Drill and saw attachments usually need non-immersion cleaning; consult and follow the manufacturer's IFU for the proper cleaning method.

Cleaning Instrument Containers and Basins

Cleaning rigid instrument containers and basins requires procedures that differ from those used for instruments. A neutral-pH detergent is usually recommended because acidic or alkaline pH detergents will damage aluminum and some composite materials. If processing manually, carefully clean all surface areas while the item is immersed in the cleaning solution. Rinse with softened water, then with pure water. If cleaning these items mechanically, place on the appropriate rack or manifold. When cleaning containers, the filter retention plate should be removed and not

processed attached to the container or lid. Handles, locking mechanisms and container rims should be inspected for cracks and missing components. If basins are dented or bent, or if containers are damaged, mark them for repair or removal from service prior to sending them to the assembly area.

Mobile Patient Care Equipment

Mobile patient care equipment has different processing needs than surgical instrumentation. In general, the use of mild cleaning agents and disinfectants can be utilized to clean exterior components of patient care equipment. Use of an incorrect cleaning agent may affect product warranties and device functionality. Some chemicals may cause cosmetic changes in plastic and other materials.

Some devices have access doors and hatches that must be opened to clean intricate parts. (See **Figure 8.54**) Extreme care is needed to avoid damage to these critical parts. Soft materials and applicators may be used to clean these areas. Care must also be taken to thoroughly clean around switches and cords. It is important that the cleaning cloth is not overly wet (dripping), as water may damage the equipment.

CS technicians must clean many pieces of mobile equipment including isolation and special procedure carts. Carts must be cleaned after each use. Do not empty the inside drawers of these carts while they are in the decontamination area because this would expose the supplies in the carts to the area's bioburden. Carts should be emptied before transport. Transport the empty cart to the decontamination area and clean all surfaces inside and out. Then transport the cart to a clean room and complete the restocking tasks.

Inspection

CS technicians play one of the most important roles in the next step of the decontamination process: inspection. It is a crucial step in the process because this step helps ensure the safety of themselves, their co-workers and the patient. Each item cleaned must be carefully inspected for visible debris. If debris is found, then the item should be cleaned again according to the manufacturer's IFU.

Quality Testing

There are several devices available to inspect instruments for cleanliness; some examples were shared at the beginning of this chapter. (See **Figures 8.2, 8.3** and **8.4**) Another method commonly used to check instruments for cleanliness is a swabbing process where an item that has been cleaned is swabbed, and the swab is processed to determine if there was residual soil present. **Figure 8.55**

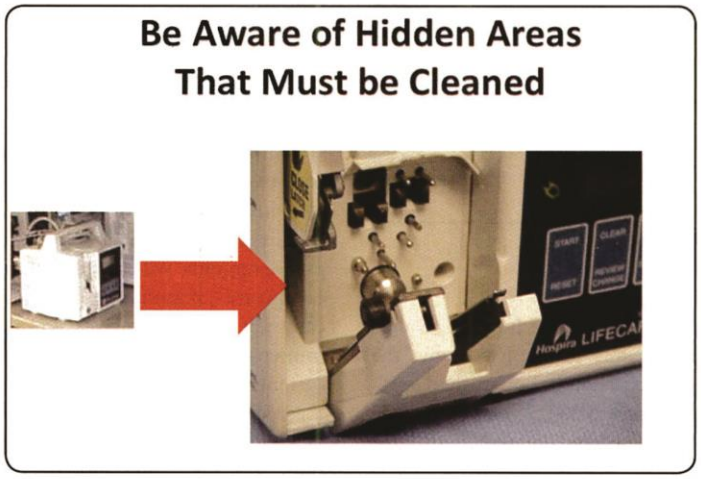


Figure 8.54

provides an example of this process.

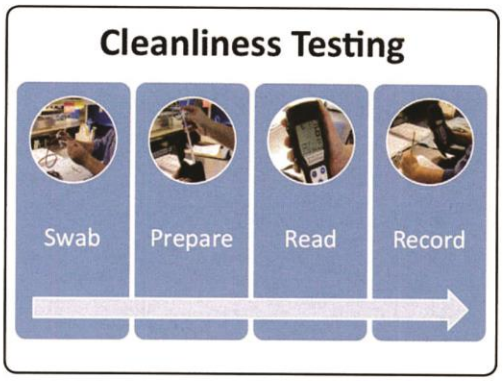


Figure 8.55

DECONTAMINATION

The decontamination process involves the use of physical or chemical procedures to remove, inactivate or destroy bloodborne pathogens on an item's surface. The purpose of decontamination is to make devices safe for people who are not wearing gloves and to reduce the bioburden to make the next processing steps easier. Some instruments are safe for handling after they have been thoroughly cleaned; however, others require exposure to a microbiocidal process. Thermal and chemical disinfection are discussed in detail in Chapter 9.

CONCLUSION

Cleaning is a complex, multi-step process. The success of disinfection and sterilization processes depends on a successful cleaning process. Central Service technicians must understand the cleaning process for each medical device, and perform it consistently to help ensure the safety of patients, visitors and healthcare personnel.

RESOURCES

Association for the Advancement of Medical Instrumentation. *ANSI/AAMI ST79:2010: & A1 2010: & A2 2011: & A3 2012: & A4, 2013. Comprehensive Guide to Steam Sterilization and Sterility Assurance in Health Care Facilities.*

Occupational Safety and Health Administration, *Regulations Standards CFR 1910.1030, Bloodborne Pathogens.*

Association of periOperative Registered Nurses. *Guidelines for PeriOperative Practice: Instrument Cleaning.* Guidelines for PeriOperative Practice. 2015.

International Association of Healthcare Central Service Materiel Management. *Central Service Leadership Manual,* Chapter 20. 2010.

CENTRAL SERVICE TERMS

Cleaning

Decontamination area

Relative humidity

Biohazardous waste

Deionized (DI) water

Distilled water

Reverse osmosis (RO)

Pyrogen

Cavitation

Impingement

Emulsifier

Surfactant

Chelating agents

Toxic anterior segment syndrome (TASS)

Chapter 9
Disinfection

Learning Objectives

As a result of successfully completing this chapter, readers will be able to:

1. Define the term disinfection and explain how disinfection differs from sterilization
2. Explain disinfection levels as identified in the Spaulding Classification System:
   - Low-level disinfection
   - Intermediate-level disinfection
   - High-level disinfection
3. Provide basic information about the types of disinfectants commonly used in healthcare facilities:
   - Quaternary ammonium compounds
   - Alcohol
   - Phenolics
   - Chlorine
   - Iodophors
   - Glutaraldehyde
   - Ortho-phthalaldehyde
   - Hydrogen peroxide
   - Peracetic acid
4. Identify good work practices for manual disinfection processes
5. Discuss automated equipment utilized for disinfection, and good work practices for working with automated disinfection processes
6. Explain disinfection quality assurance practices

INTRODUCTION

Once an item has been properly cleaned, there are some decisions to make. Is the item safe for its intended use or does it need further processing? If further processing is needed, what type of processing does it need and how can that be accomplished? (See **Figure 9.1**) Central Service (CS) technicians must be able to identify the type of **bactericidal** process needed (**sterilization** or **disinfection**), select the method that will provide that process, and perform that process effectively. (Sterilization processes are examined in later chapters.) This chapter will provide basic information on disinfectants and disinfecting processes that are frequently used in CS departments.

Figure 9.1

INTRODUCTION TO DISINFECTANTS

The Spaulding Classification System

The selection of a **disinfectant** must be based, in part, upon the intended use of the device and the degree of disinfection required for that device. The **Spaulding Classification System** divides patient care items into three categories, each based on the degree of risk of infection when the items are used in patient care. The Centers for Disease Control and Prevention (CDC) and the Association for the Advancement of Medical Instrumentation (AAMI) use the Spaulding Classification System in their guidelines and standards. (See **Figure 9.2**) The three Spaulding categories are:

- Critical items – Instruments or objects introduced directly into the bloodstream or into other sterile areas of the body; examples include surgical instruments, cardiac catheters and implants; these items must be **sterilized** before use (disinfection is inadequate).
- Semi-critical items – Although these items come in contact with intact mucous membranes, they do not ordinarily penetrate body surfaces. Examples include non-invasive flexible fiberoptic endoscopes, endotracheal tubes and anesthesia breathing circuits. Semi-critical items should be subjected to a **high-level disinfection** process that can be expected to destroy all microbial organisms, but not necessarily microbial spores.
- Non-critical items – These items usually come into direct contact with the patient's unbroken skin. Examples include crutches and countertops. These items require thorough cleaning, and in some cases, **low-level disinfection** to **intermediate-level disinfection.**

Spaulding's Classification System

Device Classification	Examples	Requires
Critical – Enters sterile tissue or vascular system.	• Implants • Surgical instruments • Needles	Sterilization
Semi-Critical – Touches mucous membranes, except dental.	• Flexible endoscopes • Laryngoscopes • Endotracheal tubes	High-level disinfection
Non-Critical – Touches intact skin.	• Thermometers • Hydrotherapy tanks	Intermediate-level disinfection
	• Stethoscopes • Tabletops • Bedpans	Low-level disinfection

Figure 9.2 Spaulding Classification System

Disinfection

Bactericidal Relating to the destruction of bacteria.

Sterilization The process by which all forms of microbial life, including bacteria, viruses, spores and fungi, are completely destroyed.

Disinfection The destruction of nearly all pathogenic microorganisms on an inanimate (non-living) surface.

Disinfectant A chemical that kills most pathogenic organisms, but does not kill all spores.

Spaulding Classification System A system developed by Dr. E. H. Spaulding that divides medical devices into categories based on the risk of infection involved with their use.

Sterile/Sterilization Completely devoid of all living microorganisms.

High-level disinfection The destruction of all vegetative microorganisms, mycobacterium, small or nonlipid viruses, medium or lipid viruses, fungal spores and some bacterial spores.

Low-level disinfection The destruction of vegetative forms of bacteria, some fungi and lipid viruses (but not bacterial spores).

Intermediate-level disinfection The destruction of viruses, mycobacteria, fungi and vegetative bacteria (but not bacterial spores).

There is no single disinfectant that will work for all situations. That is why every decontamination area has more than one disinfectant to choose from in the work area. CS technicians must be able to select the appropriate disinfectant for the job; to do so, a basic understanding of the different types of disinfectants is needed.

Understanding Chemicals

Central Service professionals work with a wide variety of chemicals every day.

While the disinfectants used in a healthcare facility may all be a type of disinfectant, they all work differently to perform different tasks.

CS technicians understand the different disinfectants they work with and know how to achieve desired results.

TYPES OF DISINFECTANTS

The term "disinfection" is a generic term that is used to describe a process. Within that process are products that perform at different levels. (See **Figure 9.3**)

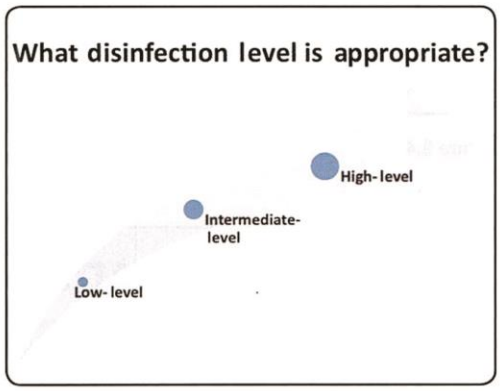


Figure 9.3

The following is a review of common disinfectants used in healthcare facilities and the level (type) of disinfection they are designed to provide.

Low-Level and Intermediate-Level Disinfectants

Items requiring low-level or intermediate-level disinfection only come in contact with intact skin. These items usually only touch the outside of the body (this includes items like crutches and countertops). These disinfectants may also be used on hard environmental surfaces and some mobile equipment. This group of disinfectants commonly includes quaternary ammonium compounds, alcohols, phenolics, chlorines and iodophors.

These low-level to intermediate-level disinfectants have one important thing in common: the germicidal action of each is reduced by the presence of **organic materials**. (See **Figure 9.4**)

Organic materials Compounds containing oxygen, carbon and hydrogen; derived from living organisms. Organic matter in the form of serum, blood, pus or fecal material can interfere with the activity of disinfectants.

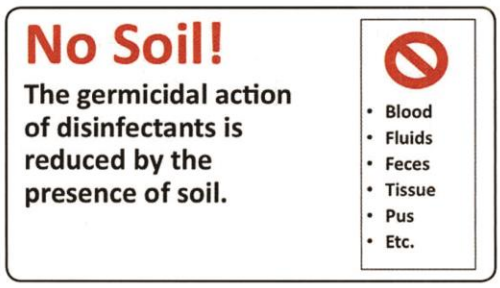


Figure 9.4

Quaternary Ammonium Compounds

Quaternary Ammonium Compounds (commonly called "quats") are low-level disinfectants. The most common chemical in most quats is benzalkonium chloride.

Quats are incompatible with soap. Soaps are not recommended for use in the CS decontamination process because of the residues they leave behind.

Some quats are absorbed by materials, such as cotton and filter paper. A quat that is absorbed by cotton should not be used with cotton towels, cloths or mop heads. It is important to consult the specific quat's Instructions for Use (IFU) to determine if cotton and/or paper can be used with them.

Figure 9.5 reviews basic information about quats.

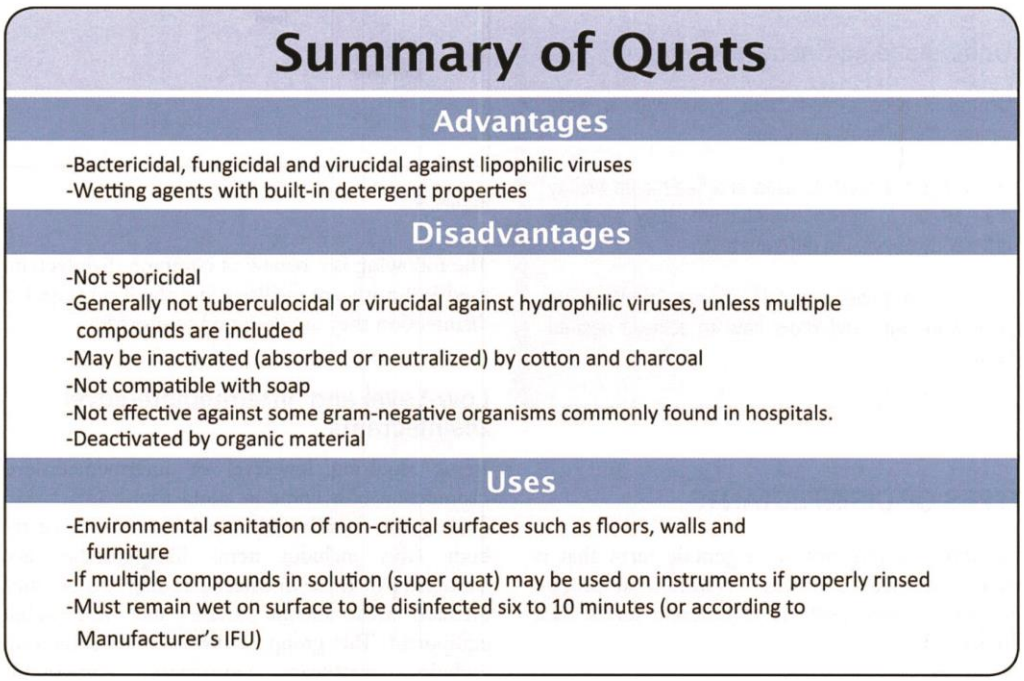


Figure 9.5

Summary of Ethyl or Isopropyl Alcohol

Advantages

- Rapid bactericidal agent against vegetative microorganisms; tuberculocidal, fungicidal and virucidal (ethyl isopropyl is not effective against hydrophilic viruses)
- Fast acting; no residue
- Nonstaining

Disadvantages

- Requires wet contact of at least five minutes to achieve a reasonable level of disinfection
- No residual activity
- Volatile; flammable
- Inactivated by organic material
- Can dissolve lens mountings on certain optical instruments
- Tends to harden and swell plastic tubing, including polyethylene
- Non-sporicidal

Uses

- To disinfect fixed equipment after cleaning and for patient-use items, such as ear specula, stethoscopes, etc.
- Can be used as a drying agent

Figure 9.6

Alcohol

Alcohol can be used as both an antiseptic and a disinfectant. Both ethyl and isopropyl (rubbing) alcohol have good disinfecting properties. One of the challenges when using alcohol as a disinfectant is that to achieve a reasonable level of disinfection, the alcohol must remain in wet contact with the surface of the object being disinfected for a minimum of five minutes. Alcohol evaporates quickly and maintaining wet contact for an extended period of time can be difficult.

Figure 9.6 reviews basic information about alcohol.

Antiseptic or Disinfectant?

Antiseptics are used on living tissue (skin); for example, receiving an alcohol prep before an annual flu shot. Disinfectants are used on inanimate objects; for example, disinfecting a piece of equipment between uses.

Phenolics

Phenolics are intermediate-level to low-level disinfectants containing phenol, which has a long history of use. During the 1800s, Dr. Joseph Lister used phenol to develop aseptic surgical techniques. Phenolic compounds have long been the agent of choice for housekeeping services because a residual phenolic film is left after use, and that film can be reactivated later by damp mopping; however, this same residual film can be a problem when left on medical devices. For example, irritation of sensitive skin can occur after exposure to phenolic residues. Like all disinfectants, for maximum disinfectant effectiveness, phenolics require a specific time for wet contact.

Figure 9.7 reviews basic information about phenolics.

Stainless steel instruments should not be subjected to strong phenolics for a prolonged period of time because phenolics can be corrosive. Some plastics also react poorly to phenolics. Follow the

Summary of Phenolic

Advantages

-Broad spectrum of use: bactericidal for gram-negative and gram-positive bacteria, fungicidal and tuberculocidal; active against lipophilic viruses
-Residual activity. *Note: This can also be a disadvantage*

Disadvantages

-Not sporicidal
-Inactivated by organic material (but less than some other disinfectants)
-Corrosive to some plastics

Uses

-Housekeeping usage for walls, floors, countertops and furnishings
-Phenolics are used in the decontamination area for disinfection of hard surfaces
-Copious rinsing is required to eliminate the potential for skin burns

Figure 9.7

Summary of Chlorine

Advantages

-Effective against gram-positive and gram-negative (vegetative) microorganisms; tuberculocidal, fungicidal and virucidal
-Fast acting

Disadvantages

-Inactivated by organic matter
-Corrosive to metals
-Non-sporicidal
-Stains fabrics, plastics and other synthetic materials
-Relatively unstable

Uses

-Widely used for disinfection of dialysis machines, hydrotherapy baths, toilets, lavatories and bathtubs; also used as a bleach for laundry and as a sanitizer for dishwashing
-A 1:10 dilution of 5.25% sodium hypochloride has been recommended by the CDC for cleaning blood spills
-Must remain wet on items to be disinfected one to two-and-a-half minutes (check specific manufacturer's IFU)

Figure 9.8

the device manufacturers' IFU for the types of materials that can withstand disinfection with phenolics.

Chlorine

Chlorine is an intermediate-level disinfectant that is commonly used for the treatment of water and sewage. Chlorine, a member of the halogen family may be found in CS departments as a hypochlorite solution, often recommended for biohazard clean-up procedures; however, chlorine is not considered a disinfectant of choice for CS due to its corrosive qualities. Metal instruments subjected to chlorine may have their finishes damaged by exposure to the chlorine solution.

Figure 9.8 reviews basic information about chlorine.

Iodophors

Iodophors are buffered iodines that are also members of the halogen family. Like alcohol, iodophors are used both as antiseptics and disinfectants. The best-known and most widely used iodophor is povidone-iodine. Iodophors can stain both skin and patient equipment. Iodophors should not be used on surgical instruments.

Figure 9.9 summarizes basic information about iodophors.

High-Level Disinfectants

High-level disinfectants (HLDs) are used to process semi-critical items that may come in contact with mucous membranes of the body. Items, such as flexible fiber optic endoscopes and laryngoscopes, require HLDs. There are several types of disinfectants in this category. Some can be used in a manual (soak) process, and others are used in mechanical processes. (See **Figure 9.10**)

Like their low-level and intermediate-level counterparts, HLDs are inactivated by organic materials; therefore, thorough cleaning is critical to successful outcomes. As with other disinfectants, CS technicians must understand the differences between the HLDs and how to use them effectively. The following section provides some basic information on HLD. As with all disinfectants, consult individual manufacturer's IFU before attempting to process items.

Summary of Iodophores

Advantages

-Bactericidal, virucidal and tuberculocidal
-Rapid action against vegetative bacteria

Disadvantages

-Corrosive to metals unless combined with anti-corrosive agents when formulated
-Detrimental to some plastics
-Stains fabrics and other materiel
-May require long contact time to kill some fungi

Uses

-Used in skin preparations
-Disinfection of some equipment
-The corrosive nature of iodine on metals and some plastics limits its use as a primary disinfectant in Central Service
-Must remain wet on items to be disinfected for at least two minutes (Check Manufacturer's IFU)

Figure 9.9

Figure 9.10

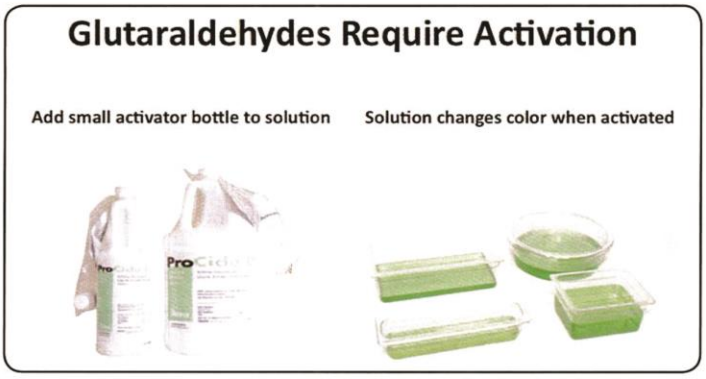


Figure 9.11

Glutaraldehyde

Glutaraldehyde is an HLD used for semi-critical devices, such as endoscopes and ultrasonic probes. Glutaraldehyde is compatible with materials used in many modern medical devices and can be used to process medical devices containing heat-sensitive materials. It kills microorganisms by **alkylation** of protein. Glutaraldehyde is usually a clear liquid that turns color when **activated** (See **Figure 9.11**) and it has a sharp, pungent odor. It is a strong irritant to the skin, eyes and respiratory system. Nitrile or butyl gloves and face/eye protection should be used when working with glutaraldehyde.

Following immersion in a glutaraldehyde solution, instructions for rinsing items should be carefully followed to ensure the chemical is completely removed. Care must be taken to ensure that the item is not recontaminated.

Glutaraldehyde should be used in a separate, designated area. Any room where glutaraldehyde is used should be well-ventilated with a minimum of 10 air exchanges per hour. When a dedicated area is not available, glutaraldehyde disinfection may be performed at an enclosed work station. These self-contained workstations manage air flow and reduce exposure to fumes. **Figure 9.12** shows some examples of these stations.

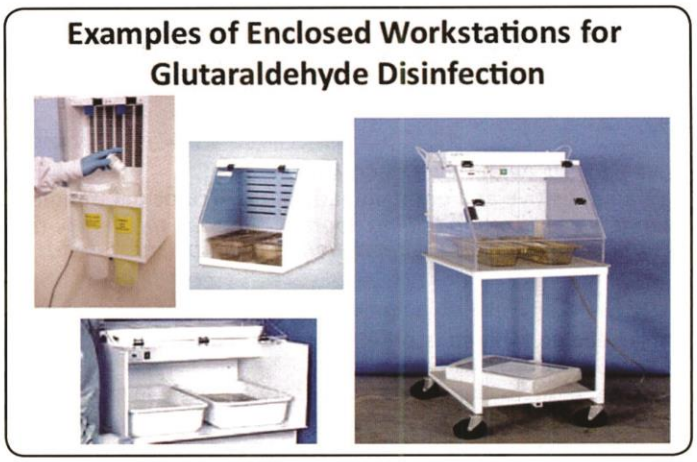


Figure 9.12

Unused glutaraldehyde solution should be stored in a cool, secure location and in tightly-closed, properly-marked containers labeled with the activation date.

Alkylation A chemical reaction where hydrogen is replaced with an alkyl group. This causes the cell to be unable to normally metabolize or reproduce, or both.

Activated (activation) Process by which a solution is combined with an activating chemical before use. Glutaraldehydes must be activated before initial use.

Glutaraldehyde-based products can be used in automated or manual HLD processes. Most glutaraldehyde-based instrument disinfectants are labeled for reuse for 14 to 28 days. During the recommended reuse period, the concentration of the glutaraldehyde in the solution should be tested with test strips recommended by the manufacturer. If the solution falls below its **minimum recommended concentration (MEC)** level it should be discarded, regardless of how many days the solution has been in use.

Glutaraldehyde vapors increase whenever the solution is agitated, such as when it is poured into or dumped out of a soaking bin. Exposure levels for CS technicians during disposal can be reduced by adding a glutaraldehyde-neutralizing agent to the solution prior to disposal. Consult state and local requirements and the manufacturer's IFU for proper disposal measures.

Minimum effective concentration (MEC) The percentage concentration of the active ingredient in a disinfectant or chemical sterilant that is the minimum concentration at which the chemical meets all its label claims for activity against specific microorganisms.

Figure 9.13 presents basic information about glutaraldehyde.

Ortho-Phthalaldehyde (OPA)

Ortho-phthalaldehyde (commonly called OPA) is an HLD that provides a fast and effective way to disinfect a wide range of instruments.

The OPA solution may be used and reused within the limitations indicated by the manufacturer for up to 14 or 28 days. The concentration of the OPA solution should be tested with test strips recommended by the manufacturer, before each use. If the solution falls below its MEC level, it should be discarded, regardless of how many days the solution has been in use.

Following immersion in OPA solution, instructions for rinsing items should be carefully followed to

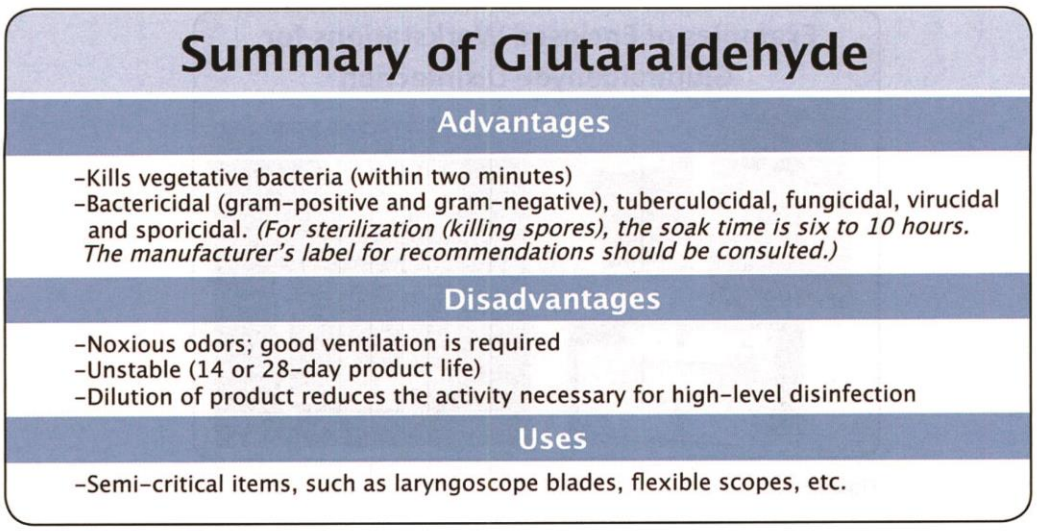


Figure 9.13 Glutaraldehyde

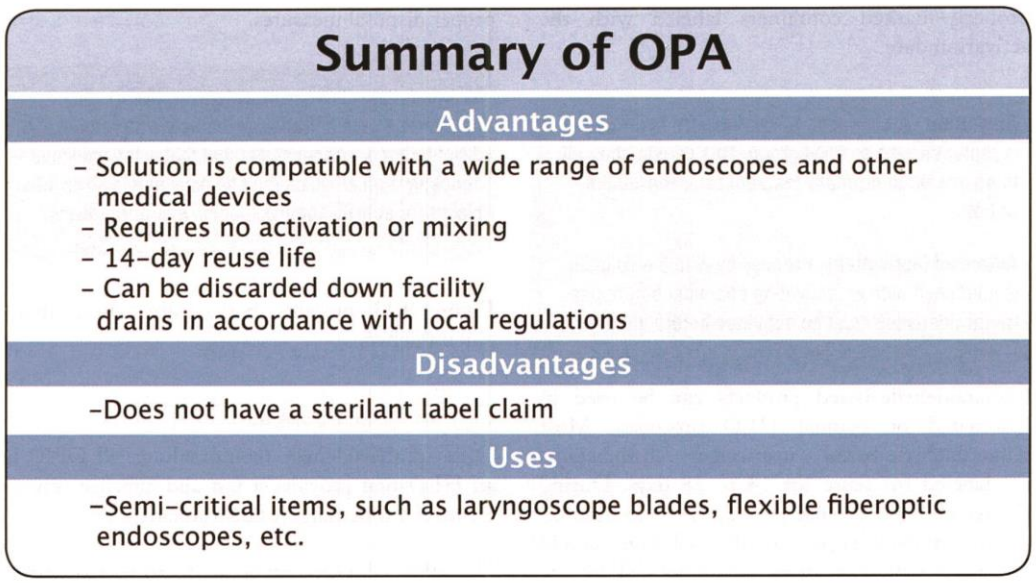


Figure 9.14

ensure the chemical is completely removed. Care must be taken to ensure that the item is not re-contaminated.

Figure 9.14 provides a summary of basic information about OPA.

Hydrogen Peroxide

Hydrogen peroxide is a broad-spectrum HLD that is available in different concentrations.

As with other HLDs, hydrogen peroxide dilution must be monitored by regularly testing the MEC.

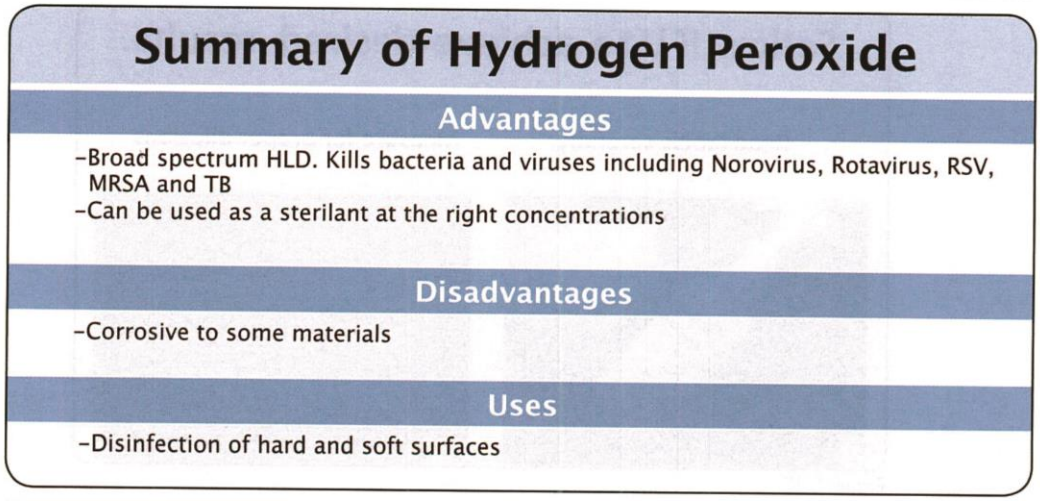


Figure 9.15

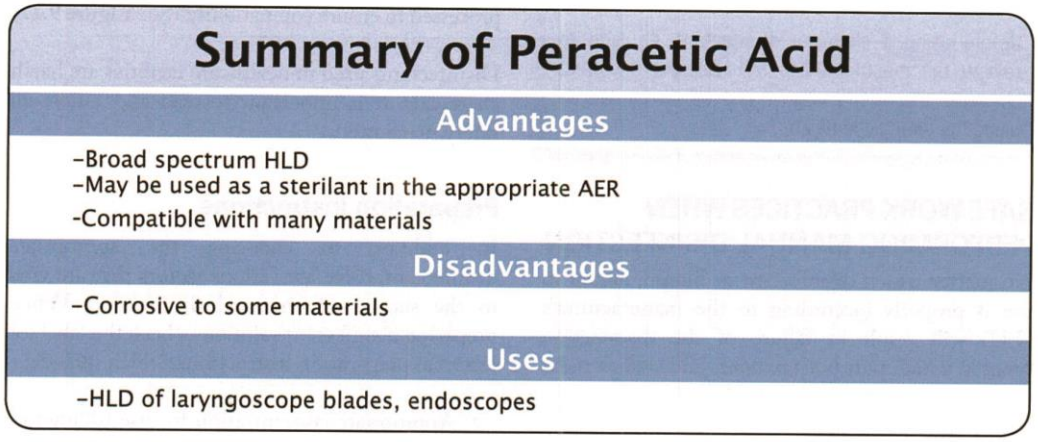


Figure 9.16

Follow the manufacturer's IFU for specific instructions.

Figure 9.15 provides a summary of basic information about hydrogen peroxide.

Peracetic Acid

This chemical achieves HLD in five minutes at room temperature. Some dilutions are designed to be used in a manufacturer-specific automated endoscope reprocessor (AER) as a sterilant only. Peracetic acid is compatible with many materials and can be used to disinfect laryngoscope blades and endoscopes; however, it is also known to be corrosive, so check with the device manufacturer to determine material compatibility. Follow the manufacturer's IFU for specific instructions.

Figure 9.16 provides a summary of basic information about peracetic acid.

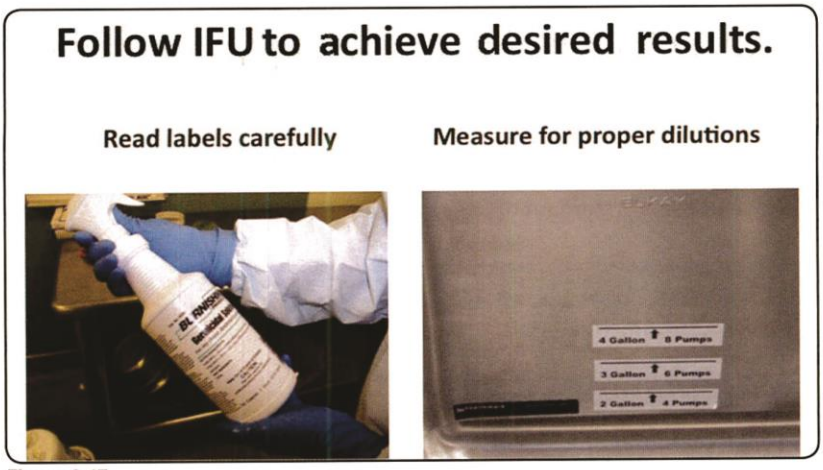


Figure 9.17

> **Caution!**
>
> Before using a chemical disinfectant, be sure to review the manufacturer's IFU. Using the correct chemical the wrong way is just as dangerous as using the wrong chemical.

SAFE WORK PRACTICES WHEN PERFORMING MANUAL DISINFECTION

No matter which disinfectant is chosen, failure to use it properly (according to the manufacturer's IFU) will result in failure of the disinfection process, which puts both patients and staff at risk.

Work Area Set Up

Disinfection processes should be performed only in designated areas separate from the area used for cleaning. The workflow should help ensure that the item(s) being processed are not recontaminated during or upon completion of the disinfection process.

Any accessories needed for the disinfection process, such as measuring devices, soaking bins and timers, should be collected prior to beginning the process.

Labels

Since chemical disinfectants have different capabilities, it is important to read the product labels to ensure they are used appropriately. Check the IFU of the disinfectant and medical device(s) to be processed to ensure compatibility. (See **Figure 9.17**)

Disinfectants used in healthcare facilities are harsh chemicals. It is important to read and follow all safety precautions.

Preparation Instructions

In addition to choosing the appropriate disinfectant, there are various factors that are vital to the success of chemical disinfection. When preparing disinfectant solutions, check the label for essential preparation instructions, which include:

- Appropriate concentration for use (diluted or full strength?).
- Dilution or mixing requirements.
- Correct temperature required for the disinfectant.
- Water quality and pH requirements.

> **Important Safety Note**
>
> While manufacturers may combine chemicals to create a more effective disinfectant, CS technicians should never mix chemicals on their own. Some common chemicals can be lethal when combined.

Contact

Disinfectants are not effective unless they make direct contact with all surfaces of the device. Improper cleaning will leave organic matter that prevents direct contact. Lack of contact through improper application or because soil remains on a device will result in a failed disinfection process.

Direct contact may also be impeded if items are not disassembled properly, or if they are only partially submerged in a disinfectant soak solution. When disinfecting a lumen, care must be taken to ensure there are no air bubbles in the lumen that prevent the disinfectant from coming in contact with all interior surfaces of the lumen. (See **Figure 9.18**)

Exposure Time

Exposure times vary by type of disinfectant. Many times, the term "wet contact" is stated in the IFU. This means the amount of time the device must remain wet with the disinfectant. Use a timer to ensure the proper exposure time is met.

What Is Wet Contact Time?

Wet contact time means that the item must remain wet with the disinfectant for the entire stated contact time. If the disinfectant evaporates or the item is allowed to dry before the total contact exposure time is met, the disinfectant must be reapplied and the exposure time must start over.

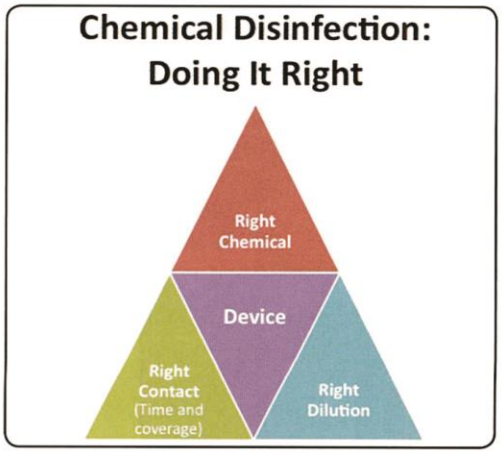


Figure 9.18

Rinsing

Disinfectants require a rinsing process. Pure water should be used to rinse disinfected instruments, with care being taken to thoroughly rinse all surfaces according to manufacturer instructions.

ACHIEVING DISINFECTION USING MECHANICAL PROCESSES

Sometimes disinfection is performed using a mechanical process. The most common mechanical process is the one carried out in washer-disinfectors. These automated washers provide a cleaning process followed by a **thermal disinfection** process. Thermal disinfection uses heat to reduce the amount of bacteria on items, such as surgical instruments and utensils. (See **Figure 9.19**) Water temperature is the key source of disinfection in any automatic washer that claims to provide thermal disinfection. The exposure time and temperature used to achieve thermal disinfection differs by brand of washer. Check the manufacturer's IFU and the washer operator's manual for specific information.

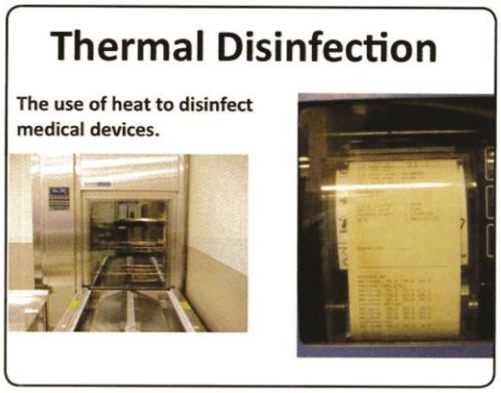


Figure 9.19

Thermal disinfection The use of heat to reduce the amount of microorganisms (excluding spores) on a medical device.

Pasteurizers

Pasteurization equipment provides disinfection at water temperatures of 150° to 170°F (65° to 77°C). The temperature is maintained for a minimum of 30 minutes of exposure to the instruments. Items must be able to withstand immersion in solution and be thoroughly cleaned prior to placing them in a pasteurizing unit. Water temperature and exposure time must be closely monitored. **Figure 9.20** is an example of a pasteurizer.

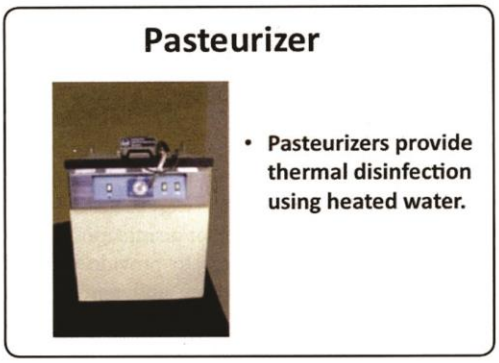


Figure 9.20

Automated Endoscope Reprocessor

The most recent addition to mechanical disinfectors are Automatic Endoscope Reprocessors (AER). These units make the process of disinfecting flexible fiber optic endoscopes simpler and safer.

AERs offer several advantages over manual processing. They reduce personnel exposure to the HLD disinfectant and its vapors. Their use may also increase quality assurance by providing consistent processes and documenting several cycle parameters.

Advantages of most AER include:

- Consistent exposure to the cleaning agent.
- Timed contact with the liquid chemical disinfectant.
- Continuous movement of the HLD.
- Alcohol flush cycle to facilitate drying.
- Use of an air flush cycle to remove excess moisture.
- Use of copious and consistent amounts of water.
- Monitoring of channels during processing.
- Documentation of the cycle parameters.

Endoscope design limitations create the need for some manual reprocessing steps. Refer to the AER's operating manual for information about limitations of automated cycles.

Figure 9.21

When using an AER:

- Follow the scope manufacturer's IFU for proper manual cleaning prior to placing the scope in an AER
- Follow the manufacturer's instructions to connect the endoscope to the AER.
- Place valves and other removable parts in the AER, if possible.
- Follow the manufacturer's IFU for the types of disinfectants and their proper use.
- Set the machine for the recommended cycle time.

QUALITY ASSURANCE PRACTICES FOR DISINFECTION

In addition to reading and following the manufacturer's IFU when performing disinfection processes, other quality assurance practices should be in place. Those practices should help ensure that disinfection processes are performed correctly, safely and according to product-specific requirements.

Education

All technicians who perform disinfection activities should be trained and should meet competencies for each disinfection process they perform. Each time a new product or process is introduced into the work area, training must be performed and competencies established.

Safety

Safety of patients and staff is of concern when performing disinfection processes. Improperly disinfected medical devices pose a risk to patients. The harsh chemicals (and sometimes fumes) associated with chemical disinfection can pose a safety risk to CS technicians, as well. It is important to understand the following recommendations for handling disinfectants:

- Personal protective equipment (PPE) requirements.
- Environmental (ventilation) requirements.
- Spill and leak procedures.
- Storage requirements.
- Disposal requirements.

QUALITY ASSURANCE TESTING FOR HIGH-LEVEL DISINFECTANTS

HLDs are much more complex chemicals than low- to intermediate-level disinfectants, and the items processed in these chemicals are used in semi-critical areas of the body. It is important to monitor these chemicals to assure they are performing as expected, and to document the results of that monitoring.

Minimum Effective Concentration Testing

In order to determine if the HLD can be reused, it is important to routinely test the solution with a chemical indicator. HLDs must be tested prior to each use and the results must be clearly documented. Chemical indicators are developed to be used for specific products. Be certain to use the correct indicator for the solution being tested. **Figure 9.22** provides an example of a chemical test strip. Follow specific manufacturer testing protocol and carefully document all MEC testing. **Figure 9.23** provides an example of an MEC testing log sheet.

Figure 9.22

Example of a High-Level Disinfectant MEC Testing Log Sheet

Location/Dept.	High-Level Disinfectant	Equipment
Warning: Do not use solution beyond its stated reuse life or below the designated MEC		

Date Solution Opened	Date Solution Expires	Date Test Strips Expire	Test Date	Test Time	Test Results + = Pass - = Fail	Tested By (Initials)	Comments

Figure 9.23

HLD LOG SHEET

Date/Time of Test	Pt. ID	Physician/ Procedure	Items processed (include serial numbers)	Technician who cleaned items	Technician performing HLD	HLD Solution	Expiration Date of HLD	Test strip quality test results	MEC Test Results	HLD Equipment Used (include lot number of	Verification of Rinsing (Tech initials if manually disinfected)	Comments

Figure 9.24

Documentation

In addition to documenting the MEC of the HLD, concise documentation must be kept to enable tracking of the disinfected items to the patient receiving the items. A manual or computerized record should be maintained when using HLD. Documentation should at least contain:

- Lot number of the HLD process, including AER or soak basin number.
- Items being disinfected, including quantities and device serial numbers, if applicable.
- Patient name or identifier.
- Physician's name and procedure.
- HLD solution information including activation or dilution date and the last date the solution may be used (unless MEC testing fails before that date).
- Exposure time and temperature, if manually soaking.
- Date and time of the process.
- Technician identification.
- MEC test strip results.

Figure 9.24 provides an example of a HLD log sheet. *Note: It is not always necessary to have both a MEC and a HLD log sheet. The documentation may be combined on a single document, as long as all required information is documented.*

CONCLUSION

Performing any successful disinfection process is much more difficult than it appears. Careful attention to detail from the initial cleaning process through the completion of the disinfection process is critical to achieve desired results.

Central Service technicians must select the appropriate disinfectant designed for the job they want to do, prepare the items properly and use the disinfectant as directed to ensure the safety of staff and patients.

The success or failure of any disinfection process depends on the knowledge of the CS technician and their attention to detail. (See **Figure 9.25**)

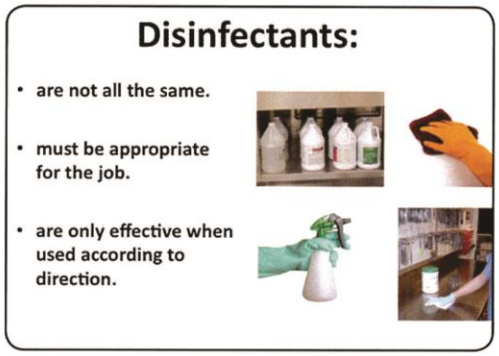


Figure 9.25

RESOURCES

Block S. *Disinfection, Sterilization and Preservation, 5th Ed.* 2001.

Society of Gastroenterology Nurses and Associates. *Guideline for Use of High-Level Disinfectants & Sterilants for Reprocessing Flexible Gastrointestinal Endoscopes.* 2013.

Centers for Disease Control and Prevention. *Guideline for Disinfection and Sterilization in Healthcare Facilities.* 2008.

Association for periOperative Registered Nurses. *Guidelines for PeriOperative Practice: High Level Disinfection.* Guidelines for PeriOperative Practice. 2015.

Association for the Advancement of Medical Instrumentation. *Chemical Sterilization and High-Level Disinfection in Health Care Facilities.* 2013.

CENTRAL SERVICE TERMS

Bactericidal

Sterilization

Disinfection

Disinfectant

Spaulding Classification System

Sterile/sterilized

High-level disinfection

Low-level disinfection

Intermediate-level disinfection

Organic materials

Alkylation

Activated (activation)

Minimum effective concentration (MEC)

Chapter 10

Surgical Instrumentation

Learning Objectives

As a result of successfully completing this chapter, readers will be able to:

1. Discuss the importance of surgical instruments and the role of the Central Service technician in instrument care and handling
2. Review basic steps in the surgical instrument manufacturing process
3. Define basic categories of surgical instruments based upon their functions and identify the points of inspection, anatomy and procedures to measure the following types of instruments:
   - Hemostatic forceps
   - Needle holders
   - Tissue forceps
   - Dressing forceps
   - Retractors
   - Scissors
   - Suction devices
   - Single- and double-action rongeurs
   - Kerrison/laminectomy rongeurs
   - Nail nippers
   - Graves and Pederson vaginal speculums
4. Identify solutions that can damage stainless steel instruments
5. Explain procedures to test instruments for sharpness and identify (mark) them
6. Emphasize the importance of instrument lubrication and review tray assembly safeguards

INTRODUCTION

Approximately 51.4 million inpatient procedures are performed in the U.S. each year. Procedures performed in ambulatory surgery centers and clinics significantly increase the total number of procedures performed in the U.S. Add in procedures from dental centers and other facilities, and it is easy to see that literally billions of surgical instruments are processed in the U.S. annually. Each of these devices has the potential to cause harm to a patient.

Central Service (CS) technicians are responsible for helping ensure that instruments needed for each procedure are safe, functional and available when needed. To reach this critical goal, it is essential that CS professionals can properly clean, decontaminate, package and sterilize instruments. It is also critical they understand how to identify, inspect and test these devices.

Beyond that, CS professionals must ensure that instrument sets and trays are complete and neatly organized to enable the end user to find instruments easily.

It is impossible for any technician to be able to identify every instrument in existence; however, skilled technicians can identify the vast majority of instruments in their facility's inventory. This chapter provides some background information about common instruments and instrumentation-related processes applicable to most facilities.

THE IMPORTANT ROLE OF INSTRUMENT SELECTION AND INSPECTION

Although many instruments may appear similar, they may have very different functions. Each one is designed to perform in a specific situation. Placing the wrong instrument into a set can cause serious problems during a surgical procedure. Many instruments come in various sizes. Placing the wrong size instrument in a set may have the same effect as placing the wrong instrument in the set.

While identifying and selecting the correct instrument for each set is crucial, knowing how to inspect the instrument is just as important. Placing dull scissors or forceps with a missing tooth into a set for example, can cause delays in the procedure and may also harm the patient. Loose or damaged parts can fall off into a patient during a procedure, potentially causing injury to the patient.

Inspecting devices for cleanliness is also important. Instruments may appear clean on the outside, but careful inspection of the entire instrument may show that it was not properly cleaned. Instrument assembly is another vital role of the CS technician. When an instrument tray or set is completed by the CS technician, it will not be checked again until it reaches the point of use. At that point, errors—such as defective or missing instruments—can cause serious problems. (See **Figure 10.1**)

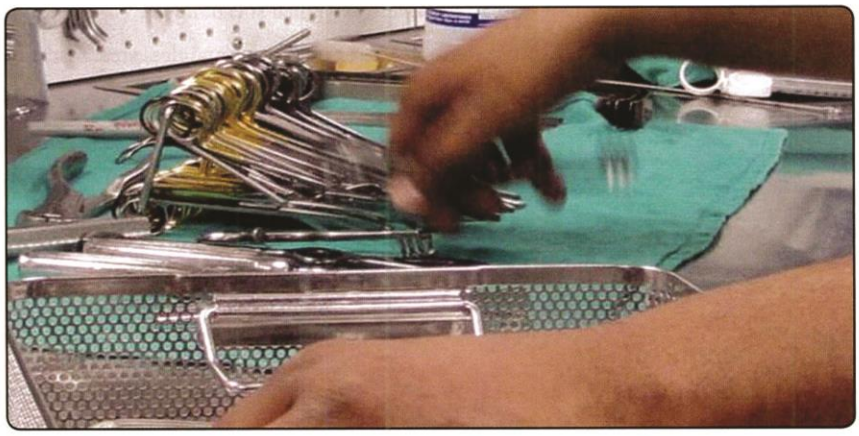


Figure 10.1 Proper instrument set assembly is critical for positive outcomes.

Some Basic Questions

CS technicians usually have some common questions when they begin to learn about surgical instrumentation. Knowing the answers to those questions can help establish a good starting point for instrument care and handling. Some key questions may include the following:

Where do instruments come from?

Physicians identify the specific instruments needed to perform various procedures. Most instruments are purchased by the healthcare facility and maintained by CS. Some instruments are sent to the facility on loan for a specific surgery and must be returned to the vendor after use. *Note: Loaner instrumentation will be discussed in Chapter 11.*

Why must all instrument requirements be so exacting?

The human body is very complex. Surgeons need exactly the right instrument in order to perform specific functions. Devices that appear similar can be used for very different procedures/purposes.

Where do the instruments get their names?

As discussed in Chapter 3, many instruments get their names from the part of the anatomy where they were designed to be used. Instruments are sometimes named after the surgeon who invented them. The Bookwalter retractor, for example, is named after its inventor, Dr. John Bookwalter. Other common examples of instruments named after surgeons include Debakey and Mayo.

Why are instruments so expensive?

Surgical instruments are precision tools. Manufacturing surgical instruments is very labor-intensive process. Most instruments are made using a combination of machine and hand labor. Fine details, such as sharpening, inspection and other steps, are performed by hand. The combination of materials used and labor costs make instruments expensive.

In this era of high technology, CS technicians may imagine that instruments are stamped out on a high-speed assembly line, packaged and then shipped to the customer; however, this is not the case. The manufacturing process requires time-consuming and hands-on labor from highly-skilled professionals.

INSTRUMENT MANUFACTURING PROCESS

The manufacturing process begins with the selection of the materials used to construct the instruments.

Stainless Steel

The study of the surgical instrument manufacturing process begins by considering the raw materials used to create them. Most are produced from **stainless steel**; however, other materials like materials, such as titanium, copper and silver, are also widely used.

Stainless steel can, in fact, stain, spot and rust; therefore, more appropriate name is "stain-resistant." Proper care will ensure that a stainless instrument performs as it should and lasts a long time.

Several types of stainless steel are used to produce surgical instruments. One type (400 series stainless steel) is hard, and used when sharp cutting edges are needed. Instruments produced with 400 series steel include **scissors**, **osteotomes**, **chisels**, **rongeurs**, **forceps**, **hemostatic forceps** and **needle holders**. This hardened steel is known as **martensitic** stainless steel.

The second most popular steel used to manufacture surgical instruments is 300 series stainless steel. While it offers high corrosion resistance, this material doesn't provide the hardness properties of its 400 series counterpart; therefore, it is more workable and malleable. Instruments produced with 300 series stainless steel include **retractors**, **cannulas**, **rib spreaders** and **suction devices**. This softer type of steel is called **austenitic** stainless steel.

Stainless steel An alloy of steel with chromium and sometimes another element, such as nickel or molybdenum, that is highly resistant to rusting and ordinary corrosion.

Scissors Surgical instruments used to cut, incise and/or dissect tissue.

Osteotomes Chisel-like instruments used to cut or shave bone.

Chisels Wedge-shaped instruments used to cut or shape bone.

Rongeurs Surgical instruments used to cut or bite away at bone and tissue.

Forceps Instruments used for grasping, holding firmly or exerting traction upon objects.

Hemostatic forceps Surgical instruments used to control the flow of blood.

Needle holders Surgical instruments designed to drive suture needles to close or rejoin a wound or surgical site. Also known as needle drivers.

Martensitic (stainless steel) This metal is also known as 400 series stainless steel. It is magnetic and may be heat-hardened.

Retractors Surgical instruments primarily used to move tissues and organs to keep the surgical site exposed throughout surgery.

Cannulas Surgical instruments with a hollow barrel (or lumen) through their center. Cannulas are often inserted for drainage.

Rib spreaders A retractor used to expose the chest.

Suction devices Surgical instruments used to extract blood and other fluids from a surgical site.

Austenitic (stainless steel) This metal is also known as 300 series stainless steel. It is non-magnetic, cannot be heat-hardened and is more corrosion-resistant than martensitic stainless steel.

Manufacturing Steps

The next step in manufacturing a surgical instrument is forging the material to create a stamp of its rough outline from a heated bar of stainless steel. (See **Figure 10.2**) The heating and cooling process used to create an instrument is very important because good forging produces good instruments. Most high-quality forgings come from mills in Germany, but forgings also come from Japan, Pakistan, Malaysia, France and Sweden. After the forging is completed, the instrument must be ground and milled first, and have the excess steel removed. Some instruments require more than 20 milling operations to create the male and female halves and the cutting of **serrations** and **ratchets**.

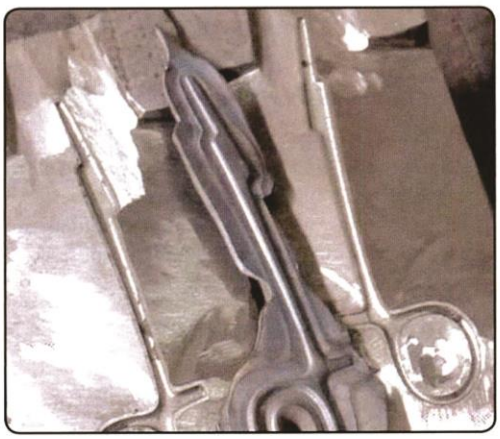


Figure 10.2

In today's instrument manufacturing environment, there is more reliance on machines than in years past. Despite technical advances, however, there is still a significant amount of the milling process that must be done by hand. Instrument manufacturers perform hundreds of quality checks and finishing applications to every instrument during the manufacturing process to ensure quality.

Upon completion of the assembly process, instruments undergo a final heating procedure, called tempering.

After tempering, the instruments are polished. Polishing is necessary to achieve a smooth finish, which ultimately determines the final appearance

or finish of the instrument. Surgical instruments can be shiny (mirror finish), or they can have a matte or satin finish (gray-colored surface that does not reflect light). (See **Figure 10.3)** Both finishes are widely accepted and create a smooth surface; however, the mirror finish is smoother, it tends to stain less frequently.

Figure 10.3

Next, the passivation layer is applied. **Passivation** uses nitric acid (HNO_3) to remove all the iron content still found on the outside layer of the instrument. The removal of this iron helps build a protective outside layer of chromium oxide (Cr_2O_3). This layer is highly resistant to corrosion and continues to build up throughout the instrument's life. The passivation layer may become damaged when the instrument is abused by using abrasive cleaners, saline and chemicals not approved for use by the manufacturer.

Serrations Parallel grooves in the jaws of surgical instruments.

Ratchet The part of a surgical instrument that "locks" the handles in place.

The instrument is now ready for final inspection and it will be carefully examined. Ratchets, tips, scissor blades, serrations, **box locks** and spot welds will be tested. Finally, the instrument is ready to be etched with the company name and catalog number. Acid chemical, stamping and lasers are some methods used for this process.

Box locks Point where the two jaws or blades of an instrument connect and pivot.

Passivation A chemical process applied during the instrument manufacturing process that provides a corrosion-resistant finish by forming a thin, transparent oxide film.

As you have read, the surgical instrument manufacturing process is lengthy and detailed, and requires a significant amount of experience, skill and craftsmanship. A typical manufacturing cycle—from forging to finished instrument—usually takes up to six weeks.

CLASSIFICATION AND OVERVIEW OF SURGICAL INSTRUMENTS

Surgical instruments are designed for a specific surgical purpose. Injury to the patient and destruction of or damage to the instrument can occur when the incorrect instrument is used. For example, one might incorrectly pull a pin using a needle holder instead of a pin puller or a pair of pliers, and this can damage the needle holder.

To properly inspect and test surgical instruments, CS technicians must know the anatomy and points of inspection of the devices, and how to measure them. This will enable them to properly and efficiently assemble instrument sets.

Many of the most common categories of surgical instruments will be discussed in this section.

Hemostatic Forceps

The primary function of hemostatic forceps is to control the flow of blood. **Figure 10.4** identifies the anatomy and points of inspection of a hemostatic forceps. **Figure 10.5** shows the correct way to measure this instrument.

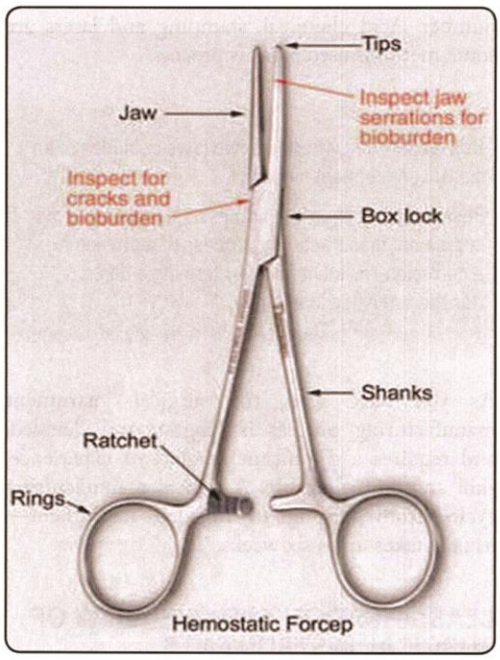


Figure 10.4

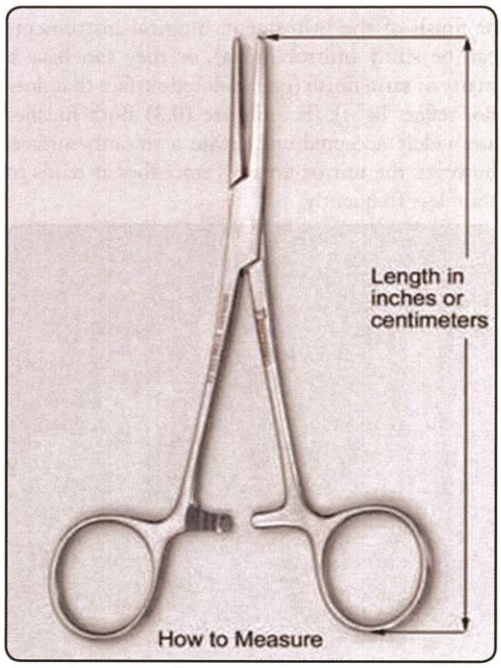


Figure 10.5

Identification of Hemostatic Forceps

Length		Jaw Pattern	Name
3½ inches	8.9cm	Full serrations	Hartman Mosquito (see Figure 10.7)
5 inches	12.7cm	Full serrations	Halstead Mosquito (see Figure 10.7)
5½ inches	14.0cm	Full serrations	Crile Hemostat (see Figure 10.8)
5½ inches	14.0cm	Partial serrations	Kelly Hemostat (see Figure 10.8)
6¼ inches	15.8cm	Full serrations	Rochester Pean
6¼ inches	15.8cm	Full serrations with 1x2 teeth	Rochester Ochsner or Kocher
6¼ inches	15.8cm	Longitudinal serrations and cross-serrated tip	Rochester Carmalt

Figure 10.6

Figure 10.6 provides basic information that can help CS technicians identify several types of hemostatic forceps.

Figure 10.7 identifies two common hemostatic forceps: the Hartman Mosquito 3½" and the Halsted Mosquito 5".

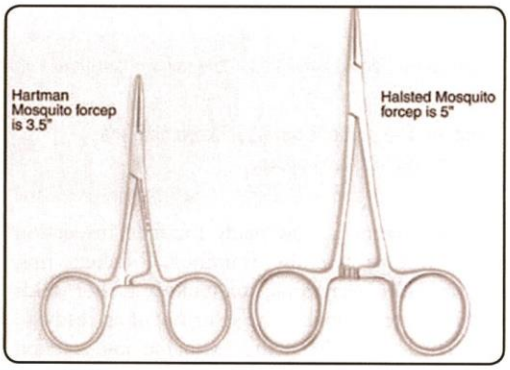


Figure 10.7

Jaw features can consist of full serrations (Crile hemostat) or partial serrations (Kelly hemostat). *Note: These two types of forceps are shown in* ***Figure 10.8***. Hemostatic forceps can also have longitudinal serrations (Rochester Carmalt) and serrations with 1x2 teeth (Kocher forceps).

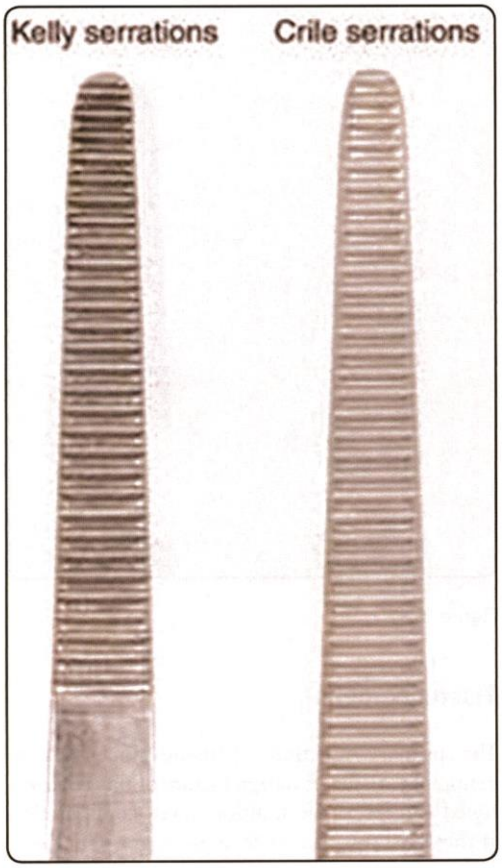


Figure 10.8

Needle holders

These instruments are designed to drive suture needles to close surgical sites. **Figure 10.9** identifies the anatomy and points of inspection of a needle holder, and **Figure 10.10** shows the correct way to measure this instrument.

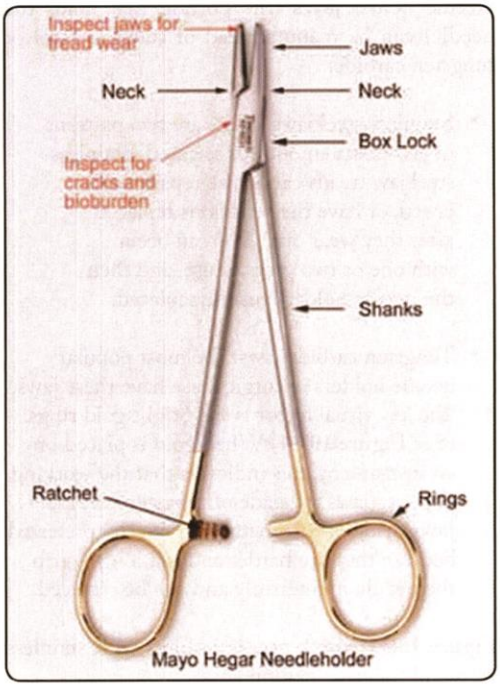


Figure 10.9

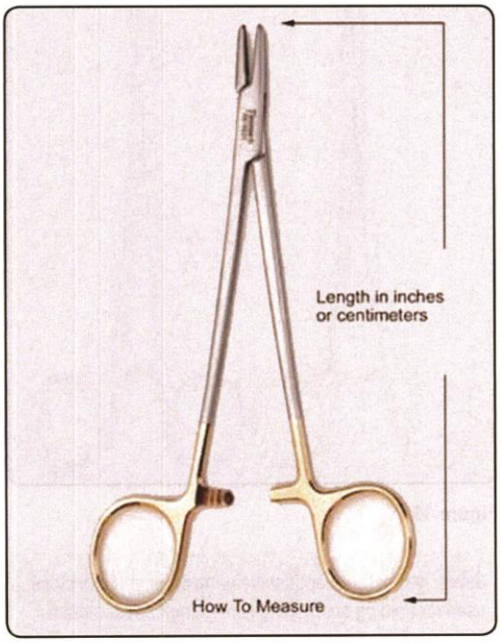


Figure 10.10

Needle holder **jaws** (the portion that holds the needle) can be manufactured of stainless steel or tungsten carbide:

- Stainless steel jaws. There are two patterns of jaw tread: smooth or serrated. Stainless steel jaw treads cannot be repaired, re-jawed, or have the serrations replaced after they wear out. This can occur with one or two years of use, and then the needle holder must be replaced.

- Tungsten carbide jaws. The most popular needle holders in surgical use have these jaws. The key visual factor is the bright gold rings. (See **Figure 10.11**) When gold is placed on an instrument, this indicates that the working portion (jaws) is made of tungsten carbide. Jaws made of this metal are typically preferred because they are harder and last longer, grip the needle more firmly and can be replaced.

Figure 10.11 shows needle holders with stainless steel and tungsten carbon jaws.

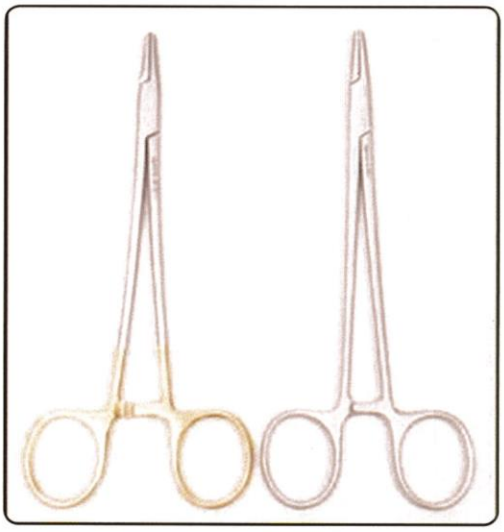


Figure 10.11

Jaws Two or more opposable parts that open and close; used for holding or crushing something between them.

Other names for needle holders are needledrivers, diamond jaws and gold handles. The two most common needle holder designs are Mayo-Hegar and Crile-Wood, and they are shown in **Figure 10.12** *Note: The Crile-Wood is narrower than the Mayo-Hegar design.*

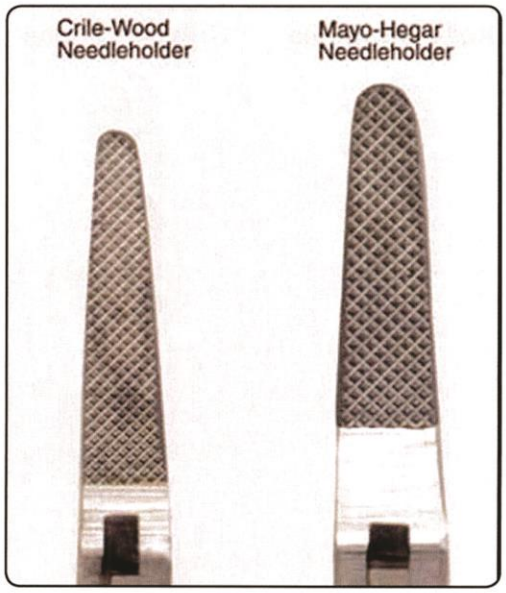
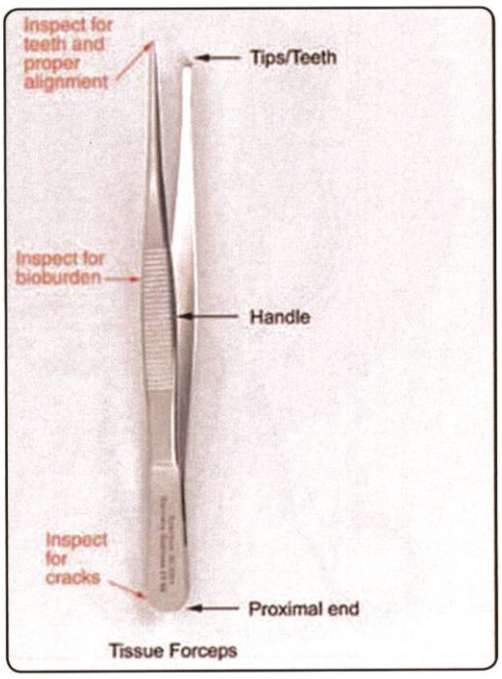


Figure 10.12

Tissue Forceps

The primary function of tissue forceps is to manipulate tissue. A design feature of this tweezer-styled forceps is the multiple-teeth configuration at the distal tips. The teeth assist in grasping tissue and provide a more secure grip. **Figure 10.13** identifies the anatomy and points of inspection of a tissue forceps. **Figure 10.14** shows the correct way to measure this instrument.

The most common teeth configurations for tissue forceps are one tooth on one side and two teeth on the other. With this design the teeth interlock one another, and the teeth configuration is indicated by 1x2. Other common teeth configurations are 2x3, 3x4, 5x6, 9x9, and 1x2 with serrations. Other names for tissue forceps are rat tooth, brown forceps and pickups.



Figures 10.13

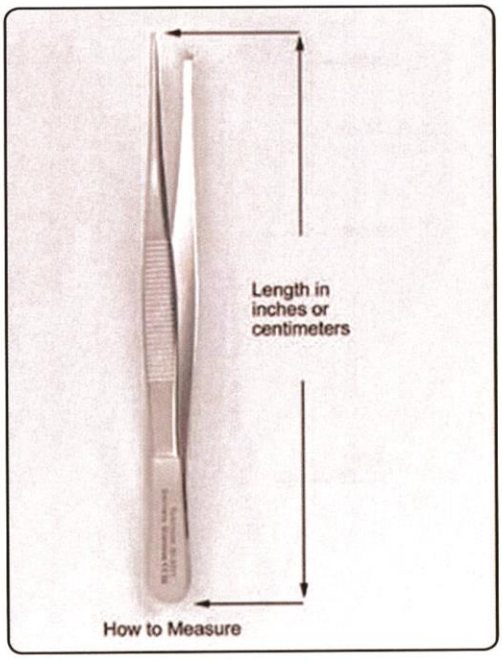


Figure 10.14

Dressing Forceps

Dressing forceps are similar to tissue forceps, except they have serrations instead of teeth at the distal end. The primary function of this instrument is to manipulate tissue and pack surgical sites. **Figure 10.15** shows the anatomy of a dressing forceps and points of inspection. **Figure 10.16** shows the correct way to measure this instrument. Other names for dressing forceps are smooth forceps and plain forceps.

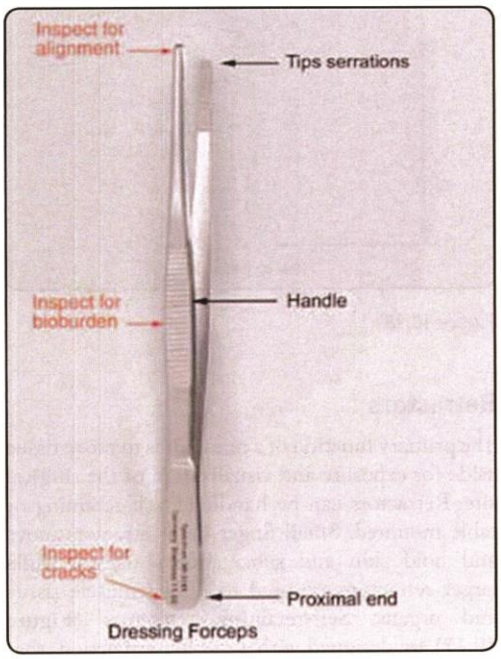


Figure 10.15

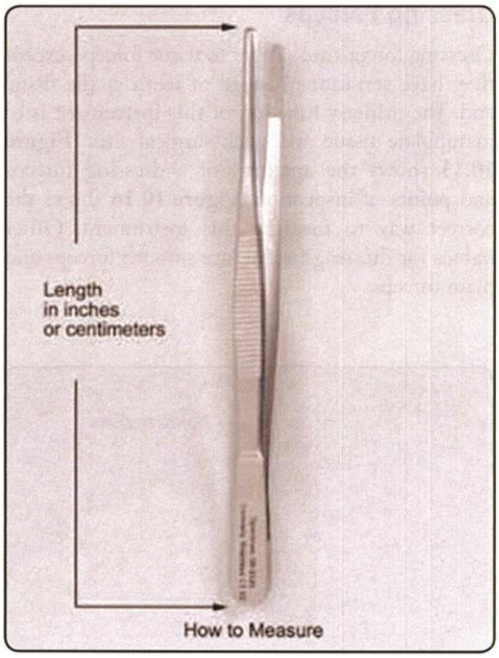


Figure 10.16

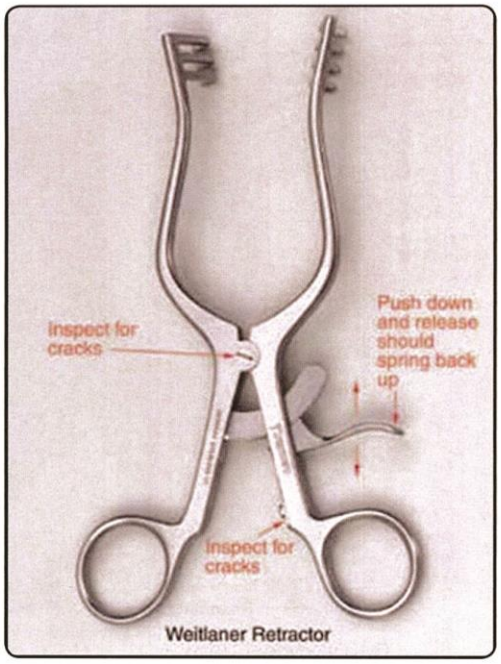


Figure 10.17

Retractors

The primary function of a retractor is to move tissue aside for exposure and visualization of the surgical site. Retractors can be handheld, self retaining or table mounted. Small finger-held retractors move and hold skin and subcutaneous tissues, while larger retractors are used to retract muscle tissue and organs. Self-retaining retractors (**Figure 10.17**) are designed with a mechanical action that keeps them open to retract. To test a self-retaining retractor, simply push down on retractor lever and let it go. If the lever springs up, the instrument is working properly. If the lever remains in the down position, remove it from the instrument set and send the instrument to the repair vendor. Some common self retaining retractors are Weitlaner, Gelpi and Beckman-Adson.

Figure 10.18 shows the points of inspection of a loop handle retractor. **Figure 10.19** shows the correct way to measure a hollow handle retractor.

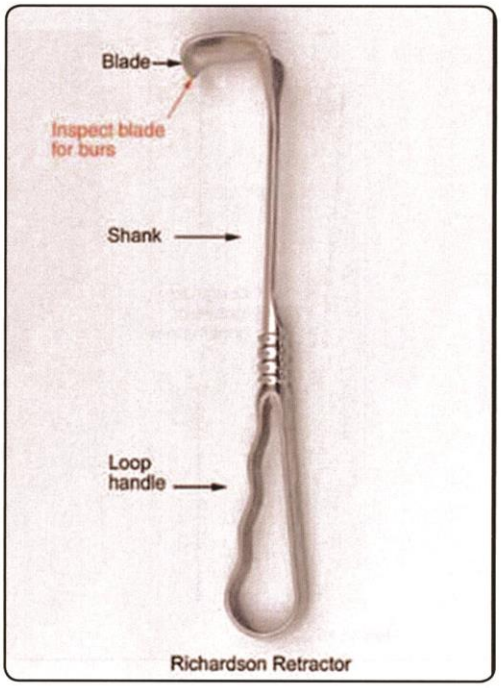


Figure 10.18

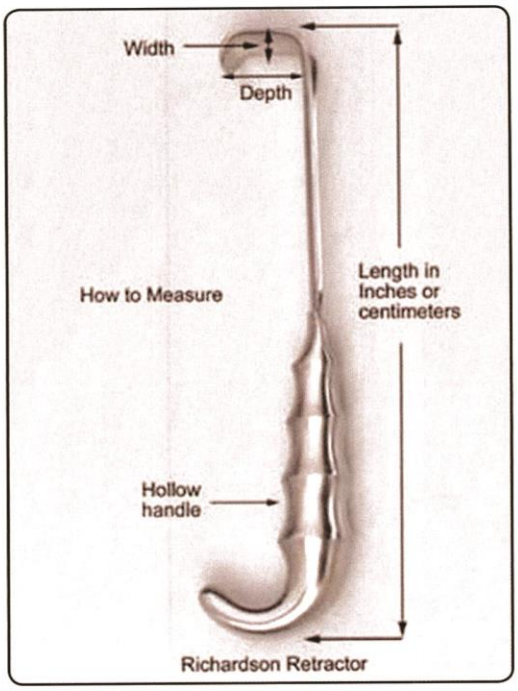


Figure 10.19

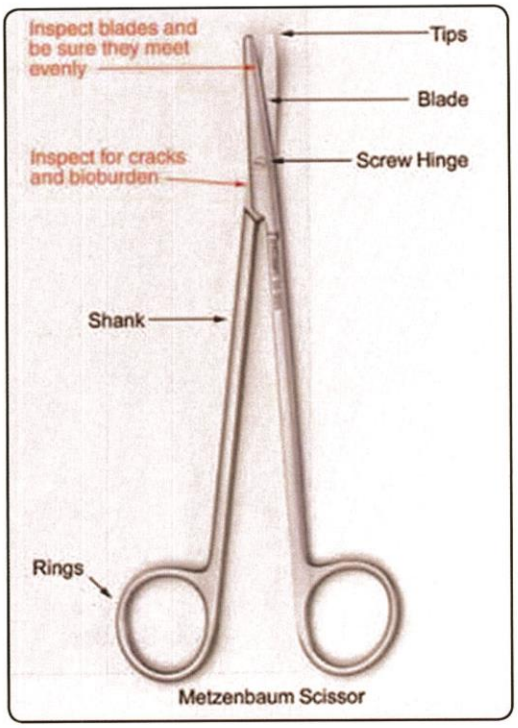


Figure 10.20

Scissors

The primary function of scissors is to cut tissue, suture and other material in the surgical field. For **dissection**, curved scissors are primarily used because their curve allows for better visualization. The opening action of the scissors also helps to dissect and spread tissue. **Figure 10.20** shows the anatomy and points of inspection for scissors. **Figure 10.21** shows the correct way to measure this instrument.

Dissection The process of cutting apart or separating tissue.

Mayo scissors are one of the most popular scissors used and are identified by beveled blades. The second most popular Mayo design is the Mayo Noble. As seen in **Figure 10.22**, it does not have a beveled blade.

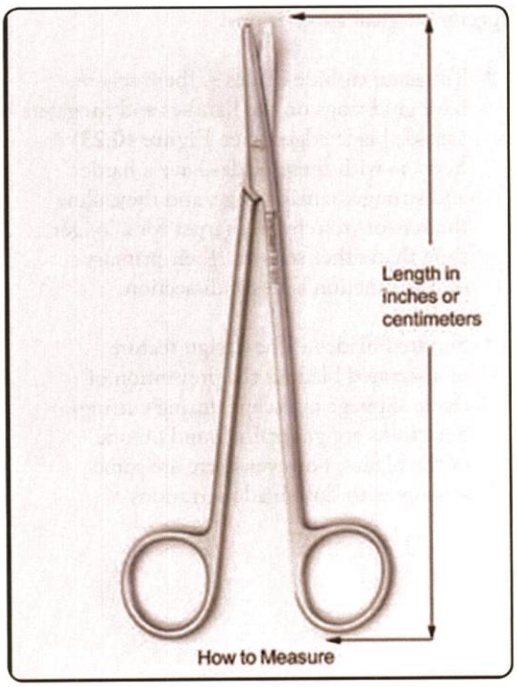


Figure 10.21

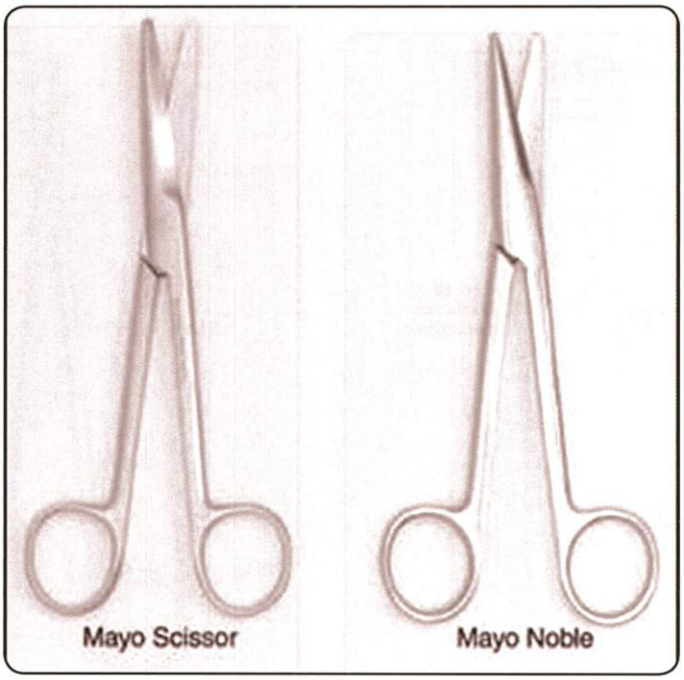


Figure 10.22

Surgical scissors have various blade features for specific surgical applications:

- Tungsten carbide blades – These scissors have gold rings on the handles and tungsten carbide blade edges. (See **Figure 10.23**) Scissors with these blades have a harder and stronger cutting edge, and they allow the scissors to remain sharper for a longer time than other scissors. Their primary design function is tissue dissection.

- Serrated blades – The design feature of a serrated blade is the prevention of tissue slippage or escape during cutting. Serrations are generally found on one of the blades; however, there are some scissors with dual-blade serrations.

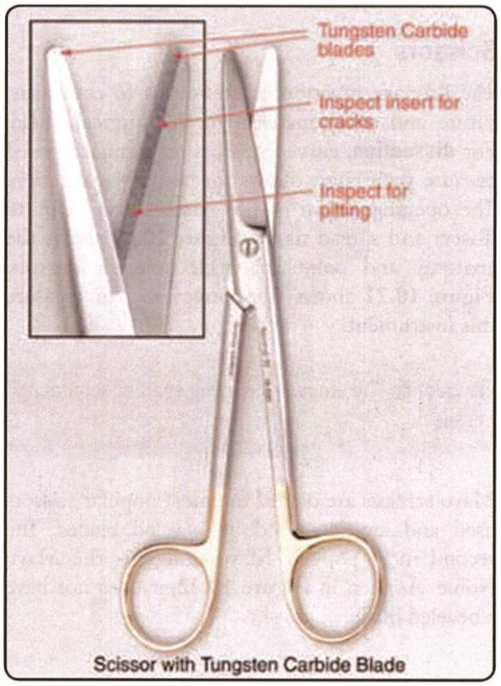


Figure 10.23

- Microgrind or supercut blades – Black rings visually identify these scissors from standard or gold-handled tungsten carbide scissors. The design of a black-handled scissors is to simulate a tissue lancing/slicing action. While all other scissors cut tissue with a crushing action, a black-handled scissors has one blade sharpened like a knife to slice tissue. The other blade is a standard design that causes a guillotine effect. (See **Figure 10.24**) Black-handled scissors must be specially sharpened.

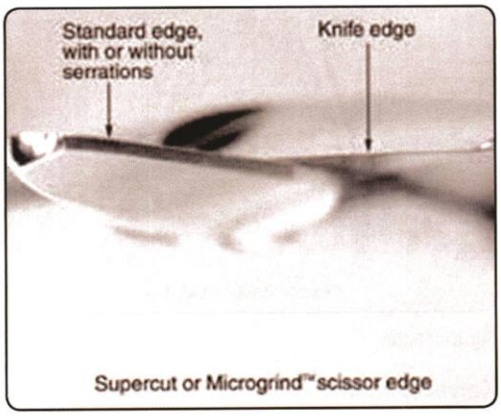


Figure 10.24

Suction Devices

The primary function of suction devices is to extract (suction) blood and fluids from the surgical site. **Figure 10.25** shows the anatomy and points of inspection for a suction device. **Figure 10.26** shows the correct way to measure this instrument. The two most common suction devices are Baron and Frazier suction tubes. These suction devices include a metal stylet that is used during the surgical procedure to unclog the suction channel. *Note: This stylet is not to be used to clean the device. The only cleaning tool for a suction device is the proper cleaning brush.*

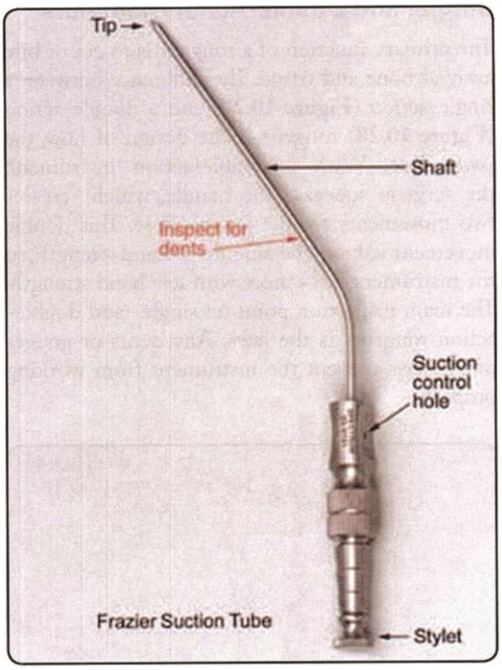


Figure 10.25

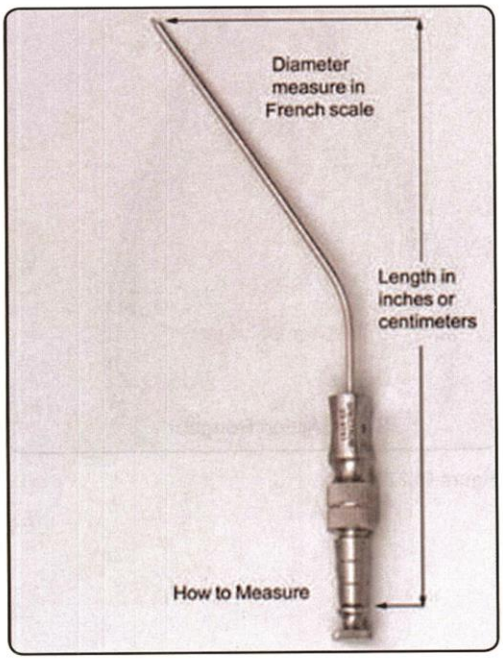


Figure 10.26

Single- and Double-Action Rongeurs

The primary function of a rongeur is to cut or bite away at bone and tissue. The difference between a single-action (**Figure 10.27**) and a double-action (**Figure 10.28**) rongeur is the design of how the jaws close. With a double-action instrument, the surgeon squeezes the handle, which creates two movements for the jaw to close. This double movement reduces the amount of hand strength, so the instrument bites more with less hand strength. The main inspection point on single- and double-action rongeurs is the jaws. Any dents or gouges of the jaws prevent the instrument from working properly.

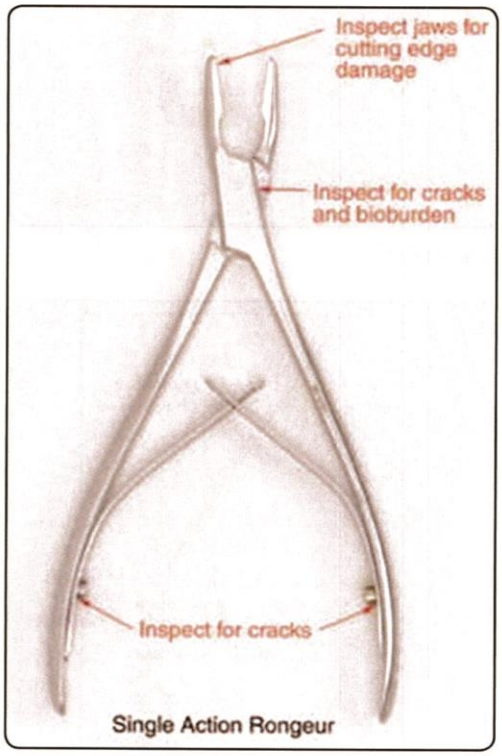


Figure 10.27

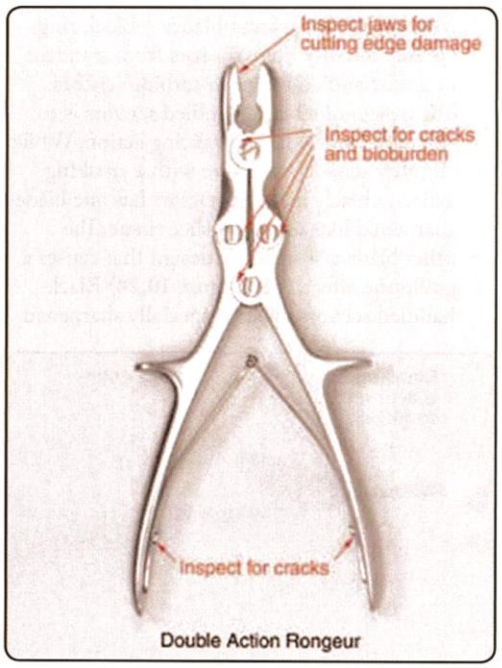


Figure 10.28

Kerrison/Laminectomy Rongeurs

The primary function of this style of rongeur is to remove the disc or lamina during spine surgery. The distal portion must be inspected after each use to look for bioburden and cutting edge damage. (See **Figure 10.29**) When Kerrison rongeurs are being assembled in trays, it is important to identify the different bite designs (e.g., the 90-degree up bite, as shown in **Figure 10.30**). If a Kerrison rongeur is sticking in a closed position, a repair vendor will need to disassemble, polish, sharpen and re-assemble the instrument.

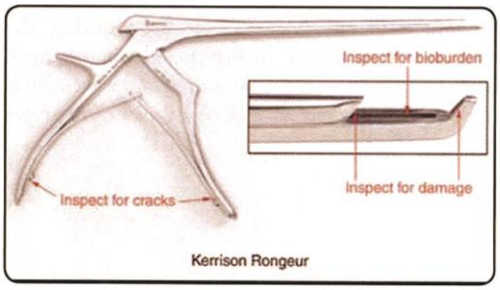


Figure 10.29

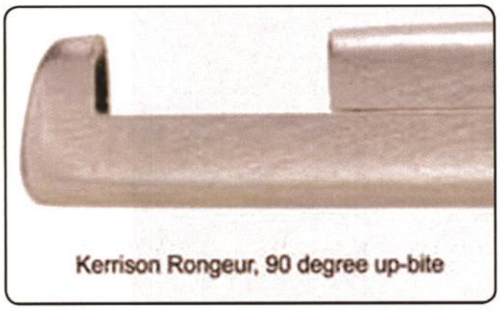


Figure 10.30

Nail Nippers

The primary function of nail nippers (see **Figure 10.31**) is to cut toenails and fingernails and, occasionally, to trim small bone fragments. The cutting surface and edge should be inspected along with the hinge area and spring.

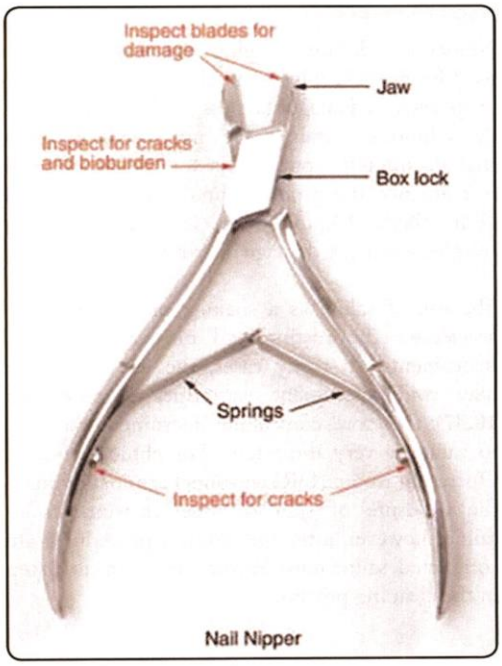


Figure 10.31

Graves and Pederson Vaginal Speculums

The primary use of these medical instruments is to expose the vaginal cavity. **Figure 10.32** shows the anatomy the of a vaginal speculum. One important inspection point is to ensure that the thumb screws are present and functioning. It is also important to inspect all sides of the blades for damage. As noted in **Figure 10.33**, a Pederson blade is narrower than that on a Graves speculum.

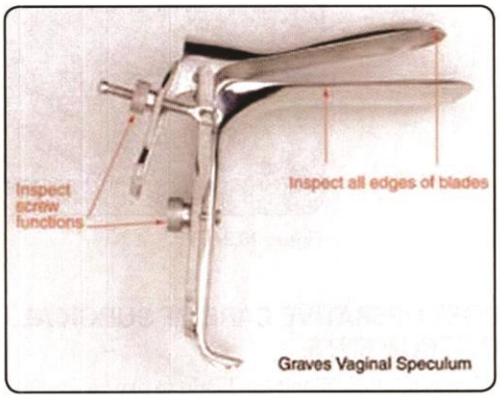


Figure 10.32

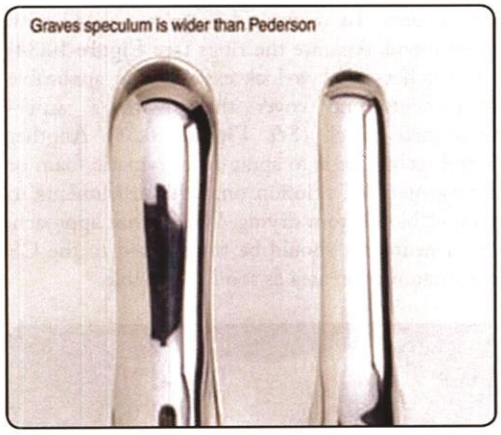


Figure 10.33

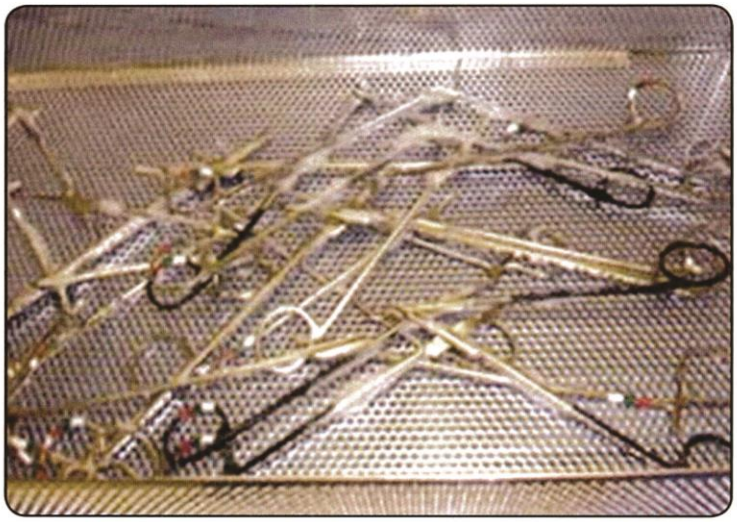


Figure 10.34

POST-OPERATIVE CARE OF SURGICAL INSTRUMENTS

Within minutes, blood can begin to dry on surgical instruments. Users should take precautions to ensure that blood and soil is not allowed to dry on instruments. To prevent damage associated with dried blood, separate the rings (see **Figure 10.34**) and ratchets for box-lock exposure on applicable instruments and cover them with a water-moistened towel. (See **Figure 10.35**) Another useful technique is to spray an enzymatic foam or detergent-based solution onto the instruments to prevent blood from drying. With either approach, the instruments should be transported to the CS decontamination area as soon as possible.

Figure 10.35

SOLUTIONS THAT DAMAGE INSTRUMENTS

Numerous solutions, ranging from those typically used for housekeeping to kitchen-related cleaning purposes, can damage stainless steel instruments. If the solution's container does not specifically note that its intended purpose is for use on surgical instruments, the product should not be used to clean them. **Figure 10.36** identifies common solutions that can damage instruments.

The use of saline as a soaking or rinsing agent accelerates the rusting and pitting of surgical instruments. In many cases, the use of saline may void instrument warranties (See **Figure 10.37**); therefore, controlling instrument exposure to saline is very important. For clinical reasons, Operating Room (OR) personnel cannot eliminate the exposure of stainless steel instruments to saline; however, after the surgical procedures are completed, saline must be removed as an early step in the cleaning process.

Soaking in water
Soaking in saline
Bleach
Iodine
Hand soaps
Saline
Long term soaking in rust remover
Long term soaking in stain remover
Porcelain cleaners
Household lubricants
Household powder cleansers
Surgeons' hand scrubs
Laundry detergents

Figure 10.36

Rusts and Stains

Stainless steel is composed of rust-resistant alloys. No steel is truly "stainless," although rusting is relatively rare. Proper processing helps control both staining and rusting.

"Rust" that appears on an instrument is often a stain. A pencil eraser can be used for an "eraser test" to help determine the difference between staining and rusting. After a stain is discovered, use the eraser to remove the discoloration. Then, look at the metal below the discoloration to determine if there are any tiny pit marks. If pit marks are discovered, this is corrosion: the origin of the rusting. If the metal is smooth and clean below the stain, the source of discoloration is a stain; there is no rust.

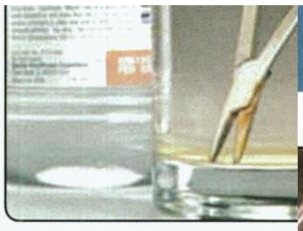


Figure 10.37

INSTRUMENT SHARPN AND IDENTIFICATION

Instrument sharpness testi monitor the sharpness of s **Figures 10.38** through **10.4** sharpness testing procedures f instruments.

Figure 10.38

Instrument: Scissors 4.5" and

Test material: Red test mate material (latex free).

Test: Scissors must be able to tip two to three times. The dist the most crucial portion becau first become dull. They must the tips of the instrument.

TESTING

is essential to al instruments. llustrate proper mmon surgical

(latex); orange

through to the s of scissors are is is where they leanly through

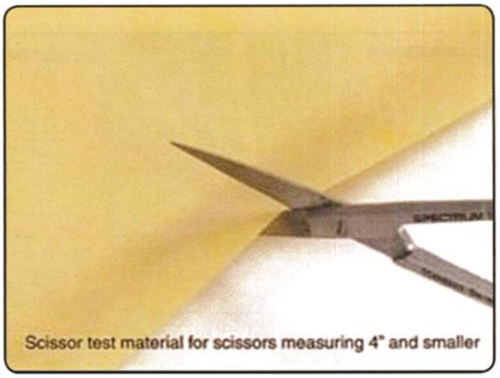


Figure 10.39

Instrument: Scissors 4" or smaller.

Test material: Yellow test material (latex or latex free).

Test: Scissors must be able to cut through the tips two to three times. The distal tips of scissors are the most crucial portion; they must cut cleanly through the tips of the instrument.

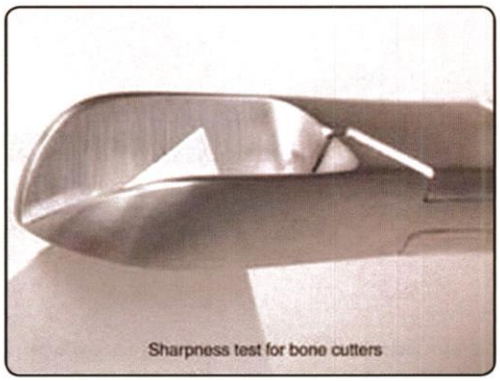


Figure 10.40

Instrument: Bone cutter.

Test material: Index card.

Test: Cut off a piece of the index card.

Figure 10.41

Instrument: Kerrison rongeur.

Test material: Index card.

Test: Punch a clean hole through the card.

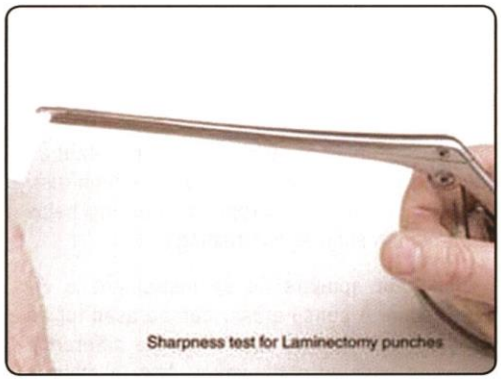


Figure 10.42

Instrument: Laminectomy rongeur.

Test material: Index card.

Test: The rongeur should make a clean bite using half the jaw.

Figure 10.43

Instrument: Double-action rongeur.

Test material: Index card.

Test: The rongeur should make a clean bite through the card.

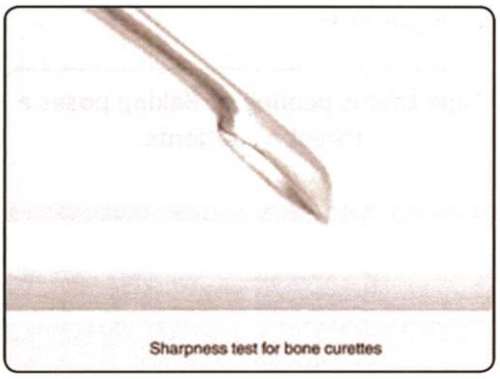


Figure 10.44

Instrument: Bone curette.

Test material: Plastic dowel rod.

Test: Shave off pieces of the dowel rod.

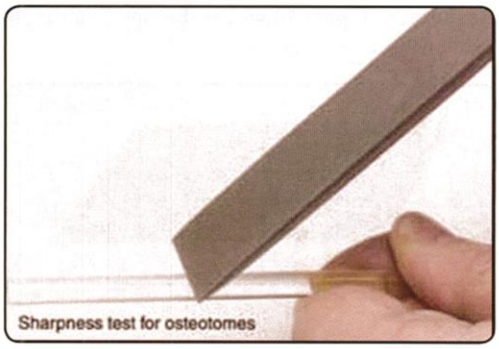


Figure 10.45

Instrument: Chisels and osteotomes.

Test material: Plastic dowel rod.

Test: Shave off pieces of the dowel rod.

INSTRUMENT IDENTIFICATION METHODS

There are thousands of different surgical instruments and many look quite similar. CS technicians must ensure that the correct instruments are placed into the proper trays. Many healthcare facilities use different instrument marking methods to mark instruments for faster and easier identification.

Marking surgical instruments for identification can be done several ways. The use of tape is one popular method for identifying instruments. Although this is a seemingly simple approach, it is important to follow proper application techniques. What follows are some important steps to ensure proper device taping:

- Clean fingertips with alcohol to remove oils, grease and dirt.
- Wipe alcohol on the site of the instrument where the tape will be placed to remove any lubricant or moisture that might be on the instrument. *Note: Tape should always be placed on the shank of the instrument and never the rings. Tape that is applied to a rounded surface, such as instrument rings, will not adhere to the instrument's surface.*

As shown in **Figure 10.46**, cut the tape on an angle to allow its edge to lay flat.

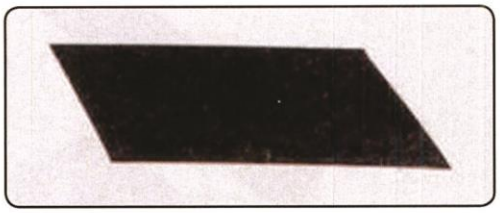


Figure 10.46

- Wrap the tape one to one and one-half times around the device. Apply the tape with a firm, pulling tension. Be careful not to apply excessive tape. (See **Figure 10.47**)

- After the tape is applied, autoclave the instrument to allow the heat to help bond the tape to the instrument. **Figure 10.48** provides an example of properly applied tape.

Note: Please refer to the tape manufacturer's IFU for special instructions.

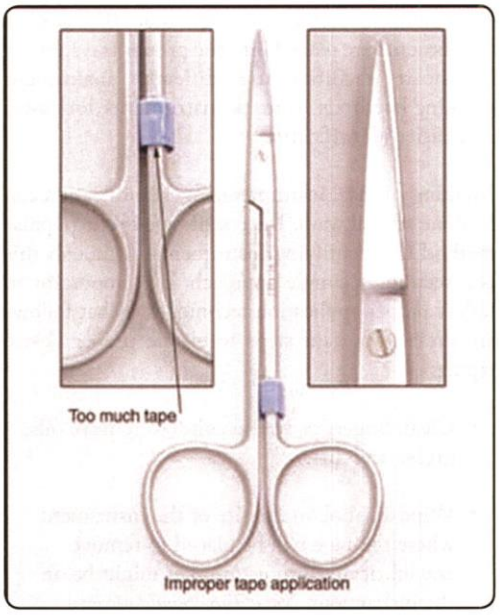


Figure 10.47

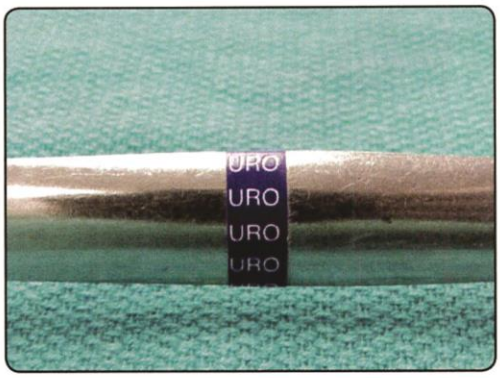


Figure 10.48

When using tape to identify instruments, inspection of the tape each time the device is processed is very important. Tape that is loose, damaged or peeling must be removed and replaced as microorganisms under the loose or damaged tape are very difficult to clean. Peeling and damaged tape can inadvertently fall into the patient potentially causing an infection. (See **Figure 10.49**)

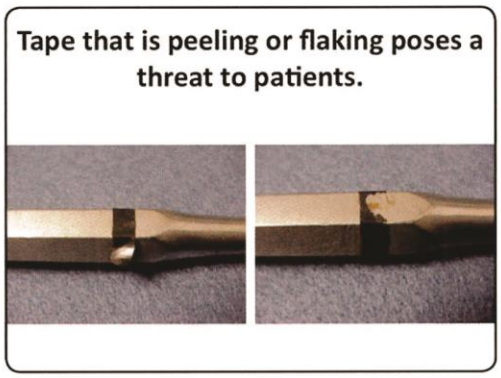


Figure 10.49

Other methods of marking instruments include:

- Acid-base etching – This process can be done by the instrument repair vendor, or a kit may be purchased, so the etching process can be done at the facility. Acid base etching uses a stencil, solutions and electricity to mark stainless steel. This process is semi-permanent, and it can be buffed off during the instrument repair process. (See **Figure 10.50)**

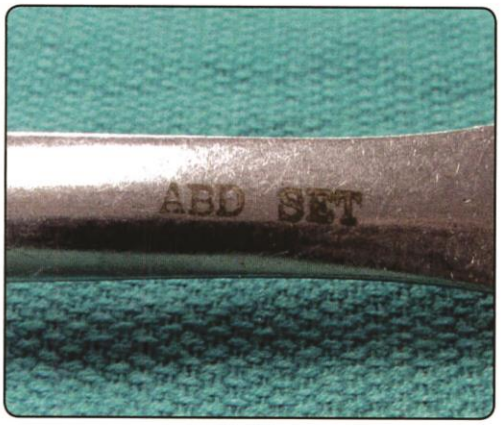


Figure 10.50

- Heat-fused nylon – This color coding is often referred to as "dipping," and is typically done in a repair facility. Heat-fused nylon is a powder-coating process that leaves a thin layer of colored nylon on the instrument. Nylon coating can last years; however, once it begins to chip, all nylon must be removed from the instrument. (See **Figure 10.51**)

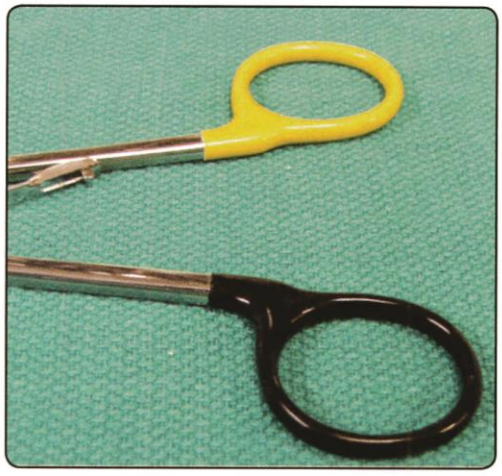


Figure 10.51

- Laser etching – This durable process is usually done by the manufacturer or an outside vendor. (See **Figure 10.52**)

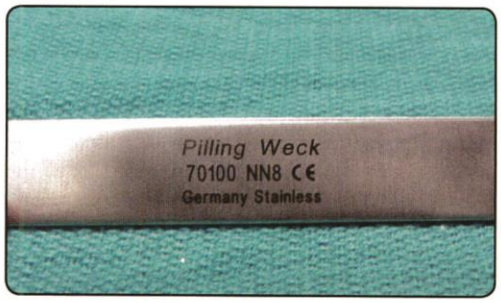


Figure 10.52

- Dot matrix - These systems are relatively inexpensive and can be applied by CS technicians. (See **Figure 10.53**) The two most popular types of dot systems are:
  - The dot marking system, where a small barcode containing the instrument information is applied with pressure-sensitive tape.
  - The dot peen system is done by using a laser or tungsten stylet to implant the information onto an instrument.

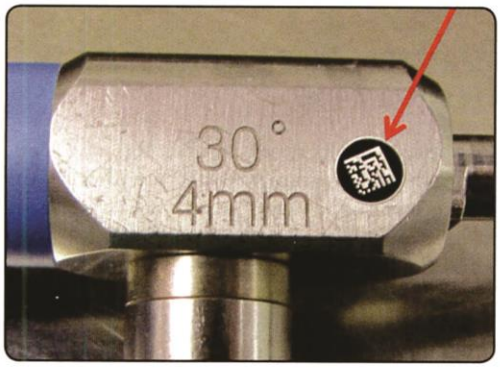


Figure 10.53

INSTRUMENT LUBRICATION

Many surgical instruments with moving parts must be lubricated after each use or in accordance with manufacturer's recommendations. The use of a neutral-pH lubricant extends the life of the instrument, and makes the device easier for the surgeon to use. While most washer-disinfectors will lubricate instruments, some instruments may need to be lubricated again during assembly. Each CS

workstation should have lubrication available for this purpose. Lubricants are available in spray bottle formulas. All lubricants must be approved for use as a surgical instrument lubricant and for the type of sterilization method that will be used on the instrument. The point of application should be the instrument's hinged area or any working component, such as a moving/sliding area. (See **Figure 10.54**)

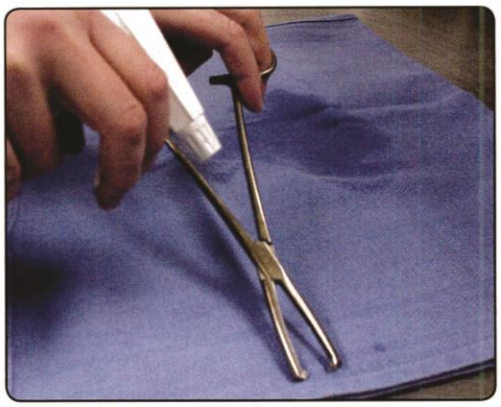


Figure 10.54

TIPS TO PROTECT INSTRUMENTS FROM DAMAGE

Instruments are an expensive asset for any facility. Protecting the instruments is a part of every CS technician's job. When treated properly, many instruments can remain in active service for many years. The following are some helpful tips:

- Always follow the manufacturer's instructions for cleaning, lubrication and sterilization. These instructions were developed by the instrument manufacturer to help ensure the instrument's longevity.
- Place heavy instruments on the bottom or side of the tray. This will help protect the smaller, more delicate instruments.
- Select an instrument tray that allows adequate space for weight distribution. Overcrowding instruments can cause damage.
- All curved instruments should be curved in the same direction to protect tips from being damaged.
- Tissue and dressing forceps should be softly nested together or placed close to each other in the tray or peel pack. Do not push the forceps together. Leave some space between each forceps so the sterilant can reach all surfaces.
- Delicate instruments should be kept in approved micro cases or small protective cases within the surgical tray.
- The use of metal instrument holders, called stringers, can assist in faster sterile field assembly and safer handling of the instruments, especially sharps. Stringers also hold the instruments in the open position during sterilization. (See **Figure 10.55**)

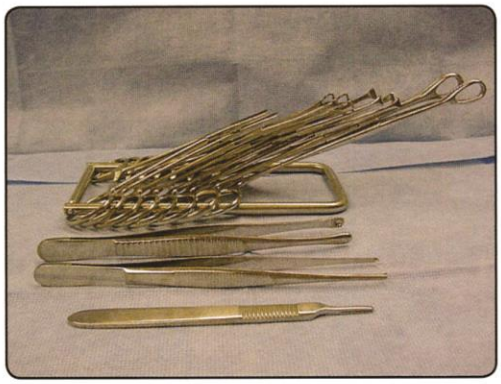


Figure 10.55

- Laser-finished instruments should never have metal-to-metal contact that can damage, chip and scratch the finish during decontamination, tray assembly and transport. A silicon nipple mat can prevent metal-to-metal contact, as can foam or a lint-free towel.

CONCLUSION

Properly identifying instruments and following the proper inspection protocols help ensure instrument trays are assembled correctly and all the instruments are clean and functional. Carefully following the manufacturer's IFU and paying meticulous attention to detail will help keep the instruments in good repair and extend the life of these expensive items.

Central Service technicians are the last to touch instruments before they are received in a procedure area; therefore, their quality of work is critical to successful patient outcomes.

RESOURCES

Centers for Disease Control and Prevention. *FastStats.* http://www.cdc.gov/nchs/fastats/insurg.htm. Accessed March 2014.

Schultz R. *Inspecting Surgical Instruments: An Illustrated Guide.* 2005.

Gregory B. *Orthopedic Surgery.* 1994.

Tighe S. *Instrumentation for the Operating Room.* 1994.

Glaser Z. *Surgical Instrument Quality. Infection Control and Sterilization Technology.* 1997.

Storz Instruments. *The Care and Handling of Surgical Instruments.* 1991.

Reichert M. *Sterilization Technology for the Health Care Facility, Second Edition.* 1997.

CENTRAL SERVICE TERMS

Stainless steel

Scissors

Osteotomes

Chisel

Rongeurs

Forceps

Hemostatic forceps

Needle holders

Martensitic (stainless steel)

Retractors

Cannulas

Rib spreaders

Suction devices

Austenitic (stainless steel)

Serrations

Passivation

Box lock

Jaws

Dissection

Chapter 11

Complex Surgical Instruments

Learning Objectives

As a result of successfully completing this chapter, readers will be able to:

1. Provide an overview of and discuss procedures to care for and effectively process powered surgical instruments
2. Explain important basic concerns when handling and processing endoscopic instruments
3. Discuss detailed information about rigid and flexible endoscopes and their accessories
4. Review general processing and inspection requirements for endoscopes and accessories
5. Identify infection prevention concerns regarding endoscopes and loaner instrumentation
6. Identify basic protocols important for each step in the loaner instrumentation process

INTRODUCTION

Advances in many types of surgical procedures have improved patient outcomes and shortened both hospital stays and recovery time. At the same time, the instruments used in these procedures have become more complex and difficult to process.

From their origin in early times, surgical instruments have evolved from simple devices to the complex surgical instruments used today. Forceps, scissors, needle holders and retractors, along with numerous other simple instruments, are still commonly used, but they are joined by powered surgical instruments, endoscopes and other highly sophisticated and delicate devices with complex components, such as circuit boards and computer chips.

Many of these complex instruments that Central Service (CS) technicians process require special handling and care. This instrumentation may range from a single instrument or a few sophisticated devices in a small tray to those that comprise many trays and consist of hundreds of devices.

Whatever the specialty, the requirements for processing complex instruments remain the same: thorough cleaning, detailed inspection, proper packaging, and sterilization. One of the greatest challenges that CS technicians face is keeping abreast of new and evolving instruments and their specific processing requirements. Complex instruments are costly to purchase and repair and, therefore, represent a large financial investment to the hospital. Due to the associated expense, many facilities may not have back-up instrumentation available, so careful handling of these instruments is essential.

This chapter addresses basic information about some of the complex instruments that may cause processing concerns for CS technicians.

POWERED SURGICAL INSTRUMENTS

The use of drills and saws by physicians dates as far back as 5,000 to 7,000 years ago. In the mid-1800s, the dental industry took the lead in powered instrumentation by developing powered dental drills.

The fields of neurosurgery, orthopedics, otology and dentistry have also played key roles in the development of high-powered surgical instruments now used in every surgical and dental subspecialty. These developments have revolutionized surgery, making procedures both safer and faster.

The size, compactness and design complexity of powered surgical devices range from drills used on the tiniest ear bones to drills and saws used on the largest leg bones. Powered surgical instruments have greatly reduced the brute force historically required for orthopedic surgeries and they have also decreased the time required to perform them. This, in turn, has allowed surgeons to complete surgeries quicker and with more precision.

Materials used to construct powered surgical instruments are varied, so careful selection of cleaning and disinfection products is critical. Products chosen must be compatible with materials used and they must yield successful processing results. Equipment manufacturer's processing instructions must be followed to prevent damage to instruments containing lumens, channels, attachments and

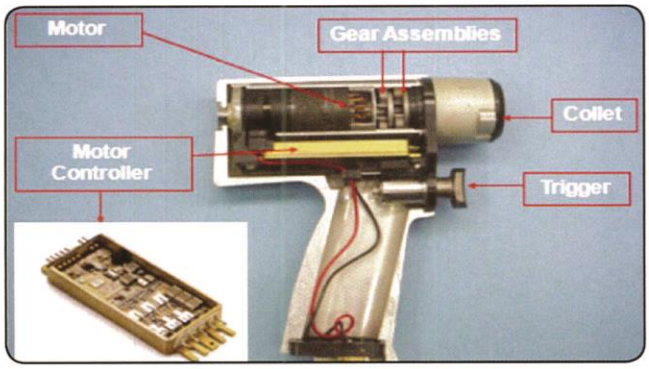


Figure 11.1

multiple moving parts. **Figure 11.1** shows some internal components of a motorized handpiece and demonstrates the complexity of powered surgical instrumentation.

Powered surgical instruments contain several working components that will be damaged if fluid (such as water or a cleaning solution) is allowed to penetrate into the device's interior. **Figures 11.2** and **11.3** illustrate the type of damage that occurs when powered surgical instruments and their accessories are invaded by fluid. CS professionals should be specifically trained to clean, process and handle powered surgical devices and equipment, and ensure that fluid invasion doesn't occur.

Fluid Invasion Damage on a Powered Surgical Instrument

Figure 11.2

Interior Components Damaged by Fluid Invasion

Figure 11.3

Power Sources

There are three main sources of power used for powered surgical instruments: electric, compressed gas (pneumatic) and battery.

Complex Surgical Instruments

Electric-Powered Surgical Instruments

Electric-powered instruments are used when physicians need a lightweight instrument for procedures where access is limited, such as in maxiofacial, dental and small bone (e.g., hand) procedures.

Instruments powered by electricity require a power cable that can be sterilized. One end of the cable attaches to the motorized handpiece on the surgical field; the other end attaches to a power unit (motor/electrical adapter) that plugs into an outlet. These cables require routine maintenance that involves disassembly, cleaning, lubrication, and inspection to look for cuts, nicks and/or other damage. During cleaning, fluid must not enter the cable or handpiece. Many manufacturers recommend connecting the cable to the handpiece during processing to help prevent fluid invasion. Care must also be taken not to bend the connector pins on the cable.

An arthroscopy shaver is an example of an electric-powered instrument. (See **Figure 11.4**)

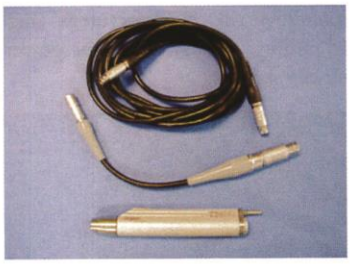


Figure 11.4

The most common problems associated with electric-powered equipment are:

- Damage to electrical parts during cleaning and sterilization.
- Condensation that enters the equipment when seals wear out.
- Electrical contacts that become worn and affect equipment handling.

The following are general guidelines for proper care and handling of electric-powered instruments and accessories:

- Do not immerse the equipment in any solution, including water, unless the manufacturer's Instructions for Use (IFU) specifically state that the device can be submerged.
- Do not use solvents or lubricants, unless specified by the equipment manufacturer.
- Use a brush to clean the distal tip and lumens. Follow the IFU for the correct size and type of brush to use for each area.
- Dry the equipment with a clean, lint-free cloth.

Electric-powered equipment can be operated with a foot switch (foot-controlled pedal). (**Figure 11.5** shows an operational foot pedal and **Figure 11.6** shows a foot pedal damaged by fluid invasion.) Foot switches may have a cable to attach the instrument console, or they may be wireless. To clean foot switches, follow the manufacturer's instructions and avoid pulling on or stressing the power cord or damaging the sensors.

Figure 11.5

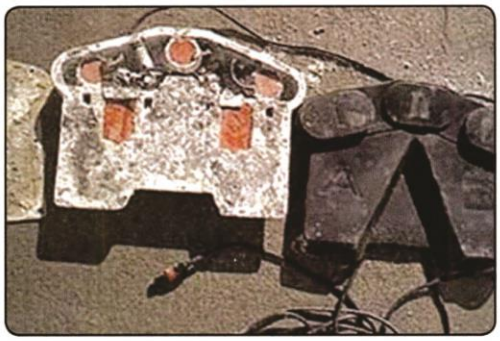


Figure 11.6

Pneumatic-Powered (Air-Powered)

Pneumatic-powered (air-powered) instruments come in various sizes and allow the surgeon to work on small, medium and larger bones. Sternum saws, sagittal saws and drills are popular pneumatic-powered instruments.

Pneumatic-powered instruments require a hose that can be sterilized. (See **Figure 11.7**) One end of the hose attaches to the motorized handpiece on the surgical field; the other end attaches to the source of compressed gas, which can come from a stand-alone cylinder (tank) with a pressure regulator (See **Figures 11.8** and **11.9**), or be "piped in" through a wall or column-mounted regulator panel. (See **Figure 11.10**)

Figure 11.7

Figure 11.8

Figure 11.9

Instrument hoses must be carefully inspected for cleanliness. *Note: These hoses are usually black, so it is often difficult to see blood and debris.* Hoses must also be inspected for nicks and other possible damage. They must be pressurized for proper inspection; therefore, an air source is required in the processing area.

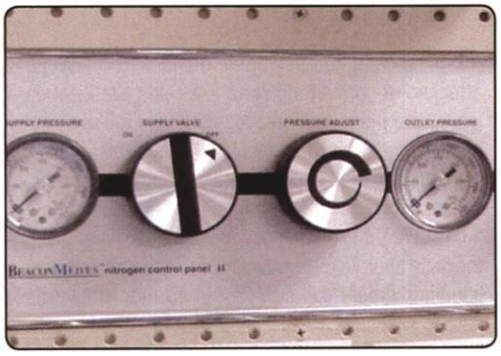


Figure 11.10

If the hose casing becomes damaged (or "bubbled") it must be removed from service. Fluid must not enter the hose or handpiece during processing. Many manufacturers recommend connecting the hose to the handpiece during cleaning to help prevent fluid invasion and related damage.

Different types of powered instruments require different operating pressures, and a chart of these pressures should be available where the instruments are processed. CS technicians must be certain to follow the manufacturer's instructions and test instruments using the appropriate gas. Extreme care is required because testing instruments at an improper pressure can injure the operator and/or severely damage the instrument. **Figures 11.11** and **11.12** provide examples of air-powered instruments.

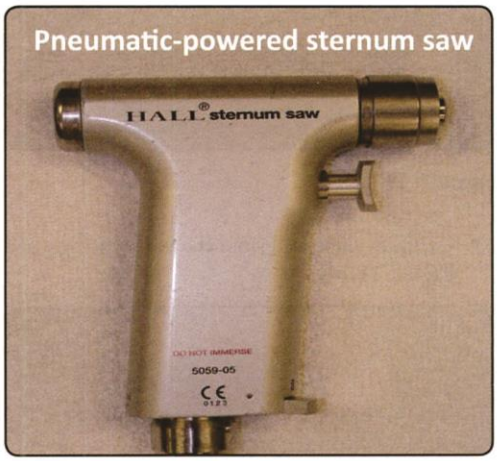


Figure 11.11

Figure 11.12

To properly care for and handle pneumatic equipment:

- Never immerse in any solution (including water) unless the manufacturer's IFU specifically states the device can be submerged.
- To clean, insert the appropriate manufacturer-recommended cleaning brush into attachments and burr guards. (See **Figure 11.13**)

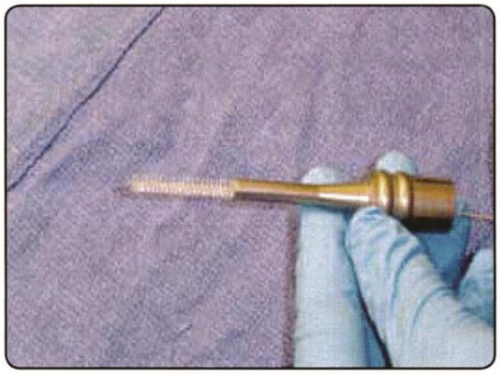


Figure 11.13

- Carefully wipe and rinse the outer casing. (See **Figure 11.14**)

Figure 11.14

- Use a decontamination hose to protect inner components. (See **Figure 11.15**)

How to Create a Decontamination Hose

Decontamination hoses are made by cutting small pieces of damaged pneumatic hoses, placing both regulator ends on the hose, and marking the hose in some way to identify it as nonfunctional. A popular way of marking the hose is with red tape.

Figure 11.15

- Burr guards must be lubricated according to manufacturer instructions.

Care of Air Hoses

All pneumatic (air-powered) equipment must be attached to an air hose to operate. Sterilization issues are the primary reason air hoses fail because heat from sterilization breaks down the rubber components and O-rings, and causes air leakage. To clean the hose, use a mild detergent. Don't allow fluids to enter hose and never use abrasives to wash the hose liner. Take care when coiling the hose during handling. Proper coil size for sterilization should be nine to 12 inches. Hoses should not be coiled tightly.

Battery-Powered Instruments

Battery-powered surgical instruments are high powered and work well with the procedures performed on larger, denser bones. Total hip and knee replacement surgeries are examples of such procedures. (See **Figure 11.16**)

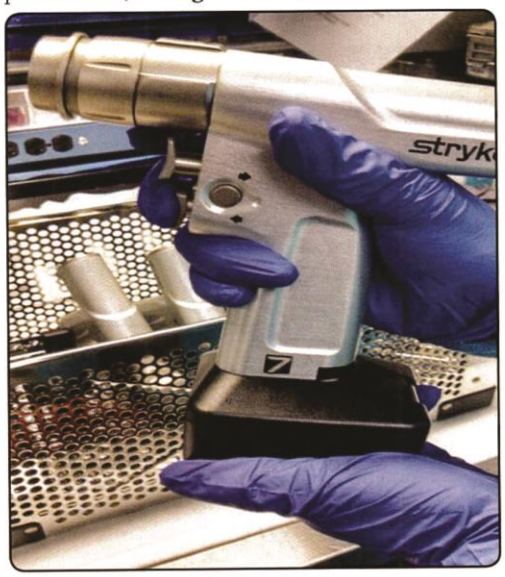


Figure 11.16

Batteries and chargers are specific to each system, and are not interchangeable. Additional space must be provided to accommodate the chargers. (See **Figure 11.17**)

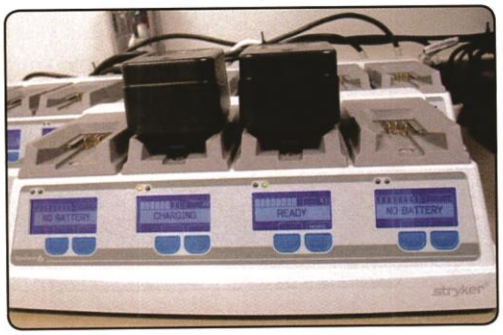


Figure 11.17

Figure 11.18 provides examples of battery-powered instruments.

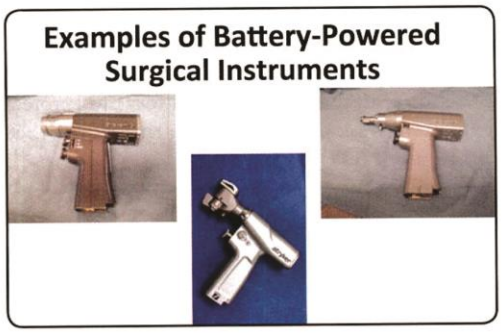


Figure 11.18

Common Powered Surgical Instruments

- Dermatome/dermabraders for harvesting skin grafts or reshaping skin surfaces.
- Cebatomes for removing bone cement.
- Sternal saws to split the sternum and allow access for open-heart surgery.
- Dental drills for repair/reconstructive work on teeth and jawbones.
- Micro drills for reshaping middle ear bones or driving very small wires through bones.
- Wire drivers, drills and saws in the appropriate size and shape to work on the smallest facial bones to the largest bones (such as those in the leg).
- Saws designed to perform specific cutting actions, such as reciprocating or oscillating.

To properly care for and handle battery-powered instruments:

- Never immerse handpieces, attachments or batteries in any solution, including water, unless approved by the manufacturer.
- Clean surgical debris from attachments and handpieces using brushes and a manufacturer-recommended mild detergent.

- Rinse with water, while assuring that the water does not enter the battery contact area.

- Use a decontamination battery to protect electrical components from moisture. (See **Figure 11.19**)

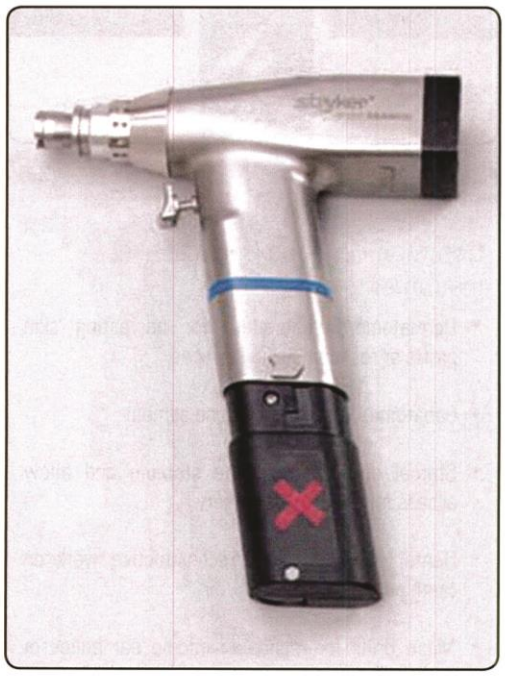


Figure 11.19

How to Create a Decontamination Battery

Locate a dead, unrepairable battery for each style of powered surgical instrument. Use instrument marking tape to make a red "X" on the battery packs and keep these batteries in the decontamination area. When battery-powered equipment enters the Central Service decontamination area, select and insert the appropriate battery pack to protect the electrical components from moisture. *Note: While this does help prevent moisture from entering the unit, care should still be taken to avoid contact with excess moisture.*

- Check all moving parts for cleanliness and function. (See **Figure 11.20**)

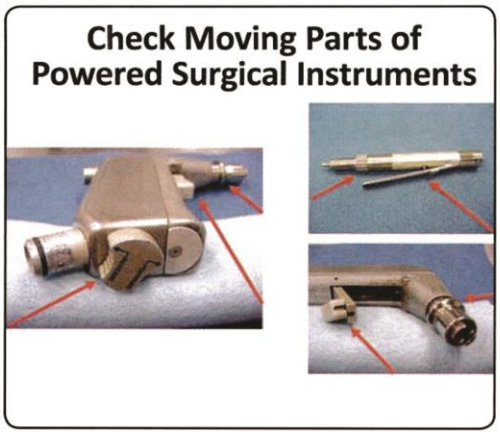


Figure 11.20

- Lubricate the handpiece with the type and amount of lubricant recommended by the equipment manufacturer. *Note: Not all powered instrumentation or accessories are lubricated. Refer to the device's IFU.*

- Some manufacturers recommend operating handpieces to ensure proper functioning, and dispersing lubrication (if added) prior to packaging for sterilization. (See **Figure 11.21**)

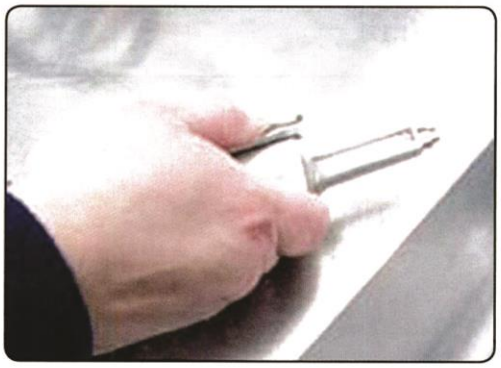


Figure 11.21

- Attach accessories, including batteries, to the handpieces to ensure they fit properly. (See **Figure 11.22**)

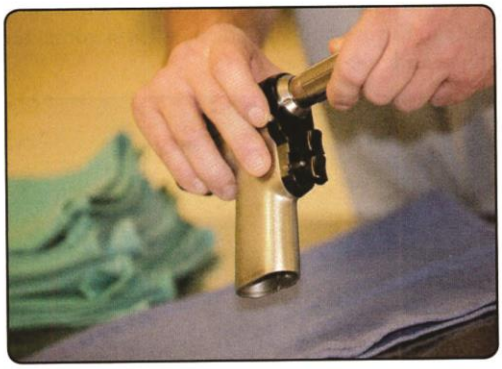


Figure 11.22

- Package and sterilize the device, per manufacturer recommendations. Special racks or positioning devices may be needed to ensure that all device surfaces are properly exposed to the sterilant and to ensure that condensation does not collect. Some types of packaging, such as peel packs, are not suitable for all types of powered instruments and accessories. Check manufacturers' packaging recommendations.

Common Reasons for Powered Equipment Repairs

Powered surgical equipment is expensive to purchase and repair. Everyone who handles this equipment should use caution to prevent damage. Common causes of damage include:

- Corrosion of internal components from condensation, steam, fluid invasion or improper cleaning.
- Physical damage due to mishandling. (See **Figure 11.23**)
- Lack of or improper preventive maintenance.

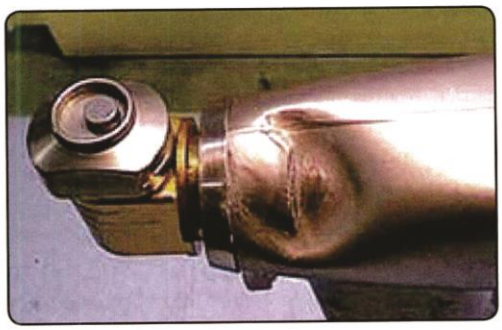


Figure 11.23

Motorized handpieces are very delicate and expensive and require special care. Proper use and handling, along with regular preventive maintenance and service, will help ensure that the devices are available for safe, effective use.

ENDOSCOPES

The term "endoscopy" means "looking inside." Endoscopic procedures allow a physician to look inside the body through the use of an **endoscope**. Endoscopic procedures are considered minimally-invasive because they do not involve a large incision. This minimally-invasive instrumentation allows the physician to perform procedures either through natural body openings like the mouth, nose or anus, or through small incisions that provide access for endoscopic instrumentation. This instrumentation may be used to view a specific area of the body or, with the addition of other instruments, perform multiple types of surgeries.

Endoscope An instrument used to examine the interior of a hollow organ or body cavity.

All endoscopes allow for light and image transmission. Some endoscopes also provide a working channel, allowing the surgeon to perform surgical procedures.

The first endoscopes were developed in Germany in the 1800s; however, the use and development of endoscopes became more popular after World War II. In the 1950s, the flexible endoscope was

introduced. Today, fiber optics [a technology that uses glass (or plastic) threads (fibers) to transmit data] and **light-emitting diodes (LED)** are the primary carriers/sources of light for endoscopic surgery.

Light-emitting diode (LED) Semiconductor diode that emits light when voltage is applied.

LED act as tiny light bulbs. Fiber optics do not produce light; instead, they act as wires to carry light generated from an external source. (See **Figure 11.24**)

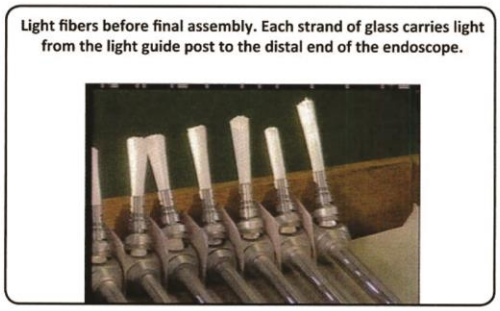


Figure 11.24

Proper light is a critical factor in endoscopic procedures, as the quality of the image or pictures is largely dependent on light quality and quantity. It is important to check the endoscope, the light source and the carrier (fiber optic cord) to ensure they are in working order each time the endoscope is processed. The dark areas in **Figure 11.25** indicate damaged light fibers.

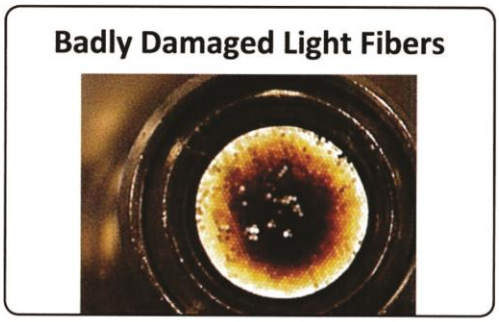


Figure 11.25

The second function of endoscopes is to transmit the reflected image back to the surgeon's eye or to a video system. **Figure 11.26** shows endoscopy with the use of a video system. This can be accomplished through the use of fiber optic bundles or computer chips inside the scope.

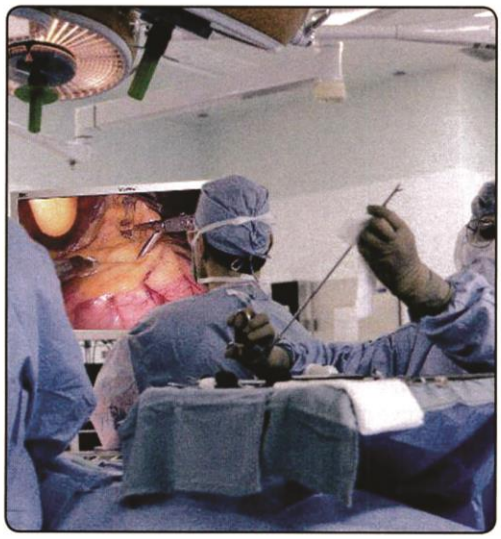


Figure 11.26

Endoscope Classification

The term "endoscope" describes all devices that are used to view inside a body cavity. **Figure 11.27** shows the different classifications of endoscopes.

It is important when discussing endoscopes to properly classify the type of endoscope in use because function, care and handling processes are different for each classification. This section will focus on rigid, semi-rigid and flexible endoscopes.

The classification of rigid, semi-rigid and flexible relates to an endoscope's ability to bend without damaging the device. Rigid and flexible endoscopes can be further classified according to how the image is captured. This divides rigid and flexible endoscopes into two broad categories: video and non-video.

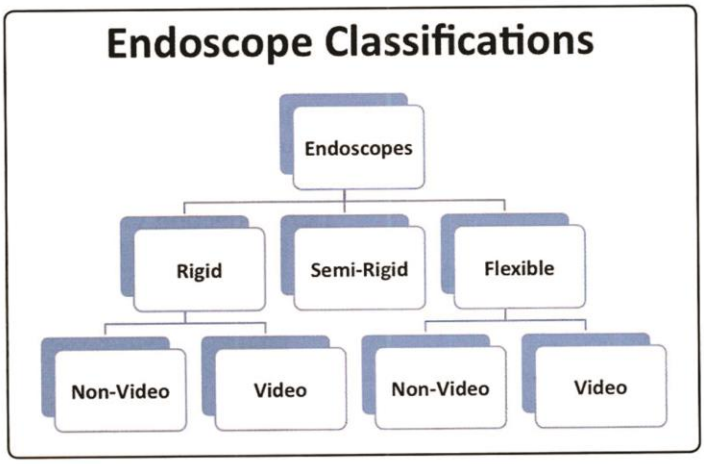
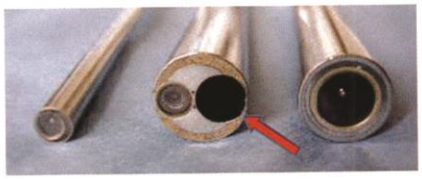


Figure 11.27

Operative and Non-Operative Endoscopes

The first endoscopes were non-operative; meaning the surgeon could view anatomy through the device, but could not perform a surgical procedure, such as a biopsy. Operative endoscope technology permitted surgeons to do much more than diagnose a condition; they could perform corrective surgeries with these new minimally-invasive instruments. Surgical procedures, such as laparoscopy and arthroscopy, came into demand as physicians and patients realized the benefit of shorter hospitalizations, less painful surgical procedures, lower healthcare-associated infection (HAI) risks, and faster recovery times.

An operative endoscope has a working channel (lumen) through which instruments or accessories can be passed to perform surgical procedures. (See **Figure 11.28**)



Operative and Non-operative Rigid Scopes

Note the operative channel in the middle scope.

Figure 11.28

Technological advancements continue today across surgical specialties, much of which has been fueled by smaller instruments and endoscopes. For example, surgeons can perform endoscopic abdominal, arthroscopic, urological, otolaryngeal, cardiac and neurosurgical procedures. Recent endoscopic developments permit heart conditions to be treated without opening the chest or cutting the ribs; pituitary surgery can now be performed through the sinus cavity, and salivary gland stones can be removed endoscopically. Further, lesions in the gastrointestinal tract and lungs can be directly visualized, and diagnostic biopsies and therapeutic procedures can be performed without surgery or general anesthesia.

Endoscope Use and Selection

Endoscopes are chosen by the physician based on the type of procedure they are performing. Rigid endoscopes are appropriate for viewing anatomy where there is straight-line access to the site. Semi-rigid endoscopes are useful where the line to the surgical site is relatively straight; however, some slight bending of the scope shaft may be needed to access the site, such as in bladder surgery. Flexible endoscopes are used where straight line access is not possible, such as when viewing the esophagus, lung, kidney or large intestine. Whether a rigid, semi-rigid or flexible endoscope is used, the device acts as the eye of the surgeon. Due to their delicate construction, as well as their size and frequent handling, endoscopes

are at risk of being damaged every time they are handled. In a single cycle of use, the endoscope can be handled by eight or more people.

Damaged or poorly-performing endoscopes result in costly procedure delays, staff and surgeon dissatisfaction and, possibly, patient harm.

RIGID AND SEMI-RIGID ENDOSCOPES

Rigid Endoscopes

Rigid endoscopes range in size from the very tiny 1.9mm scopes used for sialendoscopy (internal viewing of the salivary glands) to 15mm scopes used for robotic surgical procedures. Rigid endoscopes can be constructed using rigid rod lenses (non video) or with a video chip mounted in the distal end (video). (See **Figure 11.29**)

All rigid endoscopes are generally manufactured using tubes of stainless steel. Rigid endoscopes are designed to allow for some minimal flexing of the shaft, but damage will occur beyond the flex limits. A general rule is that a rigid endoscope should not be bent. Fiber optics are housed between the inner and outer tubes and transmit light from the light guide post to the distal end of the endoscope. (See **Figure 11.30**)

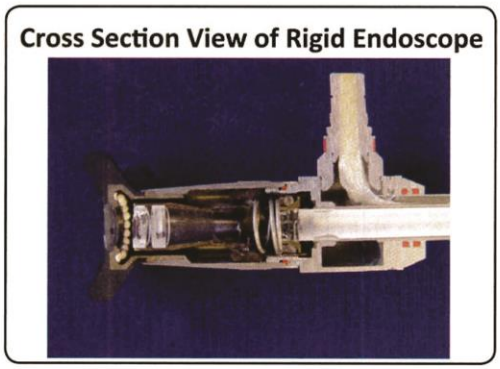


Figure 11.30

Operative rigid endoscopes have a working channel that allows the surgeon to pass instruments to perform surgery.

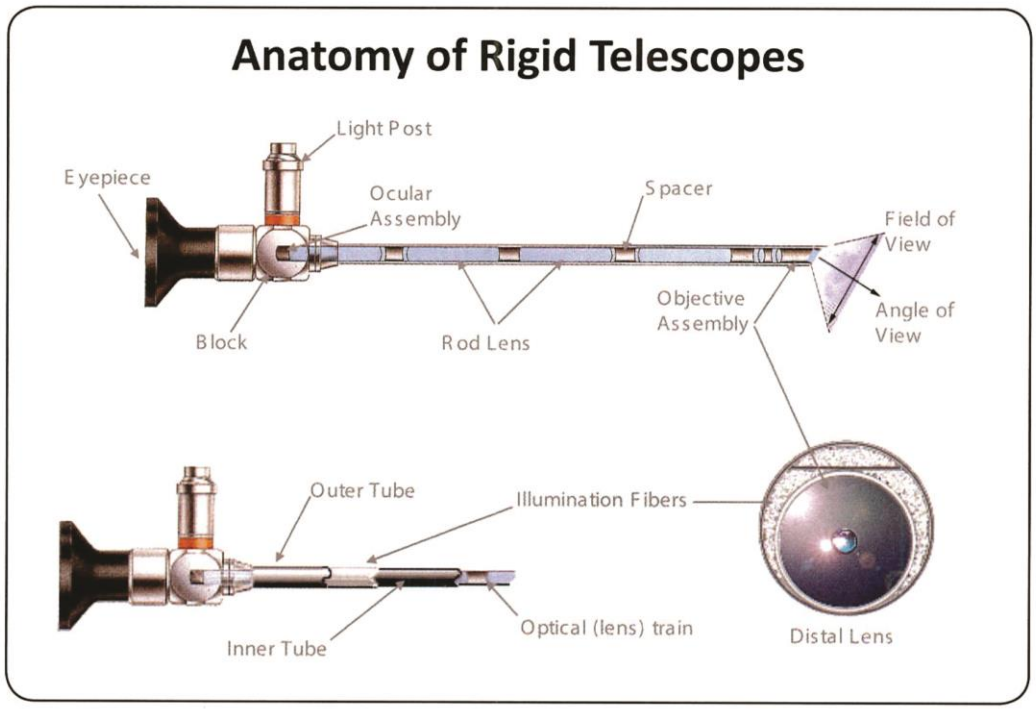


Figure 11.29

Specialty rigid scopes provide the ability to change the direction of view. The endoscope pictured in **Figure 11.31** allows the surgeon to change the direction of view by rotating a knob near the eyepiece.

Figure 11.31 Variable Direction of View Rigid Scope

Other specialty endoscopes contain filters that help the surgeon identify diseased tissue when used in combination with pharmaceuticals and/or different spectrum light sources.

Semi-Rigid Endoscopes

Semi-rigid endoscopes are termed as such because the shaft is made of a very thin stainless steel, thus allowing it to bend slightly, without kinking the metal.

Semi-rigid endoscopes are primarily used in urology to view the bladder and the distal portion of the ureter. (See **Figure 11.32**) While they have the ability to bend slightly more than a rigid scope, they will be damaged if too much pressure is applied, or if they are bent beyond their intended limits.

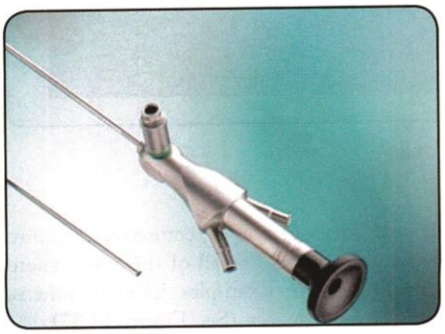


Figure 11.32

RIGID AND SEMI-RIGID ENDOSCOPE GENERAL GUIDELINES FOR DECONTAMINATION

The following are some general guidelines for cleaning rigid and semi-rigid scopes. Check with the individual scope manufacturer for specific instructions.

1. Remove the light source adaptors from the light post. (See **Figure 11.33**)

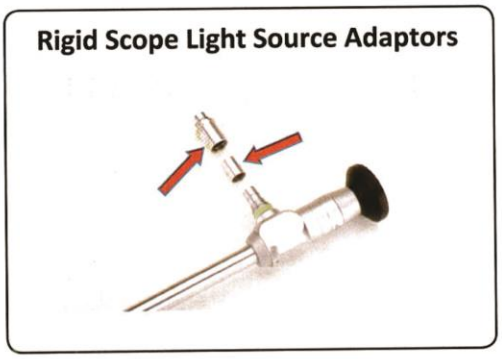


Figure 11.33

2. Use a neutral-pH enzymatic cleaning solution properly diluted per manufacturer's instructions, unless otherwise stated in the scope manufacturer's IFU.

3. Hand wash the endoscope using a soft cloth. Pay particular attention to the distal window, as this is where debris collects and is most difficult to remove.

4. If the endoscope has a working channel, thoroughly brush the channel using only the manufacturer's recommended brush size.

5. Thoroughly rinse the endoscope with treated water and flush the working channel (also with treated water) to remove all traces of enzymatic solution.

6. Dry the outside of the scope with a clean, lint-free cloth. Dry the working channel the per manufacturer's IFU.

New technology allows for the automated washing of non-operative rigid endoscopes. Check the manufacturer's IFU to verify that the tray and scope are approved for automated washing of rigid endoscopes. (See **Figure 11.34**) Automated washing provides multiple benefits:

- Consistent quality of wash.
- Reduced time spent on decontamination by staff.
- Safer devices for handling.

Note: Ultrasonic cleaning cycles must not be part of the automated washing, as damage will occur to the rigid endoscope.

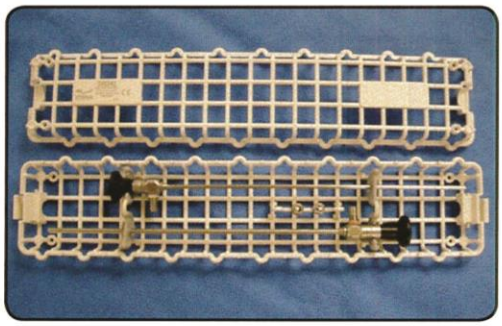


Figure 11.34 Basket and rigidscope approved for (non-sonic) automated cleaning.

RIGID ENDOSCOPIC INSTRUMENTS

Rigid endoscopic instruments come in hundreds of shapes and sizes. Many of them contain lumens that require special care to ensure that they are properly cleaned. Many instruments come with multiple parts, such as a laparoscope with a handle, working insert and outer shaft. (See **Figure 11.35**)

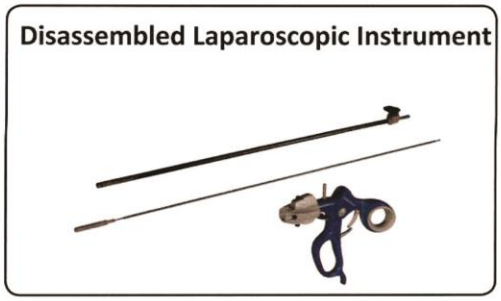


Figure 11.35

Care and handling is often complicated due to some instrument designs. If the instrument cannot be easily disassembled into component parts, it may be virtually impossible for a technician to determine that the lumens are clean. This applies to single-piece instruments with flush ports, since the technician cannot visualize the inner lumen to verify that it is thoroughly cleaned. For instruments with flush ports, if the instrument is not flushed properly after every use, there is an opportunity for debris to remain within the lumen after cleaning.

Hidden areas and moving parts can protect soil during the cleaning process. (See **Figure 11.36**)

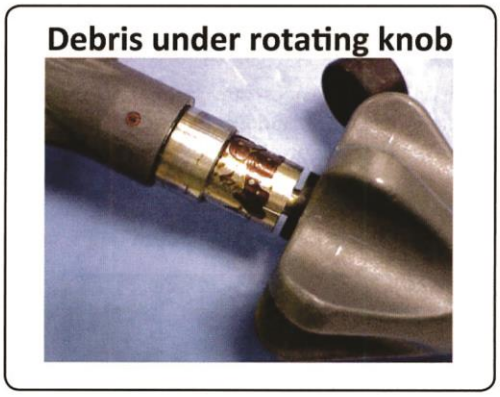


Figure 11.36

Complex designs, such as resectoscopes, require special attention be paid to all of the areas where debris could remain. Examples include lumens, hinges and covered spaces. (See **Figure 11.37**)

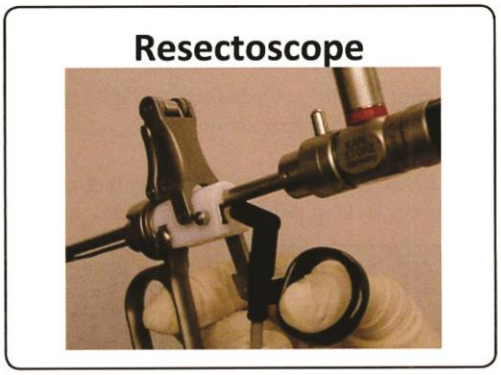


Figure 11.37

ENDOSCOPIC AND ROBOTIC INSTRUMENTATION

Operative endoscopes require special instrumentation. The following section addresses common instruments used with rigid and semi-rigid operative scopes.

Laparoscopic Instruments

Most laparoscopic instrumentation can be easily identified because they are very slender (3mm to 10mm in width) and longer than other instruments. The shafts look like the shaft of pencils or small rods, while the tips have the same design as general instruments with the same name. The distal tip of a laparoscopic Allis forceps, for example, is the same design as the distal tip of a general surgery Allis forceps. (See **Figure 11.38**)

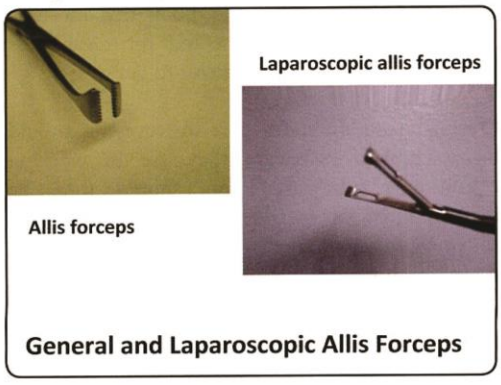


Figure 11.38

Complex Surgical Instruments

Some endoscopic instruments are used to cut or cauterize during surgery. These instruments will have insulation covering the shaft. This covering protects the patient from electrical current that flows through the instruments.

Laparoscopic insulation is susceptible to pin holes, cracks, tears and overall loosening. These defects must be identified as the instruments are tested and assembled. Failure to discover pin holes or other damage to the insulation can result in leaked electricity that can damage nearby tissue and organs. These burns can cause infection, extended patient recovery times and other complications.

To inspect the insulation, locate the metal collar at distal tip. (See **Figure 11.39**) The insulation should fit tightly against the collar, and this union should be snug, with no spaces visible. Next, grip the insulation and try to slide it back. If the insulation slides (moves), the instrument needs repair. Finally, visually check the instrument shaft, looking for cuts, cracks and nicks to the insulation, and inspect the insulated handle for chips or cracks.

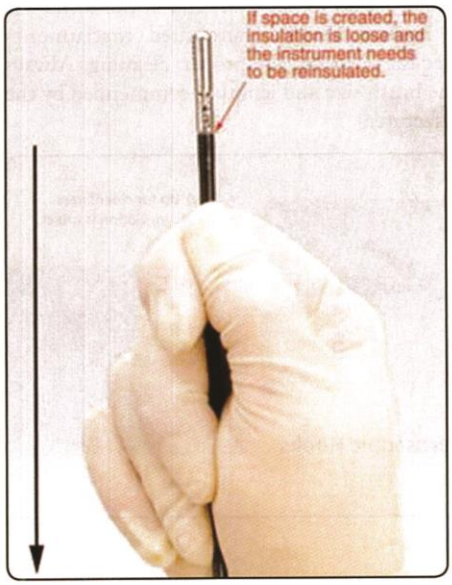


Figure 11.39

Electronic testing devices (See **Figure 11.40**) can detect microscopic holes in the shaft of a laparoscopic instrument. Electronic testing with an approved testing device should be done prior to set assembly on the clean side of the CS department.

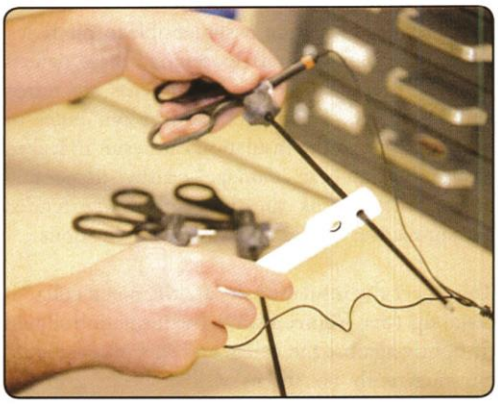


Figure 11.40

Laparoscopic hooks and spatulas are used to cut and/or cauterize. They must be inspected for insulation failure in the shaft and at the distal tip. (See **Figure 11.41**) Cannulated instruments will require a brush for proper cleaning. Always use the brush size and length recommended by the manufacturer.

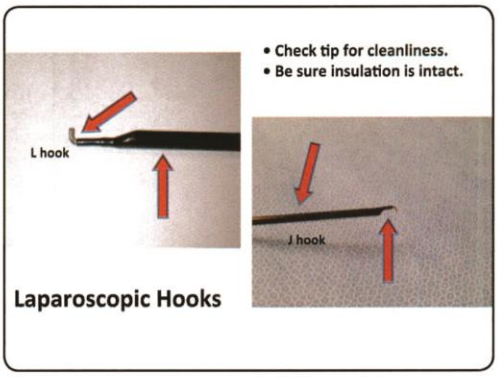


Figure 11.41

Laparoscopic ring handles are available in several styles (See **Figure 11.42**), such as:

- Free handle – No ratchet or spring finger, with an open and close action.
- Spring handle – Opens under slight tension and closes by spring action.
- Ratchet handle – Similar to hemostats with various locking points on the ratchet.

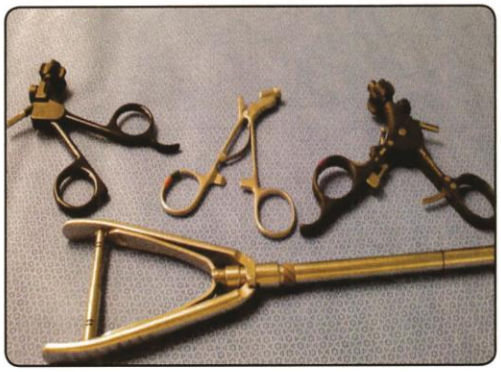


Figure 11.42

While most laparoscopic instrumentation can be mechanically cleaned, careful manual cleaning must take place first. Some laparoscopic instruments, such as scissors, use disposable tips. Disposable tips should be removed and discarded prior to instrument cleaning. Manufacturer cleaning instructions should be meticulously followed. All ports should be flushed and lumens should be brushed. Instruments that come apart should be disassembled. Due to the dark-colored surface, insulated instruments must be carefully inspected for cleanliness. Spatulas and hook tips must be carefully cleaned and inspected for cleanliness because they can be very difficult to get clean.

During assembly, multi-part instruments should be assembled to ensure they are in working condition. Multi-part items should then be disassembled for sterilization, unless otherwise stated by the instrument manufacturer. To protect these instruments from damage, care must be taken when placing them in a tray. If a tray designed for laparoscopic instruments is used, care should be taken not to bend the instrument shafts when placing or removing the instrument. Most laparoscopic instrumentation can be steam

sterilized; however, refer to the manufacturer's instructions to ensure the proper method of sterilization is used.

Robotic Instruments

In the past several years, robotic surgery has become very popular in many surgical specialties. While both laparoscopic and robotic surgery use small incisions to insert instruments and perform surgery, robotic surgery allows the surgeon to be remote from the patient (either across the room or across a continent). As with laparoscopic surgery, the instruments are complex and require careful attention to ensure they are clean, sterile and functional when needed. (See **Figure 11.43**)

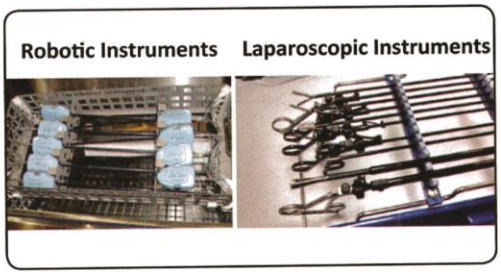


Figure 11.43

Robotic instruments are heavier than laparoscopic instruments. Mechanical and electrical components are located in the proximal end of the instrument. Robotic instruments are more difficult to clean than standard laparoscopic instruments because:

- They do not come apart for cleaning.
- The distal end of the instrument rotates.
- There may be multiple channels to flush in each instrument.

Like laparoscopic instrumentation, many of the working tips of robotic instruments look like their general surgery counterparts.

Carefully follow the manufacturer's cleaning instructions. When cleaning the distal tips of the instruments, brush as stated in the IFU, rotating the distal end to ensure the tip is clean. Flush the lumens as instructed by the manufacturer. When connecting to an irrigating sonic, ensure the sonic is approved for cleaning robotic instruments and the correct connectors are utilized. (See **Figure 11.44**)

Figure 11.44

Robotic instrumentation is very delicate and complex. Careful attention to the manufacturer's IFU throughout the entire processing process is essential.

Arthroscopy Instruments

Arthroscopic surgery is a type of endoscopic procedure performed on joints. (See **Figure 11.45**)

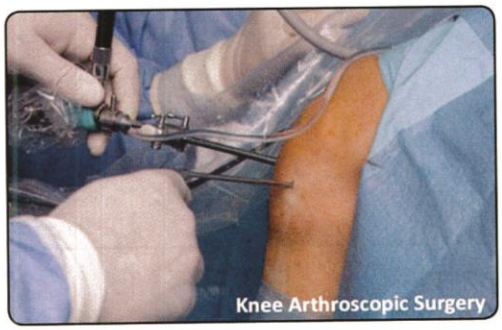


Figure 11.45

Because joints are small, enclosed areas, the instruments used for arthroscopic surgery are smaller than those used on other endoscopic procedures. Unlike laparoscopic instruments, most arthroscopy instrumentation does not look similar to general surgery instrumentation. (See **Figure 11.46**)

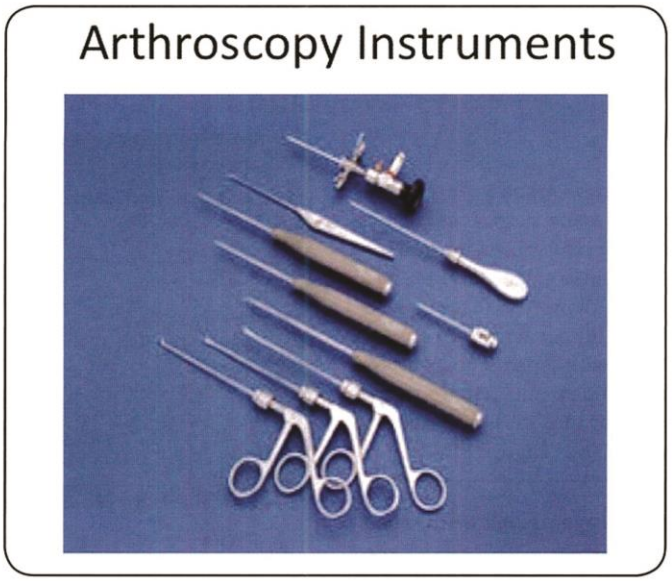


Figure 11.46

Arthroscopy shavers are complex instruments. Shavers can become clogged with debris during surgery, which can make them very difficult to clean. (See **Figure 11.47**)

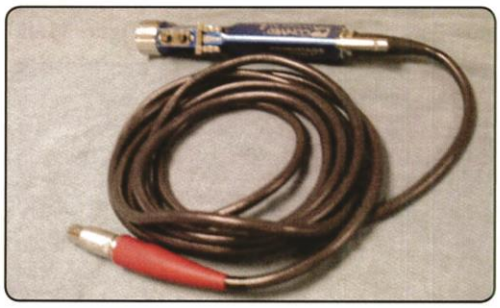


Figure 11.47

Due to the size and design of arthroscopic instrumentation, the manufacturer's IFU must be carefully followed during the entire processing cycle.

FLEXIBLE ENDOSCOPES

The term, "flexible," means capable of bending, thereby allowing the physician to gain easier access to internal body organs. Flexible endoscopes are complex instruments used to visualize inside the body, perform diagnostic tests, surgical procedures and/or to obtain tissue specimens for biopsy.

Flexible endoscopes revolutionized minimally-invasive surgical procedures because they gave surgeons access to parts of the body without performing an open procedure, thus minimizing patient discomfort and length of stay in the hospital.

Like many sophisticated medical devices, the flexible endoscope is a complex, reusable instrument that requires processing between patients.

Flexible Endoscope Components

Flexible endoscopes are comprised of a handle assembly, light source connector and a flexible shaft. The handle features control knobs that, when actuated, cause the distal end of the endoscope shaft to move. Small-diameter flexible endoscopes generally allow movement in two directions: up and down. Large-diameter flexible endoscopes allow movement in four directions: up, down, left and right. Flexible endoscopes can be classified as either fiber optic or video. The difference between the two is how the image is captured and transmitted by the endoscope.

A fiber optic flexible endoscope gathers the image via a series of lenses at the distal end of the endoscope. (See **Figure 11.49**) The image is transmitted to the eyepiece via a fiber optic bundle. Video flexible endoscopes require a power source and a video system to view the image. The image is captured and transmitted as an electrical signal to the viewing monitor.

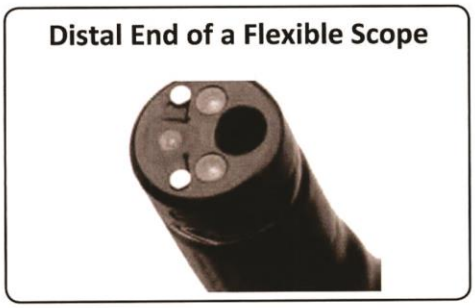


Figure 11.49

The internal components are contained and protected by an external sheath. The sheath is made of materials that can withstand exposure to bodily fluids, and they allow easy insertion and withdrawal. *Note: Care must always be taken when handling flexible endoscopes as sharp bends of the shaft or umbilical cable can cause damage.* Flexible endoscope lengths range from a typical esophagogastroduodenoscope (about 36" long) to colonoscopes (usually 60" or longer). Like rigid endoscopes, flexible endoscopes can also be described as either diagnostic or operative. Operative flexible endoscopes have a working channel that allows passage of a surgical instrument (i.e., Biopsy forceps or diagnostic brushes for scrapings). These scopes may also have channel(s) for suction, irrigation and insufflation to stretch the organ for better viewing.

Different caps are used to protect the scope from damage during various phases of reprocessing. If protective water caps are supplied, these must be in place whenever the scope is at risk of having water enter the scope. Flexible endoscopes may also come with a venting cap that opens the scope to the outside environment. The venting cap is used to allow sterilants, such as ethylene oxide (EtO), ozone or hydrogen peroxide, to enter and exit the scope channels. It is also used for shipping (particularly via air freight) to equalize pressure within and outside the scope. *Note: A venting cap must never be used when the scope will be exposed to fluids, as it will allow the fluid invasion and will likely result in damage.*

Types of Flexible Endoscopes

There are a variety of flexible endoscopes in use today.

Bronchoscope

Bronchoscopy uses a bronchoscope to directly visualize the tracheobronchial tree (bronchus) and allows:

- Diagnosis to secure uncontaminated secretion for culture, to take a biopsy, or to find the cause of a cough or hemoptysis (spitting up blood).
- Treatment to remove a foreign body, excise a small tumor, apply a medication, aspirate the bronchi or provide an airway during a tracheotomy.

Flexible intubation scopes are used to check the placement of endotracheal tubes during intubation.

Gastroscope/Esophoscope

Gastroscopy uses a gastroscope to visually inspect the upper digestive tract (including esophagus, stomach and duodenum), with aspiration of contents and biopsy, if necessary. Esophagoscopy is the direct visualization of the esophagus using a grastroscope.

Colonoscope/Sigmoidoscope

Colonoscopy involves the visual inspection of the entire large intestine with a colonoscope.

Sigmoidoscopy involves the visual inspection of the lower part of the large intestine with a sigmoidoscope.

These are important diagnostic tools, and may be used for biopsy and removal of polyps and to control bleeding ulcers.

Cystoscope/Ureteroscope

A flexible cystoscope is used to visualize the urethra and bladder. Ureteroscopes are used to visualize the ureter and kidney. It is passed through the urethra and bladder to the ureter/kidney to look for obstructions, such as strictures or kidney stones and tumors.

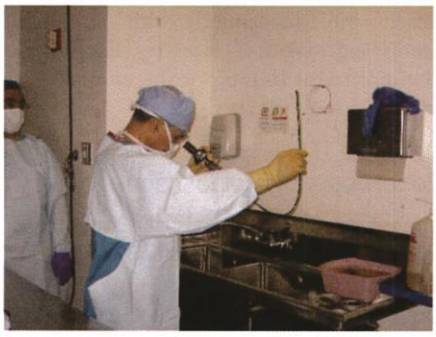
Rhino-Laryngoscopes

Rhino-laryngoscopes are used to visualize and perform procedures within the nose, sinus cavity or upper gastrointestinal (GI) tract.

CLEANING AND PROCESSING FLEXIBLE ENDOSCOPES

Manufacturer IFU, Centers for Disease Control and Prevention (CDC) guidelines, Society of Gastroenterology Nurses and Associates Inc. (SGNA) guidelines (for GI endoscopes) Association for the Advancement of Medical Instrumentation (AAMI) ST91 and hospital protocols must be followed regarding the care, handling and processing of all endoscopes and accessory devices.

Technicians who process endoscopes should also follow standard precautions. They must wear personal protective equipment (PPE), including gloves, gown, face masks and shields (or goggles),and shoe and hair coverings. (See **Figure 11.50)**



Wear appropriate PPE while cleaning flexible scopes.

Figure 11.50

Endoscopes should be processed in an area large enough to allow for the safe handling of the instruments.

Be sure to follow the scope manufacturer's IFU to ensure that only approved cleaning chemicals are used. Cleaning should be performed with soft, lint-free cloths or sponges and brushes specifically designed for use with the endoscope. Effective cleaning reduces disinfection failures by reducing the presence of organic soil that harbors microorganisms and prevents the penetration of germicides.

When selecting endoscope processing chemicals, one should consider whether:

- The chemical is approved by the specific scope manufacturer.
- The chemical is effective for the intended purpose.

Not All Scopes Are Alike

Due to the significant difference in the processes required for video and non-video flexible endoscopes, it is important to follow the manufacturer's IFU for the model and brand of flexible endoscopes being cleaned. Refer to each manufacturer's scope brand and model IFU.

Basic steps required to reprocess flexible endoscopes

1. Precleaning
2. Leak testing
3. Cleaning
4. High-level disinfecting (HLD)/sterilizing
5. Drying
6. Storing

Precleaning

Precleaning is the removal of gross debris from the endoscope's external surfaces and internal channels. Cleaning begins at the point of use to prevent blood or protein material, including patient debris, from drying on the instrument. Suction channels should be rinsed with clean water to remove as much blood and tissue debris as possible.

The insertion tube or shaft should be wiped with an enzymatic detergent solution approved by the endoscope manufacturer.

Leak Testing

The majority of flexible endoscopes require a leak test be performed prior to submerging the device during cleaning, and prior to HLD or sterilization. A leak test is necessary to ensure that the endoscope is watertight. A leaking endoscope should not be used on any patient, as the endoscope cannot be properly disinfected or sterilized. Depending upon the manufacturer's IFU, leak testing may involve dry leak testing or leak testing the endoscope while it is under water. In either case, the endoscope is pressurized via a hand pump or automated system. Damage from use, incorrect care and handling practices, or improper chemical exposure can lead to leaks in the covering or seals. Leak testing is, therefore, required before further cleaning can occur. It is necessary to consult the manufacturer's instructions for the proper leak testing procedures for the specific endoscope. *Note: Most scope manufacturers require the use of specific leak testers. Ensure the test is performed using the correct tool.*

Dry Leak Testing

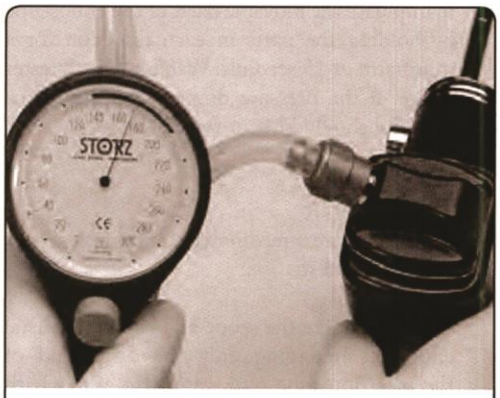
Some manufacturers recommend only a dry leak test be performed. To perform this test:

- Attach the leak tester and pressurize the scope. Do not place the scope in water. (See **Figure 11.51**)
- Follow the IFU for pressure testing the endoscope to the prescribed pressure, then manipulate the movable parts of the endoscope by holding the parts in each direction for a minimum of 15 seconds. Watch the leak tester gauge; if the pressure drops, the scope has a leak and should be sent for repair.

Wet Leak Testing

Some manufacturers recommend a wet leak test. To perform this test:

- First, pressurize the scope and check the distal end by submerging only the distal end of the insertion tube into water. The water bath should be clear water (with no chemicals), so air bubbles will be easily seen.
- Rotate the distal end of the endoscope. If no bubbles are observed exiting the bending section then the endoscope is totally submerged.
- After submerging the scope, use a syringe to flush water through all channels to remove any air that remains trapped within the channel; observe the exit area to see if air bubbles appear. (See **Figure 11.52**) Because air rises in water, bubbles can be trapped within the channel and may not emerge unless water is used to flush it out. If air bubbles are observed exiting the endoscope after previously flushing all air out of the channel, a leak has occurred. *Note: The most common areas for leaks is the bending rubber at the distal tip of the insertion tube [from within the working channel(s) or at the control knobs].* **Figure 11.53** shows leak damage to a scope.
- Remove the endoscope from the water and drain. Release pressure. Verify deflation of the endoscope.
- Disconnect the leak tester from the endoscope. *Note: Never disconnect the leak tester while it is submerged; water could enter the leak tester connector, and invade the endoscope's interior.*



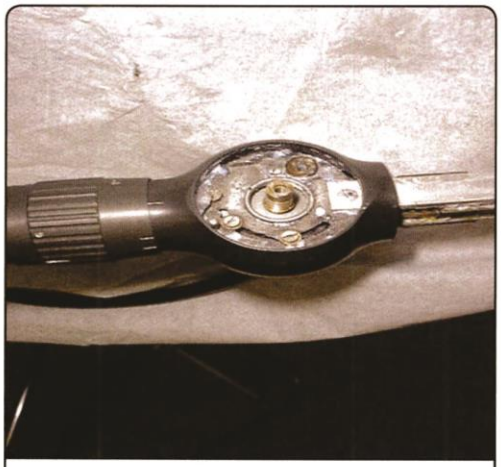
Leak Tester Connected to Scope

Figure 11.51

If the endoscope passed the leak test, it is watertight and reprocessing may proceed.

Figure 11.52

Any endoscope that fails a leak test should be immediately shipped to the manufacturer or an authorized repair company for repair. The Occupational Safety and Health Administration (OSHA) requires that medical equipment be decontaminated to the maximum extent possible before transport.



Inside of a Scope With Leak Damage

Figure 11.53

Cleaning Steps for Flexible Endoscopes

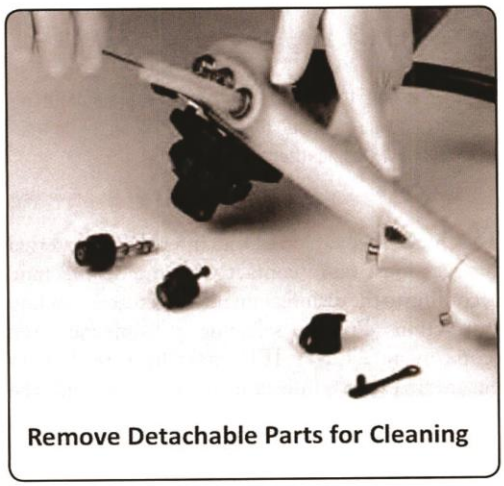
The following are general recommendations for cleaning a flexible endoscope. Always consult the scope manufacturer's IFU for specific cleaning information.

1. Thoroughly rinse the endoscope with water to remove all gross debris.

   Detach all removable parts (valves) and completely immerse the endoscope and valves in a mild/neutral-pH enzymatic cleaning solution. (See **Figure 11.54**)

2. Using a syringe or the manufacturer's supplied irrigation tubes and fill channels with cleaning solution.

3. Keep the scope immersed for the time recommended by the manufacturer.

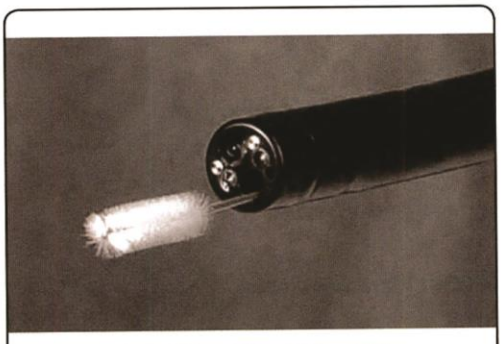


Remove Detachable Parts for Cleaning

Figure 11.54

4. While immersed, use a soft, lint-free cloth or sponge to wipe the exterior of the endoscope. Use a soft-bristle brush to clean the valves and any crevices of the videoscope. Be sure to use the correct size brush for the lumen's opening.

5. Insert a long, flexible brush into the channel at the proximal end of the endoscope. Be sure the brush is the correct diameter to clean the channel, and the correct length to reach the entire length of the channel(s). (See **Figure 11.55**)



Brush Exiting Distal Tip of Scope

Figure 11.55

6. Carefully push the brush through until the brush exits the distal end. Rinse the bristle of the brush to remove debris and fully pull the brush back through the channel. (See **Figure 11.56**)

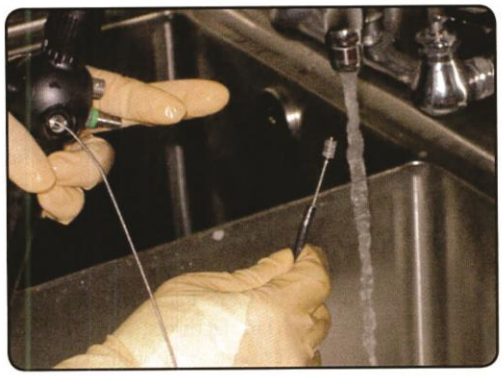


Figure 11.56

7. Rinse the brush again and repeat until the brush remains clean after passing through the channel. Consult the IFU for any special brushing instructions.

8. After the immersion period, remove the endoscope and valves from the cleaning solution and completely immerse them in treated water (water that has been processed to reduce impurities). Be sure to flush all the channels with water to remove the cleaning solution. Discard the water and repeat with fresh water, as recommended by the device manufacturer.

Scopes must be dried thoroughly to prevent the growth of microorganisms. External components can be dried with a soft, lint-free cloth. Internal channels are often dried with an alcohol flush or particle-free, low-pressure (less than five psi) compressed air. Consult the device IFU for specific internal drying instructions.

Quality Programs for Monitoring the Flexible Endoscope Cleaning Process

There is growing concern about the effectiveness of decontamination techniques for flexible endoscopes. Residual organic debris on processed scopes is a concern, and visual inspection is not 100% accurate. Scopes with lumens or channels pose one of the most difficult challenges in cleaning and inspection.

Testing any channel/lumen instrument, especially flexible endoscopes, is important because one cannot see down the channel/lumen.

AAMI TIR 12: 2010, Designing, Testing and Labeling Reusable Medical Devices for Reprocessing in Health Care Facilities: A Guide for Medical Device Manufacturers, recommends that users be able to test and verify their cleaning process.

Cleaning verification of flexible endoscopes should include:

- Visually inspecting both external surfaces and inner housing/channels of the flexible endoscope.
- Testing the cleaning efficacy of mechanical equipment, if used.
- Monitoring key cleaning parameters (e.g., temperature and dilution of chemicals) of both the manual and automatic cleaning process.
- Monitoring the results.

Published studies support testing flexible endoscopes for cleaning effectiveness. Users now have available various technologies that allow the inside of flexible endoscopes to be tested for organic soil residue or microbial contamination. Testing internal and external cleaning effectiveness on a routine basis will help ensure scopes are properly cleaned prior to disinfection or sterilization.

High-Level Disinfection

The minimum recommended practice for endoscope disinfection is HLD with an approved disinfectant.

High-Level Disinfection or Sterilization?

The decision to sterilize or high-level disinfect a surgical device is based upon its use according to the Spaulding Classification System.

To achieve adequate HLD, all internal and external surfaces must be in contact with the disinfectant, according to the disinfectant manufacturer's labeling instructions. Prior to selecting a disinfectant, the scope manufacturer's IFU must be consulted to ensure that the disinfectant is compatible with the instrument. In addition, if an automatic endoscope reprocessor (AER) is used, that manufacturer's IFU must also be consulted.

Several HLD solutions, including glutaraldehyde, ortho-phthalaldehyde (OPA), and peracetic acid solutions, are approved for endoscope disinfection. Testing of the dilution of each of these chemicals is required prior to each use. Ensure that the monitoring processes and strips are correct for the brand and concentration of disinfectant selected.

What about Other Disinfectants?

Some disinfecting agents are not recommended for use on endoscopes and endoscopic equipment. Reasons include incomplete antimicrobial coverage (failure to meet the definition of a high-level disinfectant), toxic exposure to personnel, or physical damage to equipment.

The disinfection process used (manual or automatic) is selected based on the type of scope and equipment available.

Manual Disinfection

Many departments do not have automated equipment readily available to high-level disinfect flexible endoscopes.

General Guidelines For Manual High-Level Disinfection

1. Prepare the disinfectant solution for use, per the manufacturer's IFU.
2. Place the clean scope into the appropriate container containing the HLD solution. Ensure that the scope is fully immersed and remove any air bubbles adhering to the surface of the scope.
3. Use a syringe, the cleaning adaptors, or the supplied irrigation tubes to fill all channels (including air, water, suction/ biopsy, elevator and auxiliary water) with disinfectant solution until no bubbles are seen exiting the channels.
4. Place all valves and removable parts in the disinfectant.
5. Set the timer for the correct exposure time.
6. After disinfection is complete, remove the endoscope, valves and removable parts from the disinfectant solution, and rinse the instruments by completely immersing them in treated water. Flush lumens carefully according to the device manufacturer's IFU.
7. Dry the endoscope according to the device IFU.
8. Document all processing information, as discussed in Chapter 9.
9. Label the scope with the date processed or date to process, depending on the facility's scope storage policy. (See **Figure 11.57**)

General Guideline for Automatic Endoscope Reprocessors

AER are machines that clean, disinfect and rinse flexible endoscopes. (See **Figure 11.58**) Their design permits the exterior of the scope and all lumens to be exposed to cleaning, disinfecting and rinsing solutions. To facilitate the flushing of the lumens, specific tubing connections must be connected. Endoscopes are then are placed in the AER after initial cleaning and brushing. The labels of some disinfectants require elevating their temperature above room temperature to achieve HLD. Most AER feature a heater that conveniently and rapidly elevates the temperature to a pre-determined setting. Because they are typically enclosed systems, most AER limit staff exposure to liquid chemical disinfectants and their vapors.

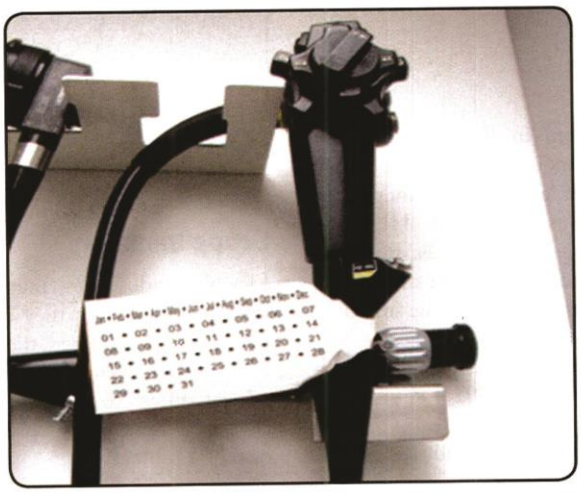


Figure 11.57

When Can An Automatic Endoscope Reprocessor Be Used?

Not all endoscopes and their accessories can be reliably processed in an AER. If not specifically indicated in the AER labeling, ask the scope manufacturer whether the endoscope being used has been tested in the AER.

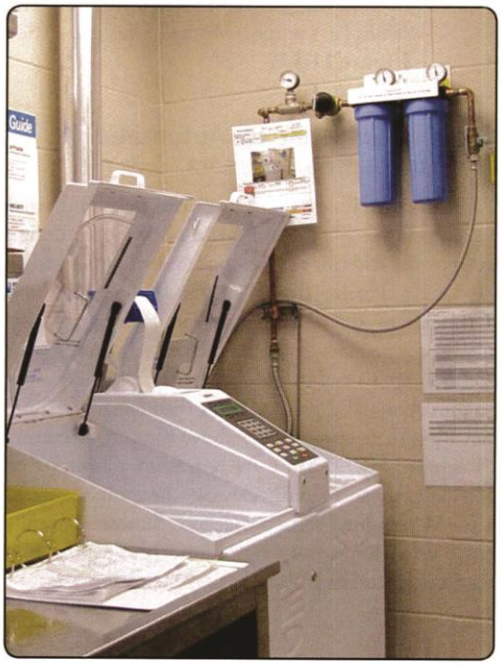


Figure 11.58

Storing

Storage is the final step in flexible endoscope processing. If flexible endoscopes are not stored properly, bacteria could grow, even though the endoscope has previously received HLD or sterilization. Dry endoscopes should be stored in a manner to prevent recontamination or damage from sharp, jagged edges. They should be stored:

- With the insertion tube hanging vertically (not coiled). (See **Figure 11.59**)
- With the weight of the control body supported, and angulation locks off.
- In a dry, dust-free cabinet with good ventilation.
- Without removable parts, such as control valves, distal hoods and caps, in place, to reduce the risk of trapping moisture inside the instrument. These items should be stored with the scope. The water-resistant cap should be removed from the video scopes while they are in storage.
- If multiple scopes are stored in the same cabinet, they should not touch other scopes.

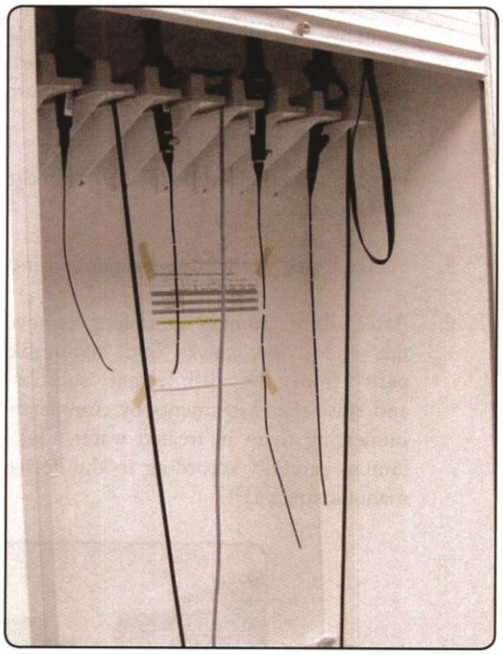


Figure 11.59

Scope Transport

Flexible endoscopes must always be carefully transported because they can be easily broken. If not properly contained, they can become damaged when struck against walls, doorways, carts and other fixtures. To prevent this, endoscopes should always be transported loosely coiled and with their distal tip protected.

Sterilization of Flexible Endoscopes

Package and sterilize the endoscope following the manufacturer's IFU. Some flexible scopes sterilized using low-temperature sterilants may require a venting cap during sterilization. (See **Figure 11.60**)

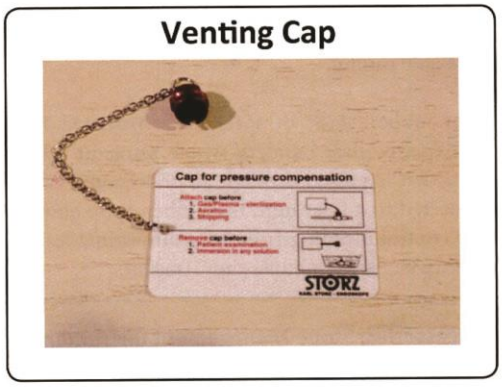


Figure 11.60

Carrying Cases

The carrying case used to transport endoscopes outside the healthcare environment should not be used to store an endoscope or transport the instrument within the facility. Contaminated endoscopes should be bagged prior to placing them in the carrying case because the case can also become contaminated. A contaminated case could recontaminate endoscopes since the inside of the case has not been decontaminated. Most cases are lined with foam that cannot be properly cleaned and disinfected.

FLEXIBLE ENDOSCOPE ACCESSORIES

With the exception of the water bottle, endoscope accessories consist of two types: diagnostic and therapeutic. Depending upon the type of procedure, various and different diagnostic and/or therapeutic accessories are used with the endoscope.

Water Bottle Precautions

The water in an endoscope's water bottle (See **Figure 11.61**) is sprayed through the water channel to the patient's internal organs. For this reason, the bottle must be cared for properly. The water bottle should be sterilized at least once a day (ideally, after each use). Only sterile water should be used to fill it, and water should never be stored in the water bottle overnight. Clean and sterilize the water bottle per the manufacturer's IFU.

Figure 11.61

Flexible Endoscope Instruments

All reusable flexible endoscope instruments should be carefully cleaned following the manufacturer's IFU. These items usually come in contact with sterile membranes; therefore, they must be sterilized prior to use.

The following are examples of flexible endoscope instruments:

Biopsy forceps. Two distally-located cups or jaws that open or close when a control located at the proximal end is manipulated. Jaws can have smooth or serrated edges. When the edges are open, they expose a sharp spike that grasps the tissue. The tissue is seized between the jaws when they close to prevent tissue slippage. (See **Figure 11.62**)

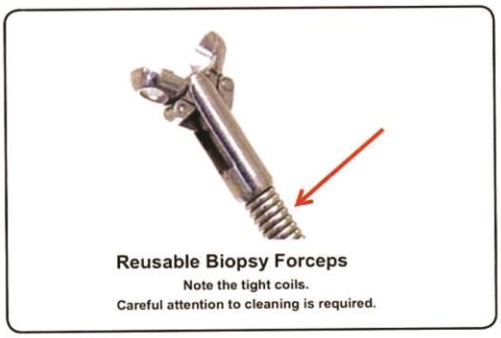


Figure 11.62

Brush for cytology. A plastic tube that encloses a wire and contains a short brush at its distal end. The brush is inserted through the endoscope's biopsy channel.

Cannulas for opacification. These small plastic (silicone) catheter-type devices have markings for visualization, located at the tip.

Measuring device. This flexible, rod-like accessory is marked at its distal end with a series of spaced bands.

Electro-coagulating ("hot biopsy") forceps. Similar to a biopsy forceps, but has a mechanism to direct electrosurgical current to lesions, so small polyps can be transected and cauterized to prevent bleeding.

Polypectomy snares. Consists of a pre-formed, oval or hexagonal wire loop (when opened) inside a plastic tubular sheath. The loop can be rotatable or nonrotatable, and is manipulated over the polyp and closed around its base like a noose. Electrosurgical current then burns the polyp free.

Polyp retriever. Features finger-like metal prongs inside a tubular plastic sheath. The prongs spread apart spontaneously when they are extruded from the sheath's distal end. The polyp retriever grasps tissue specimens for retrieval after they have been transected or cut free.

Foreign body forceps. Secures and extracts foreign bodies from the respiratory or digestive tracts. It is a modified version of biopsy forceps; the jaws are spoon, claw or serrated.

Stone management instruments. Used for the retrieval of stones from glands (such as salivary), and for retrieval from organs, such as the kidney or ureter. (see **Figure 11.63**)

Electrodes for electrocoagulation. A ball-tipped electrode is located at the distal end of a plastic cannula and is used for electrocoagulation of bleeding points and electrodesiccation of polypoid growths.

Injection needle. Used to inject sclerosis of esophageal varices (stretched veins), and for injection of marking dyes in the layer of loose connective tissue under a mucous membrane to designate the site from which a suspicious lesion was removed. It is a small (25-gauge), specially designed and retractable injection needle attached to flexible tubing.

Laser probe. Made of specially-constructed fiber optic quartz glass bundles, which transmit a laser beam that is passed through an endoscope. When connected to a laser unit, these fiber optic bundles help control bleeding from gastrointestinal lesions and can be used for stone vaporization.

Accessories; Stone Management Instruments

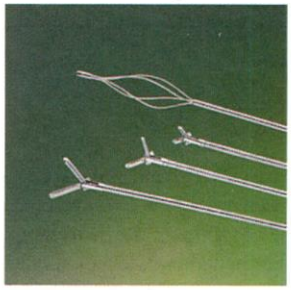


Figure 11.63

FLEXIBLE ENDOSCOPE REGULATIONS AND GUIDELINES

Federal regulations enable endoscope users to maximize safe care for the patient, while also protecting the equipment, users and the environment. In addition to federal laws, state and local governments may have stringent requirements. The following government agencies have rules or laws that impact the use of flexible endoscopes, and their requirements must be reflected in policy development and practice:

- OSHA: Provides broad guidelines and specific requirements to protect employees from workplace infections. www.osha.gov

- Department of Transportation (DOT): Ensures a safe, efficient, accessible and convenient transportation system. Its laws include those relating to the transport of biohazardous materials, such as minimally-processed endoscopes in need of repair. www.dot.gov
- CDC: Publishes disinfection and sterilization guidelines. www.cdc.gov
- U.S. Food and Drug Administration (FDA): Regulates and monitors multiple standards regarding IFU, disinfectants, sterilants and the manufacture of medical devices. www.fda.gov
- U.S. Environmental Protection Agency (EPA): Has issued regulations applicable to endoscope processing. www.epa.gov
- Numerous professional organizations have also developed professional guidelines and standards that impact endoscopy and endoscope processing. The Association for the Advancement of Medical Instrumentation (AAMI; www.aami.org); the Society of Gastroenterology Nurses & Associates Inc. (SGNA; www.sgna.org); the Association for Professionals in Infection Control and Epidemiology (APIC; www.apic.org); the Association of periOperative Registered Nurses (AORN; www.aorn.org); and others have written standards or guidelines for the safe use, reprocessing and care of endoscopes. (See **Figure 11.64**)

ENDOSCOPE-RELATED INFECTION PREVENTION

Effective infection prevention policies and practices are critical for minimizing or eliminating endoscope-related cross contamination. The flexible endoscope is particularly challenging for infection control. Its long, dark and narrow lumens

Sources for Endoscope Guidelines

Association	General Topic
The Society of Gastroenterology Nurses and Associates (SGNA) - (www.sgna.org).	• Guidelines for use of high-level disinfectants and sterilants • Safe and effective handling of glutaraldehyde solutions • Reprocessing flexible gastrointestinal endoscopes
The American Society of Gastrointestinal Endoscopy (ASGE) (www.asge.org).	• Infection control during gastrointestinal endoscopy. • Reprocessing of flexible gastrointestinal endoscopes.
The Association of Professionals in Infection Control and Epidemiology (APIC) (www.apic.org).	• Guidelines for infection prevention and control in flexible endoscopy.
The Association of PeriOperative Registered Nurses (AORN) (www.aorn.org)	• Guidelines for cleaning and processing of flexible endoscopes and accessories.
Association for the Advancement of Medical Instrumentation (AAMI) (www.aami.org)	• Guidelines for chemical disinfection. • ST91: Comprehensive guide to flexible and semi-rigid endoscope processing in health care facilities
American Society for Testing and Materials (ASTM) (www.astm.org)	• Standard practice for effectiveness of cleaning processes for reusable endoscopes

Figure 11.64

pose a fundamental processing concern because they are not directly accessible and are extremely difficult to clean. In addition, if channels are not thoroughly dried after processing and are stored wet, they become a dark and damp environment that is suitable for bacterial growth. Most flexible endoscopes cannot be sterilized by high-temperature, and are functionally and cosmetically sensitive to the chemicals needed for cleaning, disinfecting and/or sterilizing.

Other issues that can negatively impact infection prevention efforts include:

- Failure to leak test or to test correctly. An unidentified hole in the endoscope permits contaminants to grow exponentially with each use, and cleaning chemicals can damage internal components.
- Poor manual cleaning that does not effectively remove bioburden from the endoscope. This reduces the effectiveness of disinfection or sterilization chemicals.
- Failure to follow the original equipment manufacturer's instructions.
- Failure to follow directions on the labels of processing chemicals.
- Failure to use the proper brush size.
- Failure to adequately flush all channels with disinfectant solution.
- Failure to fully immerse the scope in the approved disinfectant.
- Failure to adequately time the length of disinfectant contact.
- Use of disinfectant solutions after their expiration date.
- Failure to sterilize scope instruments.
- Improper scope repair.
- Variations in staff training.
- Improper processing of reusable cleaning accessories.
- Improper storage and transport.
- Processing endoscopes more quickly than is prudent in order to perform more procedures.
- Processing scopes in inadequate space.
- Poor water quality.
- Improper drying and/or storage.

FLEXIBLE AND RIGID ENDOSCOPE CARE AND HANDLING

Due to their sophisticated and complex design, endoscopes are costly devices. On average, a rigid rod-lens endoscope will have a list price from $3,000 to $6,000.

Flexible fiber optic endoscopes have a list price between $8,000 and $25,000, and a flexible video scope can have a price ranging from $12,000 to over $100,000 for some of the advanced video scopes that contain microscopes and ultrasound units. In particular, the cost of repair and replacement of endoscopes is a major expense item, costing many large hospitals over approximately $750,000 or more per year. An average community hospital will spend over $200,000 per year on endoscope repair. It is estimated that 60-75% of scope damage is caused by improper care and handling practices; therefore, the majority of this expense is preventable.

Device damage not only impacts the healthcare organization's bottom line, it also increases stress levels and user frustration as these damaged items are often discovered during use. Damaged equipment delays cases and potentially exposes patients to longer anesthesia times, missed diagnoses and potential harm.

For these reasons, good care and handling practices for endoscopes, endoscope accessories and instruments must be used at all times by all staff members.

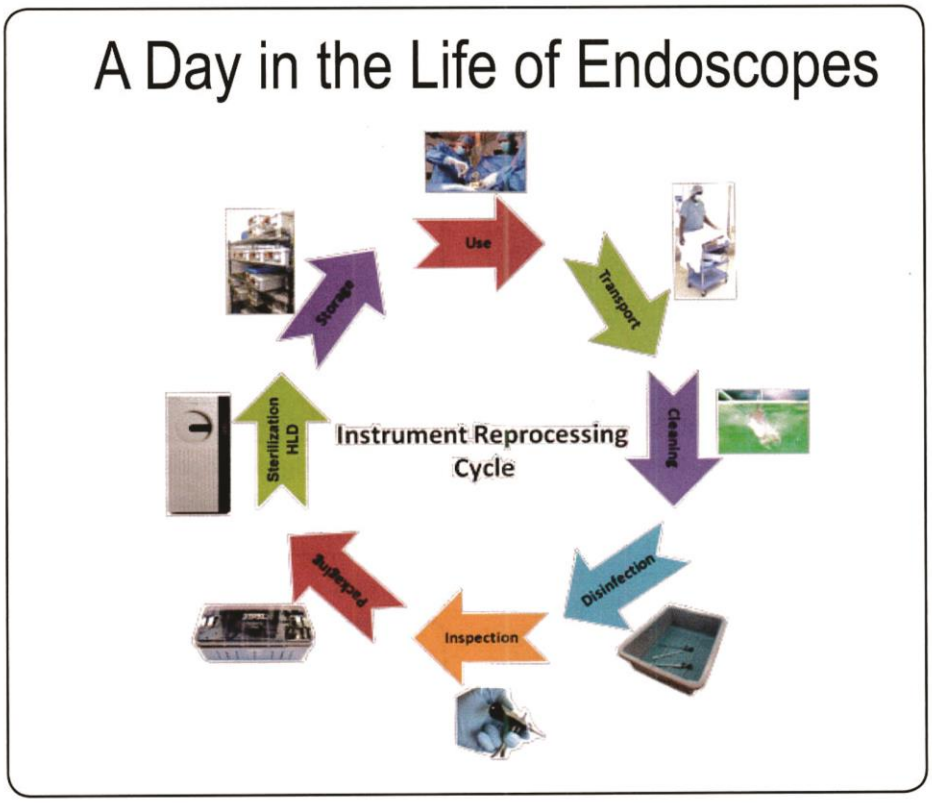


Figure 11.65

Endoscope Daily Use Cycle

Care and handling for endoscopes can be examined in each of the various stages of their daily cycle: (See **Figure 11.65**)

- Storage
- Transport
- Use in procedures
- Decontamination
- Preparation and packaging (prep and pack)
- Disinfection or sterilization

Storage

Storage should be broadly considered as any location of an endoscope when it is not in use. By this definition, lying on the back table in the Operating Room (OR) or hanging on the side of a video cart are all forms of storage. Viewing storage in this way enables one to see that storage is much more than just the container or cabinet that houses the endoscope.

If endoscope containers or trays are used, they must be of appropriate size to ensure that the endoscope is fully and properly encased. (See **Figure 11.66**) Bending or kinking a flexible scope can cause damage to the device.

If a tray is used, it should be protective and secure the endoscope so damage will not occur if the tray is tipped or dropped.

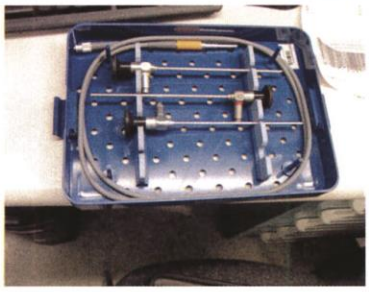
Figure 11.66

Flexible and rigid scopes should not be left in basins because the basin will not protect the scope. If left in a basin, flexible scopes will be too tightly coiled, which could result in potential damage; rigid scopes may fall out of the basin. (See **Figure 11.67**)

Figure 11.67

Transport

Transporting should be broadly defined as any time the endoscope is moved. By this definition, carrying either by hand, within a tray, or in/on a cart are all forms of transport. In each transport situation, the endoscope must be secured and protected. (See **Figure 11.68**) When carrying by hand, rigid endoscopes should be held by the housing body and not the shaft. Flexible endoscopes should be carried by the handle, while holding onto the distal end of the shaft and umbilical cable (if present). Endoscopes, even in trays, should not be transported unless safely secured. This will help ensure that they will not fall and become damaged. (See **Figure 11.69**)



Rigid Scopes in Case

The above items are packaged appropriately for transportation. Note that the endoscopes are locked in place.

Figure 11.68

Improper Transporting of Scopes

This rigid endoscope (in the silver container) was transported to the decontamination area on a ring stand. This stand was later moved and the rigid endoscope tray fell, damaging the endoscope.

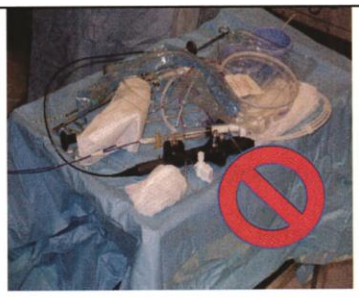
Figure 11.69

Procedural Use

An estimated 50% of damage to endoscopes and their accessories occurs during procedures. This can be caused by allowing the endoscope to come in contact with something that can cut, burn or otherwise damage the endoscope. Dropping accessory devices, using excessive force during the procedure and improperly storing endoscopes can also result in damage.

Other examples of damage caused by improper use include:

- Cuts in a flexible endoscope shaft caused by placing sharp objects on it.
- Damage caused by shaver blades contacting a rigid endoscope during arthroscopy.
- Laser damage.
- Scopes being dropped.
- Inserting the endoscope through a sheath or bridge where the sheath or bridge are bent, thus bending the endoscope as it passes.
- Inserting an instrument improperly through a working channel.
- Excessive force used by the physician, which can lead to excessive bending.
- Stacking instruments or other scopes on top of scopes. (See **Figure 11.70**)
- Allowing gross soil to dry on the scopes.
- Not securing the scopes prior to transporting.



Items Stacked on Scopes
This practice can cause scope damage.

Figure 11.70

Decontamination

Decontamination should begin in the OR/procedure room, with the department staff wiping off gross contamination and applying enzymatic spray to prevent drying. As directed by the manufacturer, suction channels should be cleared of gross debris by suctioning water or enzymatic solution through the channel. Prompt transport to the decontamination area is very important to prevent soils from drying on the endoscopes, instruments and accessories.

A significant amount of damage occurs to endoscopes in the decontamination area. Reasons may include:

- Improper placement of items in transport containers. (See **Figure 11.71**)
- Improper handling.
- Improper use of cleaning accessories, such as brushes and forced air.
- Improper chemical use.
- Failure to protect instruments and devices from damage.

Rigid Scope Improperly Placed in Basin

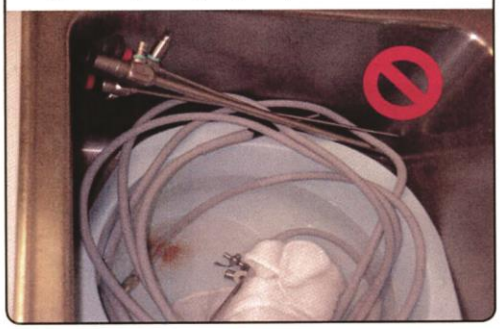


Figure 11.71

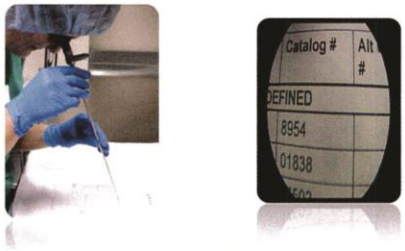
Preparation and Packaging

During the preparation and packaging process, the endoscope and accessories are examined and packaged properly for sterilization.

The inspection process is very important to ensure the proper function of the endoscope. The technician must understand the proper procedures

for inspection, and the manufacturer's IFU should be followed. The following are basic guidelines for addressing scope inspection:

- Closely inspect for damage and cleanliness.
- Functions such as light output, image quality and angulations should be examined, if applicable or possible.
- For rigid endoscopes used with bridges/sheaths, fit should be checked to ensure that the two devices go together with little to no force being applied.
- For all endoscopes, the distal and proximal windows should be inspected for cleanliness, and wiped off with 70% isopropyl alcohol and a soft cloth, if necessary.
- For non-video rigid scopes, the image quality should be tested by viewing typewritten print through the scope from a distance of about one inch. (See **Figure 11.73**) The image should be closely examined in the center and for 360 degrees around the outside edge to ensure that there are no blurry or dark areas. *Note: Most flexible fiber optic endoscopes have a focus adjusting mechanism near the eyepiece.*



Rigid Scope Testing

Left: Image inspection of a rigid endoscope. Right: Typewritten print under examination, which should be round, bright and clear.

Figure 11.73

Looking through an endoscope while viewing objects across the room is not an appropriate way to inspect image quality. Distance, color and patterns can obscure imperfections in the image.

- For non-video rigid endoscopes, the light fibers should be checked by pointing the distal end of the endoscope toward a light source and inspecting the light fibers to ensure that the color is white and that there are no (or minimal) broken light fibers.

Prep and pack is complete when the inspected endoscope is securely placed in the tray and properly prepared for sterilization.

Sterilization

Due to the variations in sterilization requirements for endoscopes, it is recommend that the manufacturer's IFU be carefully followed.

ENDOSCOPE CAMERA CARE AND HANDLING

Endoscope cameras are complex devices that typically range from $5,000 to over $25,000 each. **Figure 11.79** shows one type of endoscopic camera. An average repair cost is $3,500 and camera damage resulting in major repairs can cost over $9,000. The most common damage to cameras includes:

- Cuts in the cable.
- Cable/button damage due to improper chemical exposure.
- Damage to the coupler due to dropping or misuse.

Major damage occurs when components within the camera are affected, such as the imaging chip and/or circuitry boards. Dropping the camera can shift the prism or sensors. Fluid invasion through a button, cable or breach in the housing will also cause significant damage.

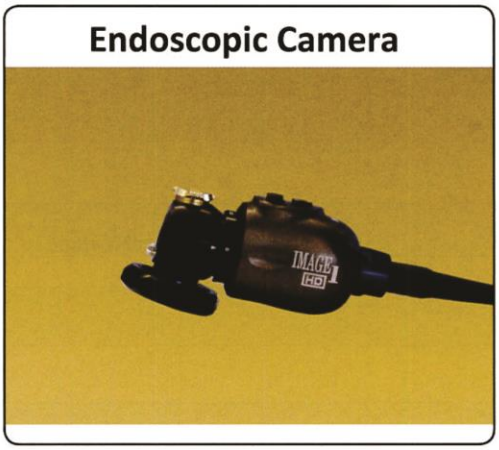


Figure 11.74

Camera Cleaning

The manufacturer's IFU should be followed to help ensure proper care and handling of the camera, including cleaning. The use of improper chemicals is a major contributor to premature failure of external components. In general, cameras should be precleaned in the operating/procedure room to remove gross debris and then transported to the decontamination area as quickly as possible to prevent drying of debris. An inspection of the camera should be performed, closely examining the camera cable for any cuts, nicks or other damage. *Note: Any damaged camera, including those with holes in the cable, must be sent for repair and should not be used in any procedure.*

Cleaning is performed using a soft cloth and a neutral pH enzymatic solution. Particular attention must be paid to the camera window. This window must be perfectly clean. If the camera has a water cap for the cable, this must be applied prior to submerging the camera. Disinfection and/or sterilization processes must be performed according to the manufacturer's IFU.

Camera Inspection

Inspection of the camera consists of checking the camera coupler by inserting a rigid endoscope onto a coupler. Most couplers open by turning in a counter-clockwise direction, and close by turning in a clockwise direction. The coupler tightens on the endoscope eyepiece, and should hold the endoscope so that the endoscope does not rotate within the coupler. If the endoscope rotates, try to tighten the coupler again. If the endoscope continues to rotate, the camera should be sent for repair. The cable and buttons should be inspected for any signs of cuts or other damage. Electrical connections should be inspected for any signs of damage or corrosion.

Image quality cannot be checked without the use of a complete video system and an endoscope.

ENDOSCOPE REPAIR

The best way to control repair costs of endoscopes and endoscope accessories is to manage and monitor care and handling practices to reduce damage.

When repairs are needed for any scope or accessory instrument, only qualified repair sources should be used.

Before any repaired or exchanged endoscope is placed back into service, a qualified staff member should inspect, clean and disinfect (or sterilize) the device prior to use.

STAFF EDUCATION

CS technicians working with complex medical instrumentation, such as endoscopes, must be thoroughly trained in proper processing protocols. Competency should be reviewed annually using a competency checklist. See the sample checklist illustrated in **Figure 11.75**.

Department-wide education is key to effective infection prevention in endoscopy and should be updated with any adopted change to chemicals or processes.

Sample Competency Checklist

Level:
0 - Cannot perform skill independently
1 - Requires assistance to perform skill
2 - Performs skill independently
N/A - Not Applicable

Method:
D - Demonstration
V - Verbal

Skill	Level/Method
Transports items according to departmental procedure	
Organizes and prioritizes work load appropriately	
Performs leak testing according to manufacturer's IFU	
Knows what product to use on each item for cleaning and disinfecting	
Understands the purpose of using alcohol to facilitate drying	
Knows how to and what to check for after cleaning the scope	
Knows how to and what to check for after cleaning the camera	
Knows how to and what to check for after cleaning the light cord	
Understands and can identify the different sizes and degree angles in scopes	
Can identify the different cameras	
Performs appropriate inspection and testing, according to manufacturer's IFU	
Knows how to correctly package all items for sterilization	
Handles all items with appropriate care	
Is familiar with and follows manufacturer instructions for handling and processing	

Figure 11.75

Other Specialty Instruments Create Processing Challenges

Each specialty service within the Operating Room and other areas within the facility and associated clinics typically have instrumentation that requires special care and handling. Examples include:

- Neurology – Stereotactic biopsy systems, aneurysm clip systems and testing electrodes
- Cardiology – Cardiac endoscopes
- Electro Physiology – Cables and cords

Each instrument must also be processed following the manufacturer's recommendations.

LOANER INSTRUMENTATION

Loaner instrumentation gets its name because the instrumentation is loaned from a vendor for a special case or procedure. Loaner instrumentation comes in many sizes and variations, and represents different challenges pertaining to ordering, receiving, decontamination, assembly, sterilization, storage and return of the borrowed items. Loaner instrumentation, once primarily used in orthopedic and neuro-surgical specialties, is now used in almost all surgical and procedural specialties. Facilities borrow instrumentation from manufacturers and distributing vendors because:

- The technology behind the instruments may change rapidly, causing instruments to be outdated rapidly.
- The cost of the instrumentation to perform relatively few procedures is prohibitive.
- More specialty cases are being performed than what the facility's instrument inventory can support.
- A physician or surgical specialty wants to trial the new instrument(s) or technology.

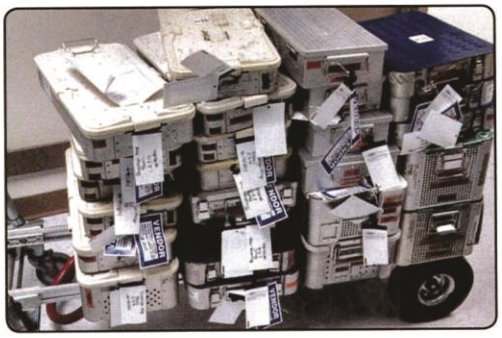


Figure 11.76

Loaner instrumentation may be received as one instrument or as numerous trays for a specific procedure. (See **Figure 11.76**) Each instrument requires special attention during processing. As the concept of borrowing instruments continues to grow, departments may receive several hundred trays in one day. Many of these instruments require special disassembly, cleaning and assembly protocols making them a challenge in most CS departments. It is important to have these loaned instruments delivered with enough time to properly process them for the scheduled procedures. After the procedure, enough time should be allowed to properly clean and disinfect these instruments prior to returning them to the loaning vendor.

Loaner instrumentation Instruments or sets borrowed from a vendor for emergency or scheduled surgical procedures that will be returned to the vendor following use.

Loaner Receipt and Inventory Procedures

Loaner instruments may be received at the facility in several different ways. Company representatives may personally deliver the instruments, or they may also arrive by next day carriers, U.S. mail and local courier services. This makes managing the process difficult. Policies and procedures need to be in place so standard practices are followed when receiving, handling and returning these expensive instruments.

The CS technician should log receipt of loaner instrumentation and implants with information including:

- Date
- Time
- Signature of delivery person
- Initials of receiving person
- Surgeon's name
- Patient's name or identifier
- Number of trays
- Number of implants

As soon as possible after receipt, loaner instruments should be inspected. This process should be done with the vendor representative, whenever possible.

The following steps should be taken when loaner instruments are received:

- Check each instrument to ensure proper function.
- Verify that the manufacturer's IFU are received (and up to date), and kept in the department's files.
- Complete inventory control check to verify the types and numbers of instruments and implants.
- Perform a quality assurance check by visually inspecting instruments and implants for damage.

Because the quality of the previous cleaning is unknown, it is advisable to wear gloves during the inspection process.

When completed properly, an inventory control sheet provides valuable information to protect the facility and the vendor. (See **Figure 11.77**)

Responsibility for the instruments should not be taken until the above procedures are completed, as the facility will be responsible for lost or damaged instruments.

Loaner Trays With Inventory Sheets

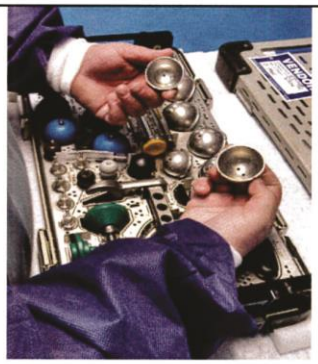
Figure 11.77

Decontamination of Loaner Instrumentation

All loaner instruments should be cleaned and decontaminated upon receipt and after use. Instruments that appear clean (even those received in sterilized containers or wrap) should be considered contaminated and must be properly cleaned. Loaner instruments can be difficult to clean and debris can be hidden in lumens, hinges and crevices. Each manufacturer has specific instructions about the type of enzymatic detergent, temperature and mechanical cleaning method to be used.

Loaner Instrument Inspection and Assembly

After cleaning and decontamination, CS technicians must inspect each device for cleanliness and functionality, and then assemble and prepare the loaner instrumentation for sterilization. Each instrument should be examined for residual bioburden and for any defects that might cause it to malfunction. (See **Figure 11.78**) Defective instruments should be documented and reported to the appropriate supervisor to prevent delays in scheduled procedures.



CS Technician Checking Loaner Instrumentation

Figure 11.78

Loaner instruments should be packaged according to the manufacturer's IFU.

Trays placed in another container system must be validated by the instrument manufacturer for use in that specific container. It is important to note that manufacturer-configured trays should not be reconfigured unless sterilization parameters for the new configuration has been validated by the manufacturer.

Each manufacturer establishes instructions for the sterilization of their instruments and sets. These instructions are based, in part, on the tray configuration and the complexity of the instrumentation. Facilities must follow the sterilization times and temperatures established by the manufacturer to help ensure sterilization of the loaner instruments.

Loaner Instrument Handling and Storage

After the loaner instruments have been sterilized, they should be moved to a department area with low traffic and allowed to cool away from the direct airflow of cooling vents. Trays should not be handled until properly cooled, which could take several hours. After cooling, trays should be handled as little as possible to prevent contamination or damage to the wrap. Care should be used when handling and moving the trays after the cooling process has taken place. These trays are often heavy and their packaging may be easily compromised (torn) if not handled properly. Loaner trays should be handled as little as possible and should never be slid across a surface. They should always be lifted and set on storage shelves or case carts for use in the OR. Use of transport trays is recommended to avoid damaging the processed trays. (See **Figure 11.79**)

Loaner Sets on Transport Trays

Figure 11.79

After the loaner trays have been used in the procedure suite, they must be processed. Each instrument should be carefully cleaned and decontaminated according to manufacturer instructions prior to releasing them to the vendor representative, or before sending the trays back via courier or shipping company. Vendor representatives may be in a hurry to take the instruments to another facility. Regardless, all instruments must be thoroughly cleaned and decontaminated prior to release.

Sometimes, loaner instruments are loaned to a facility for an extended time. These instruments should be stored in a protected area to decrease the potential of instrument loss or damage.

An exit inventory of all loaner instruments is recommended to help ensure that any missing or damaged instrumentation is identified in a timely fashion.

CONCLUSION

As technology advances, surgical instruments and equipment will become more complex, and this has been evident with endoscopic equipment and accessories. Central Service technicians will continue to be challenged with keeping current with new technologies and standards impacting endoscopic equipment, instrumentation and accessories to ensure that patients are provided with safe and functional devices for their treatment and care.

RESOURCES

International Association for Healthcare Central Service Materiel Management. *IAHCSMM Position Paper on the Management of Loaner Instrumentation.* 2011.

Centers for Disease Control and Prevention. *Guideline for Disinfection and Sterilization in Healthcare Facilities.* 2008.

Association for the Advancement of Medical Instrumentation. *ANSI/AAMI ST58: 2015, Chemical Sterilization and High-level Disinfection in Health Care Facilities.*

Association for the Advancement of Medical Instrumentation. *ANSI/AAMI ST79, A3 2012, A4 2013, section 6, Comprehensive Guide to Steam Sterilization and Sterility Assurance in Health Care Facilities.* 2012.

American Society of Gastrointestinal Endoscopy. *Multisociety Guideline on Reprocessing Flexible Gastrointestinal Endoscopes.* 2011.

Association for the Advancement of Medical Instrumentation. *AAMI TIR12, Designing, Testing and Labeling Reusable Medical Devices for Reprocessing in Health Care Facilities: A Guide for Device Manufacturers.* 2010.

The Society of Gastroenterology Nurses and Associates. *Guideline for Use of High-Level Disinfectants & Sterilants for Reprocessing Flexible Gatrointestinal Endoscopes.* 2013.

Olympus America Inc. Two Corporate Center Dr., Melville, N.Y. 11747-3157; 800.548.5515.

Circon Corp. 6500 Hollister Ave., Santa Barbara, Calif. 93117-3019; 888.524.7266.

Karl Storz Endoscopy-America Inc. 600 Corporate Pointe, Culver City, Calif. 90203-7600; 800.421.0837.

CENTRAL SERVICE TERMS

Endoscope

Light-emitting diode (LED)

Loaner instrumentation

Chapter 12

Assembly and Packaging

Learning Objectives

As a result of successfully completing this chapter, readers will be able to:

1. Explain the set up and function of the assembly area
2. Review basic procedures to prepare pack contents for packaging
3. Explain the basic objectives of the packaging process and review basic selection factors for materials to be used with specific sterilization methods
4. Provide an overview of reusable packaging materials
5. Provide an overview of disposable packaging materials
6. Discuss basic package closure methods
7. Review general packaging concepts:
   - Package labeling
   - Special concerns
   - Sterility maintenance

INTRODUCTION

When instruments have been cleaned, they are transferred to the **assembly area** of the Central Service (CS) department. This area is also known as the preparation and packaging (prep and pack) area, and its here where instruments are inspected to ensure that they are clean and in good working order before they are packaged for sterilization. This is a critical step because it is the last time the instruments will be handled before being dispensed to the Operating Room (OR) or other user area. Potentially serious problems can arise if a defective or unclean instrument arrives in the user department. When these incidents are detected, delays occur. When they are not detected, risks to the patient increase; therefore, it is imperative that protocols for inspection, assembly and packaging are followed at all times. Like other areas of the CS department, attention to detail is critical in the assembly area. CS professionals working in this area of the department must understand the configuration of their work area and the specific requirements that must be followed to work safely and effectively in that area.

Assembly area A clean area of the Central Service department where instrument inspection, assembly and packaging are performed. The assembly area is sometimes called the Preparation and Packaging (prep and pack) area.

ASSEMBLY AND PACKAGING AREA

The Physical Environment

The assembly/pack and prep area is a designated clean area; therefore, meticulous care must be taken to maintain that cleanliness. Airflow plays a critical role in keeping the assembly area clean and free of contaminants. Air pressure in the clean assembly area should be positive in relation to outside hallways, the decontamination area, break rooms, and other adjacent areas, with the exception of the sterile storage area. The purpose of this positive airflow is to ensure that when the doors to the assembly area are opened, air flows outward instead of into the work area. Positive airflow reduces the risk of airborne bacteria being introduced into the area.

Maintaining proper temperature is also critical. Temperature in the assembly area should be between 68° and 73°F (20° to 23°C). Relative humidity should be maintained between 30% and 60%.

Housekeeping standards for the assembly area should be the same as those for delivery rooms and the OR. To reduce the amount of bacteria in the area, fixtures, work tables and all other furniture in the area should be constructed of non-porous easy to clean materials. In addition to routinely cleaning surfaces, care must be taken to minimize dust and lint in the area. Dust and lint may settle on pack contents and be introduced into the patient's body during a procedure.

The Danger of Lint

Lint is composed of fine fibers that separate from items, such as wraps, towels and other textiles, paper and more. Lint can be carried on air currents and deposited anywhere. Microorganisms often adhere to lint. When lint is introduced into the sterile field, it can settle into a wound and cause infection.

CS departments should make every effort to minimize lint. Good cleaning practices and compliance with attire and housekeeping protocols can reduce lint and the chance of it entering the OR or inside of packs.

To further maintain environmental cleanliness, hand hygiene stations (handwashing sinks and waterless, alcohol-based hand rubs) should be conveniently located and readily accessible to all CS staff.

Proper lighting in the assembly area is essential. Work performed in this area is very detailed and inadequate lighting can lead to errors and eye strain.

Dress Code and Personal Behaviors

Personal cleanliness and adherence to dress code is essential for preventing microorganisms and contaminants from entering the work area. The cleaner the environment, the less chance there is of contaminants entering a pack.

Nail polish and artificial nails should not be worn in the prep and pack area because there is a potential for nail polish to chip and artificial nails to fall off. Natural fingernails should be clean and be kept at a length that does not extend beyond the fingertips. Long nails harbor bacteria that may hinder effective handwashing. **Figure 12.1** shows a technician in proper attire for the preparation and packaging area.

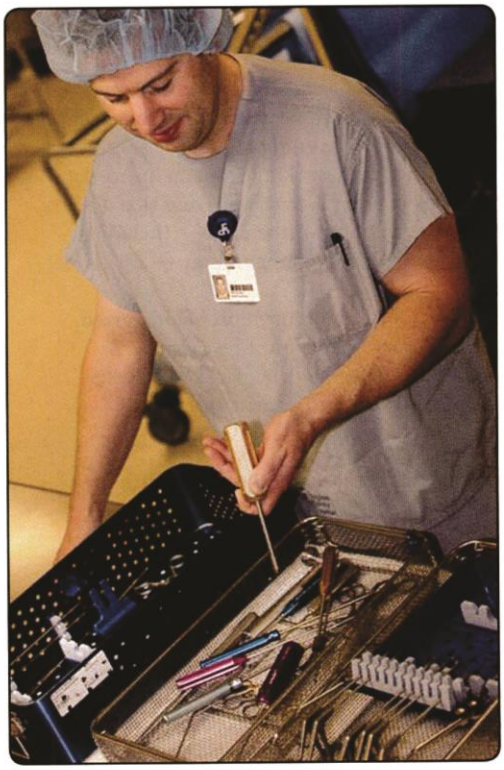


Figure 12.1

According to ANSI/AAMI ST79:2010/A4:2013, *Comprehensive guide to steam sterilization and sterility assurance in health care facilities*, all head and facial hair (except for eyebrows and eyelashes) should be completely covered with a surgical-type hair covering. Jewelry and wristwatches should not be worn in the area because they can harbor microorganisms.

All staff members in the area must monitor their cleanliness and change scrub attire if it becomes soiled. They must also perform hand hygiene, as necessary. CS professionals should not bring items into the area that may contaminate hands (e.g., money, personal items and personal electronics). *Note: CS personnel should consult their facility's policy about the use of personal electronics and how it relates to infection prevention.*

Traffic Control and Environmental Management

Everyone assigned to the prep and pack area should be mindful and protective of that clean environment. Traffic should be restricted and traffic control requirements must be followed. Care must be taken to ensure that items that may serve as vehicles for microorganisms are not allowed into the area. (See **Figure 12.2**)

Figure 12.2

Food and beverages are not allowed in the prep and pack area. Food and drinks may attract insects and rodents, and residues left on hands after eating may transfer to instruments and impede the sterilization process.

CS technicians assigned to the prep and pack area should always be mindful of potential contaminants that could have a negative impact on the packs they are assembling. Personal behaviors, such as following dress code, performing proper hand hygiene and avoiding situations that pose a threat of contamination, all help protect the patient.

Work Area Requirements

The work area in prep and pack should be adequately sized to perform inspection, testing and assembly duties. Supplies needed for those processes should be readily available. Equipment, such as computers, printers and specialized instrument testing devices, should also be readily available. (See **Figure 12.3**) The work area should be routinely cleaned to reduce bacteria and lint. (See **Figure 12.4**)

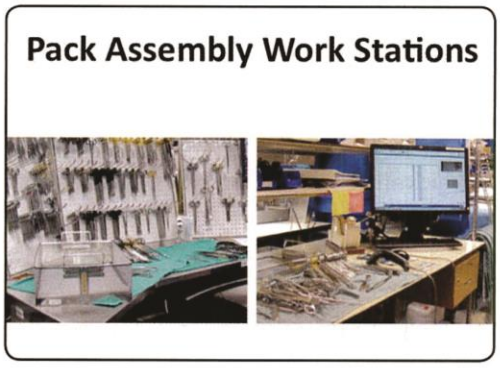


Figure 12.3

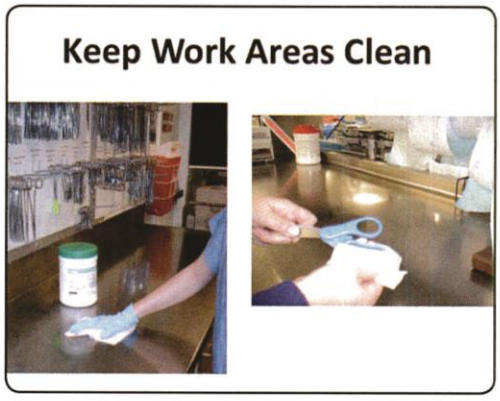


Figure 12.4

PRIMARY GOALS OF PACK PREPARATION

CS professionals assigned to the prep and pack area must understand the primary goals of creating an instrument pack. The first goal is to create a pack that meets the users' needs. The acronym"FAN," which stands for Functional, Accurate and Neat, can help reinforce that goal.

- Function. Each item in the pack must function as it was designed. This means that scissors must be sharp, clamps must hold securely, and multi-part items must be complete and functional when assembled. Technicians reach that goal by understanding how instruments operate and by relying on specific test methods to ensure that they work properly.

- Accurate. Instruments must be correct and quantities must be exact. Technicians meet this goal by learning to identify specific instruments, working from an up-to-date pack content list and verifying that all specifications for the pack — including quantities and configuration — are correct.

- Neat. Pack contents must be organized, and instruments must be easy to locate. Disorganized packs may waste time or delay treatment and care.

When assembling any pack for sterilization, remember the "**FAN**" principle.

All items must be **F**unctional, **A**ccurate and **N**eat.

In addition to creating organized packs that contain correct and functional instruments, CS technicians must also arrange pack contents in a manner that facilitates the appropriate sterilization process. As technicians arrange pack contents, they must also take precautions to protect instruments from possible damage or content shifting that may occur during handling and transport.

Technicians must then adhere to the packaging method recommended by the instrument manufacturers — one that is appropriate for the sterilization method that will be used for the items being packaged. Finally, technicians must use the proper packaging technique, as instructed by the manufacturer.

GENERAL GUIDELINES FOR PREPARATION OF PACK CONTENTS

Most instruments are prepared in groups called packs, sets, trays or kits. *Note: The specific name (kit, tray, set or pack) is determined by the healthcare facility.* Smaller groups of instruments used for smaller procedures in areas outside of the OR, such as suturing, wound irrigation or cutdowns (accessing deep veins for intravenous fluid delivery), are often called procedure trays (also known as floor trays). No matter what type of tray is being assembled and regardless of its size, preparation of pack contents begins with planning.

Clearly-written and illustrated procedures for preparation of items to be packaged (usually called count sheets) should be readily available and used by all personnel each time pack preparation procedures are performed. Many packs have unique characteristics that may require special configurations and preparations. Count sheets provide specific information that helps ensure all packs are assembled, packaged and sterilized according to exact specifications.

Item requirements for tray contents are usually identified by users. For example, a surgeon and OR staff would determine the contents of specific surgical trays. Pack content information may be collected and maintained in a manual (paper) system, or the information may be gathered and maintained with a computerized system (See **Figure 12.5**). Whichever method is used, the same basic information is provided to the assembler:

- Correct and complete name of the tray.
- A detailed list of tray contents, including item quantities, sizes and catalog or reference numbers.
- Essential steps for preparation and inspection, and for assembly and disassembly of device(s) according to the manufacturer's written directions and/or specifications.

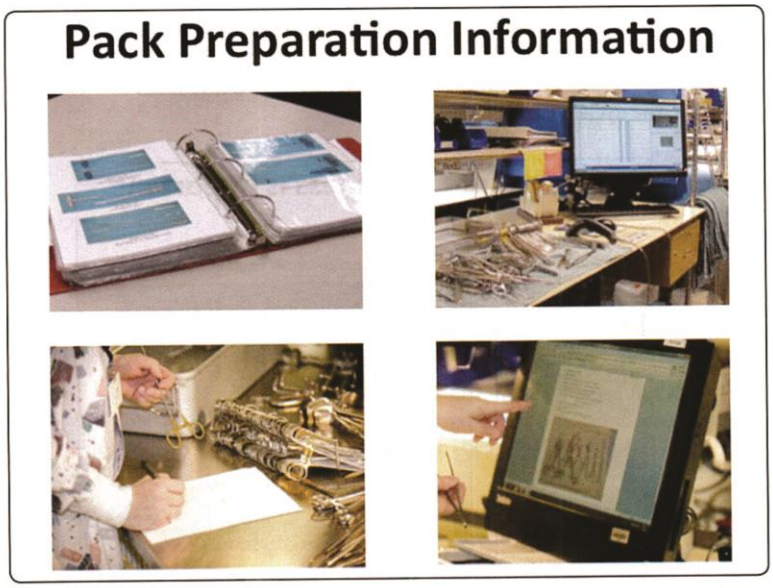


Figure 12.5

- Specific instructions for correct placement of items in the tray.
- Sterilization method and required cycle used for processing tray.
- Type(s) and size(s) of packaging to be used.
- Type and placement of internal and/or external chemical process indicator(s), in accordance with the facility's policies.
- Destination or storage location of the tray (i.e., Emergency Department or OR Cabinet 32, Shelf 4).

Once the information needed for assembly has been obtained, the pack contents can be assembled. All items to be sterilized must be completely dried prior to assembly and packaging, as water left on instruments can interfere with the sterilization cycle. Moisture issues affect different sterilization processes in multiple ways:

- Steam cycles – Moisture will change the wet/dry steam ratio.
- Ethylene oxide (EtO) cycles – Moisture will form ethylene glycol, which is harmful to staff and patients.
- Hydrogen peroxide and ozone cycles – Moisture will cause the cycle to abort.

Note: Some manufacturers recommend that lumens be moist for steam sterilization. If the manufacturer specifically requires this for steam sterilization, only those lumens should be moistened.

Pack Assembly

Before items can be assembled into trays, sets or packs for sterilization, they must be inspected and in some cases, tested to ensure that they are clean, correct and functional.

Inspection Guidelines

Each instrument should be carefully inspected upon assembly and packaging. Chapters 10 and 11 addressed inspection techniques for several common instruments. What follows are some basic guidelines for instrument inspection during pack preparation. *Note: Be sure to consult the manufacturer's IFU for inspection requirements for specific instruments.*

Inspect for cleanliness. Even though instruments have been cleaned, there may still be instances where some soil was not removed. (See **Figure 12.6**) Organic material, such as blood or other contaminants, will interfere with sterilization and optimal functioning. Inspecting instruments for cleanliness adds a safeguard to the process by reducing the chance that a soiled instrument is delivered to a user area.

Figure 12.6

If a soiled instrument is detected during the inspection process, it should be sent back to the decontamination area for proper cleaning. The tray that the soiled instrument was in should also be sent back to the decontamination area, as other instruments may have also been contaminated through contact with the unclean instrument. *Note: Do not attempt to clean the instrument in the assembly area. Doing so may contaminate the immediate area and may cross contaminate other areas of the department.*

Inspect for damage. Instruments may become damaged through use, misuse, transport and processing. Look for cracks, breaks, bent tips, misalignment and other signs of damage.

Inspect for signs of wear. Even with the best of care, instruments eventually begin to show signs of wear. Scissors and other sharp instruments become dull, surfaces break down, springs may weaken, screws may loosen and moving parts may begin to stick.

Damaged and worn instruments should be removed and sent for repair or discarded, as necessary. The continued use of broken or excessively worn instruments could put patients and/or facility personnel at risk. (See **Figure 12.7**)

Check multi-part instruments. Instruments that have been disassembled for cleaning should be reassembled and tested for proper function, and then disassembled again for sterilization. (See **Figure 12.8**) *Note: Small parts, such as wing nuts, should be placed in an approved containment device.* (See **Figure 12.9**) When placing disassembled instruments inside the tray, keep all parts close to one another, so they can be readily accessible in the OR.

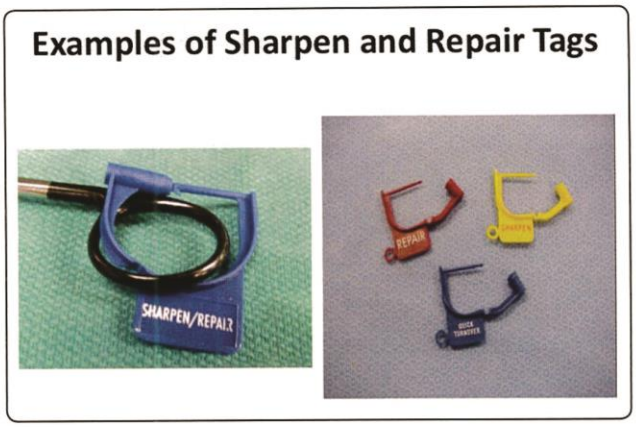


Figure 12.7

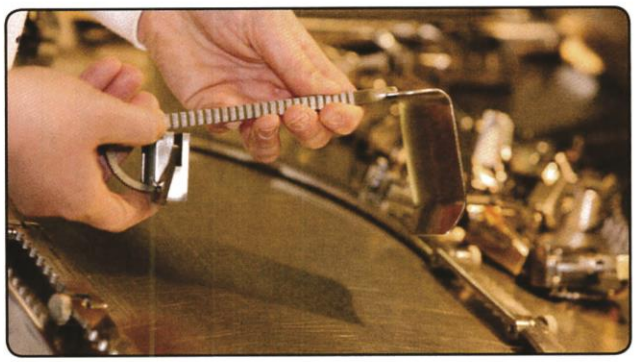


Figure 12.8

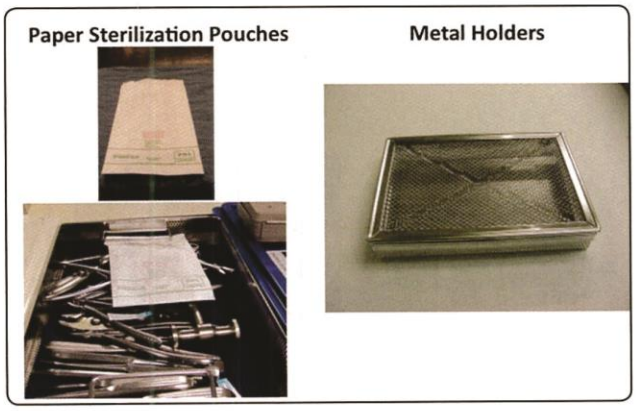


Figure 12.9

Figure 12.10

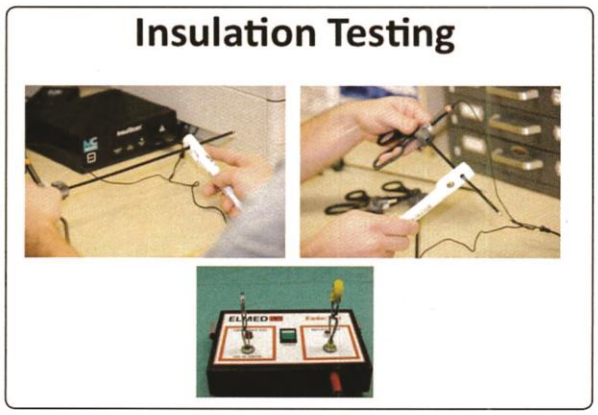


Figure 12.11

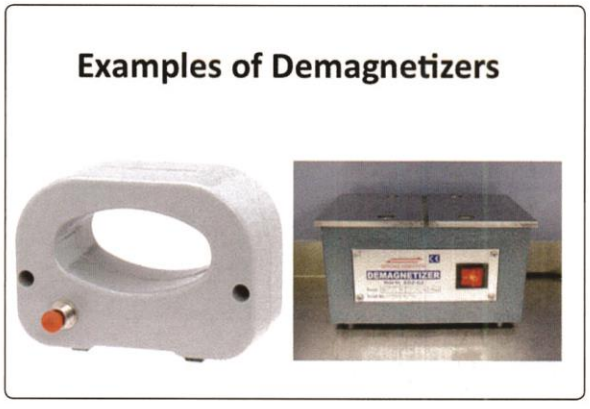


Figure 12.12

Testing

All instruments must be inspected before assembly. Some instruments must also be tested. For example, scissors should be tested for sharpness (See **Figure 12.10**) and the insulation of electrosurgical instruments must be tested between uses. (See **Figure 12.11**)

Demagnetizers. Occasionally, instruments may become magnetized. This is a source of frustration for the surgeon, especially with needle holders, as magnetization may make working with suture needles very difficult. Demagnetizers work by reversing the magnetic field away from the instrument. **Figure 12.12** provides examples of demagnetizers.

Tools for inspection. There are many tools available to help with instrument inspection. Magnifying lamps and computer magnifiers can enlarge areas to help detect residual soil, wear and damage. (See **Figure 12.13**)

Photos of instruments and instrument configurations (either hard copy or computerized) can also help ensure that items are assembled correctly.

Instrument scanning systems, instrument etching and instrument tape can help CS technicians identify devices and assist with pack assembly. (See **Figure 12.14**)

Instrument holding trays. Groups of instruments for a specific procedure or specialty are contained together in trays specifically designed to protect the devices and facilitate the sterilization process. (See **Figure 12.15**) Other instrument groups are contained in trays that can be adapted to several configurations. (See **Figure 12.16**) In most cases, the container is selected when the instrument tray is put into the surgical instrument system.

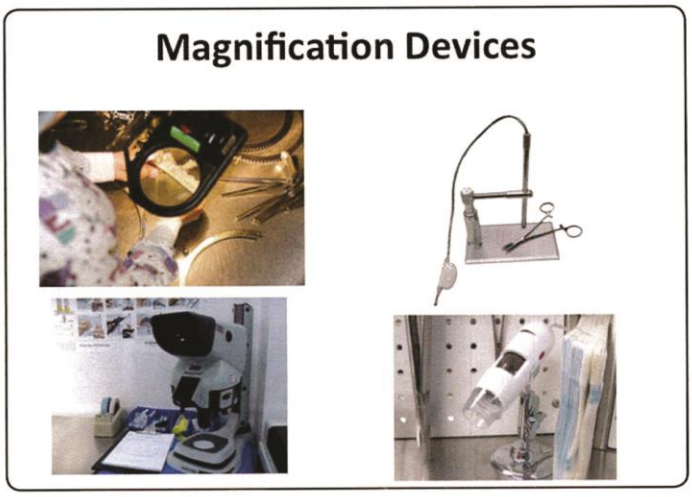


Figure 12.13

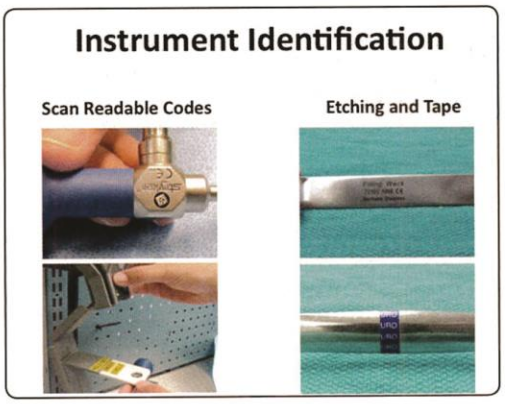


Figure 12.14

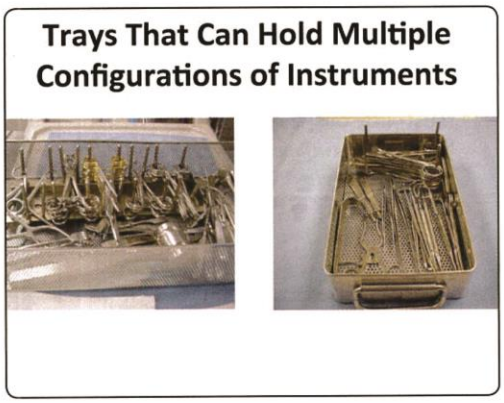


Figure 12.16

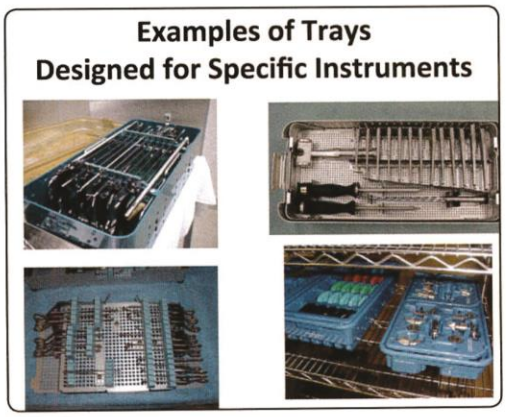


Figure 12.15

The following are points to consider when using instrument holding trays:

- Use the holding tray correctly.
- Read the manufacturer's IFU and use the tray as instructed. Failure to do so can damage instruments or cause the sterilization process to fail. For example, trays with silicone finger mats must be aligned with drainage holes to help ensure air and water removal during steam sterilization. (See **Figure 12.17**)

- Do not overcrowd the holding tray. Overcrowding often occurs when instruments are added to an existing tray. Over time, physicians' needs may change and instruments may be added to trays, creating a situation where the tray is too small for its contents. (See **Figure 12.18**) When this happens, there is a greater risk of instruments being damaged. In some cases, severe overcrowding may impact sterilization and drying.

- Don't create overweight trays. Be aware of tray weight and density recommendations from the manufacturers of sterilizers, instruments and packaging systems. In addition to possible issues associated with heat-up and drying, excessive tray weight can present ergonomic challenges for those who must lift the trays. ANSI/AAMI ST77, *Containment devices for reusable medical device sterilization* and ANSI/AAMI ST79, *Comprehensive guide to steam sterilization and sterility assurance in health care facilities*, recommend a maximum weight of 25 pounds for containerized trays; this includes both the weight of the instruments and the instrument container. (See **Figure 12.19**)

- Protect instruments from damage. As discussed in Chapters 10 and 11, all instruments should be protected from damage when handled. Delicate and sharp instruments are of special concern. Sharp points may be protected with special holders, commercially-available tip guards, silicone mats, holding brackets, posts or foam sleeves. **Figures 12.20** and **12.21** provide examples of methods to protect instruments. Suppliers of protective devices should be consulted to ensure that the devices are permeable to the sterilant being used.

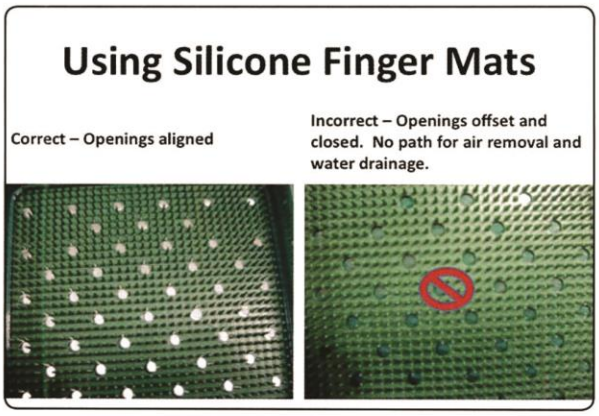


Figure 12.17

Figure 12.18

Figure 12.19

For example, latex tubing should not be used to protect instrument tips, as it may prevent the sterilant from making direct contact with the instruments.

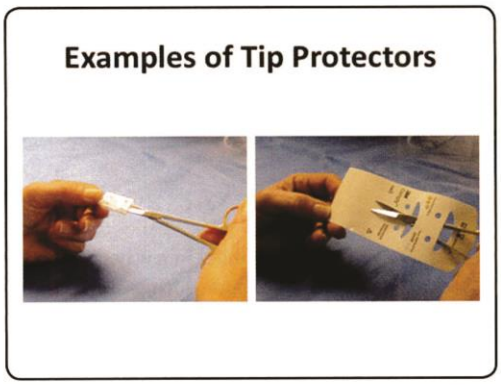


Figure 12.20

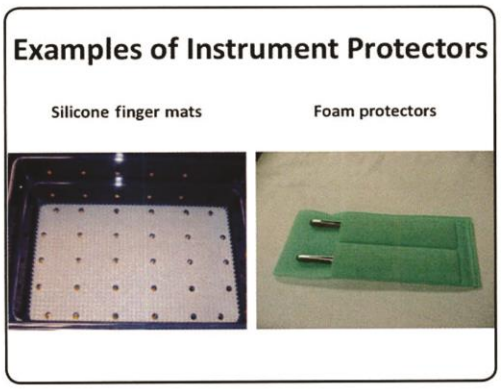


Figure 12.21

Instruments that open, such as scissors and hemostats, should be kept in unlocked, open positions to enable the sterilant to reach all parts. Devices such as instrument stringers and racks can be purchased to keep hinged instruments open. (See **Figure 12.22**) Always follow the manufacturer's IFU for specific requirements.

Protect the alignment of forceps tips by placing all tips in the same direction. (See **Figure 12.23**) Forceps tips can also be protected by using an approved containment device.

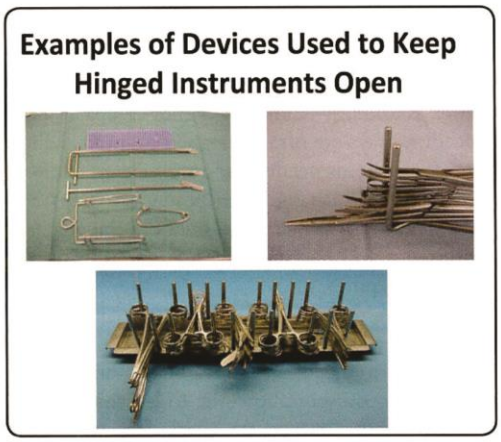


Figure 12.22

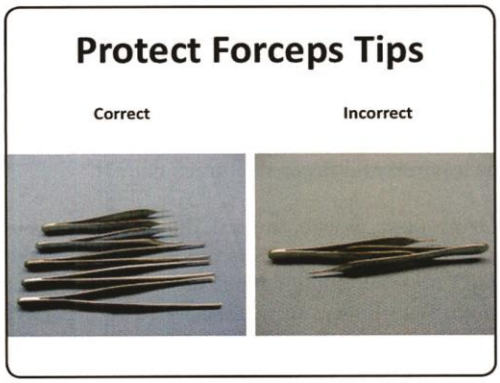


Figure 12.23

The most important thing to remember with all pack preparation is that all items must be functional, accurate and neat/organized because the next time the pack is accessed, it will be used for patient care.

Assembly Procedures

Pack contents and pack configurations are unique. CS technicians must apply basic principles to pack assembly to create packs that can be successfully sterilized and meet the users' needs. The following section provides an overview of general assembly guidelines.

Procedure Trays

Procedure trays are used in patient care settings such as nursing units and in procedure areas, such as the Radiology and Emergency Departments. Procedure trays are often designed to include all or most of the items needed for a minor procedure. It is important to disassemble multi-part items and place all items in trays in a manner that prevents air entrapment and pooling of condensate during the sterilization process.

In the past, the inclusion of disposable (single-use) items, such as needles, scalpel blades and suture, in trays was common; however, today, this practice is uncommon. To sterilize single-use items, the manufacturer's IFU (including resterilization instructions) must be on file and carefully followed. If the manufacturer's instructions for resterilization of a single-use item cannot be obtained, the item should not be included inside an in-house sterilized procedure tray. If approved single-use items are sterilized in the healthcare facility, they must not be resterilized if they are returned unused.

Gauze sponges and surgical (huck) towels were also commonly used in procedure trays in the past; however, many studies now show that lint from these items can be transferred to a patient wound — even in minor procedures — causing complications, such as blood clots or infection. Prepackaged sterile towels purchased from an outside vendor or processed in house should not be opened and used on trays because they may **super heat** within the sterilization cycle. If super-heating occurs, the tray they are in (and other trays within the load) will potentially be unsterile. Towels should be laundered after sterilization to rehydrate the fibers prior to sterilization. Prepackaged, sterile towels from an outside vendor should not be laundered unless the IFU have been obtained from the towel manufacturer because these towels are usually made of lower-quality material to allow for single use and no relaundering.

Super heating Super heating steam occurs when dry steam becomes too hot compared to saturated steam. Dry steam rises to a temperature higher than the boiling point of saturated steam. This commonly occurs when dehydrated linen is processed in a steam sterilizer. Due to the lack of moisture, dry steam is not an effective sterilant and will often char or burn items in the sterilizer.

Basin Sets

Basin sets should be assembled in a way that allows moisture to drain from them during sterilization. Moisture is a concern when preparing basins for sterilization because when steam contacts metal, it is immediately cooled when the heat from the steam transfers to the metal. As this occurs, the steam condenses and forms water droplets on the metal. When multiple basins are sterilized together, **wicking material**, such as a surgical towel (See **Figure 12.24**) or specially-designed wicking materials, can be used to facilitate drying.

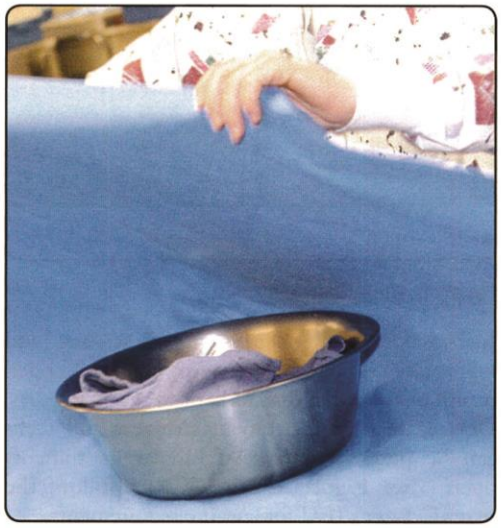


Figure 12.24

If basin sets are too dense, the excess amount of metal may cause condensation, thereby creating a wet pack. To avoid this problem, additional

absorbent materials may be added. Very dense sets should be divided into two separate sets.

All items that will collect water must be placed in the same direction to facilitate drainage. When multiple basins are sterilized, there should be at least a one-inch size difference in basins that will be placed together to allow for condensate drainage and drying.

Wicking material An approved absorbent material that allows for air removal and steam penetration, and facilitates drying.

Instrument Trays

As with procedure trays, each instrument tray should have a detailed count sheet available during instrument assembly. Technicians should never try to assemble an instrument tray from memory, as the contents change, or items could easily be forgotten. Technicians should avoid counting total tray contents as a method of assembling instrument trays (e.g., counting a total of 100 instruments instead of verifying each type of instrument needed). Each instrument should be identified, inspected, verified against the count sheet and placed properly in the tray.

Standardization of the instrument arrangement within each tray is important. Instrument trays should look the same, regardless of which technician assembled them. This saves time and reduces stress for the user. The order or arrangement in the tray should be determined by the CS manager and user department personnel.

It is important to note that CS technicians must place the required number of instruments in the tray. Placing too few or too many will disrupt the instrument count and may delay a surgical procedure while the needed instruments are located. Instrument substitutions should not occur, unless approved by the user department. If packaging an incomplete instrument tray is unavoidable, the users should be notified and the tray should be clearly marked to indicate what is missing. (See **Figure 12.25**)

Clearly Mark Incomplete Trays

Figure 12.25

Instruments of the same type should be arranged together to facilitate their location during an emergency. Hinged instruments may be grouped together on racks, tray pins or stringers to ensure that instruments with locks are maintained in the open position. Heavier items must be placed at the bottom of the tray to avoid damage to more delicate instruments. Delicate instruments should be protected using items such as approved foam pouches, tip protectors, silicon mats, holding brackets or posts. Instrument protectors should be approved by the manufacturer for the type of sterilization method to be used.

The use of towels or tray liners for cushioning instruments or wicking should be determined based on the metal mass in the tray and the external package manufacturer's IFU.

Gauze sponges should never be used as additional packaging (wicking) material in trays or packs. Surgery staff count gauze sponges during procedures, and their counts must be exact. The introduction of additional sponges into the OR as packaging material may cause confusion and affect sponge counts.

There may be sterilant penetration or weight distribution concerns that prevent the "perfect tray"

arrangement requested by the user department. CS managers should inform user department personnel about sterilization limitations. The ultimate goal must always be to create a tray that can be successfully sterilized.

Powered Surgical Instruments

Manufacturer instructions should always be followed when preparing powered surgical instruments for sterilization. This includes the use of the correct disassembly and lubrication procedures. Trigger handles should be placed in the safety position, and power switches should be turned off before placing the instruments in the tray.

Powered surgical instruments often use a sterilization container supplied by the manufacturer. (See **Figure 12.26**) Extended or special sterilization conditions may be required and details about these procedures should be supplied by the instrument's manufacturer. After items are inspected, disassembled (if necessary) and placed in a container according to the manufacturer's instructions, the tray is ready to be packaged for sterilization.

Figure 12.26

Specialty Instruments

Specialty instruments, such as laparoscopic instruments, robotics, endoscopes, cameras and others, are of special concern for CS technicians. Manufacturer IFU must be carefully followed to ensure that proper disassembly, assembly and sterilization procedures are completed. Many of these specialty instruments are contained in specialty containers to prevent damage during handling.

Single Instruments

The term "single instrument" is used to describe instruments that are to be packaged alone and it can also refer to like instruments packaged together (e.g., a single Mayo scissors or a package of six Kelly clamps). These instruments should be assembled according to the department's established protocols for size and number of instruments.

Surgical Supplies

Numerous non-instrument surgical supplies, such as cotton balls and dressings, may be required by users. Most of these items are available as commercially-sterilized products and it is often more cost effective to purchase them presterilized. If the facility chooses to process them internally, however, these and similar items should be wrapped individually or in usable quantities, based on the product manufacturer's IFU and the user's need. These items should not be sterilized without the manufacturer's IFU on file within the department. Due to the linting factor, most surgical supplies should not be sterilized inside trays or packs.

QUALITY ASSURANCE MEASURES - INTERNAL CHEMICAL INDICATORS

Part of the assembly process for every pack includes a quality assurance test designed to measure sterilant penetration. Incorrect placement of pack contents, incorrect packaging methods or incorrect loading can impede the sterilization process by creating air pockets or barriers that can prevent the sterilant from penetrating the pack and making direct contact with the items inside. Internal **chemical indicators (CIs)** are designed to identify those issues before a pack is used. *Note: Sterilization process monitoring methods are covered in detail in Chapter 17.*

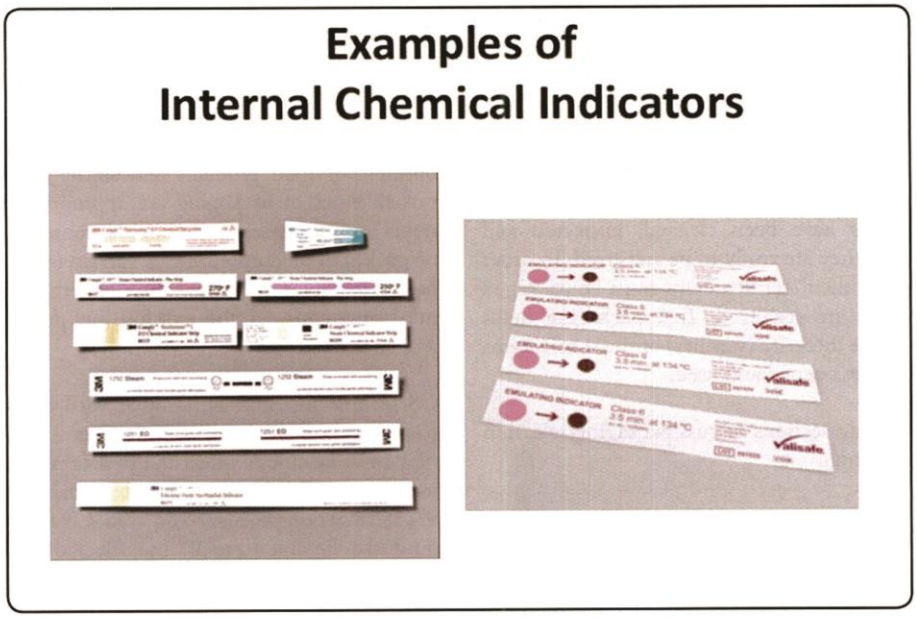


Figure 12.27

Chemical indicators (CIs) Devices used to monitor the presence or attainment of one or more of the parameters required for a satisfactory sterilization process.

A CI is a small, disposable test that helps the user verify that the pack contents were exposed to a sterilant. (See **Figure 12.27**) When exposed to the specific sterilant they are designed to detect, their color changes, providing a visual indication of the presence of sterilant in the pack. When the pack is opened at point of use, it is checked by the user. Users will not use a pack that has a failed internal CI. They will also not use a pack that does not contain a CI.

When used properly, the CI becomes a very important early warning that something may be wrong with some aspect of the sterilization process. CIs should be placed inside each pack in the area considered the least accessible by the sterilant being used. That may or may not be in the center of the pack's contents. In some cases, multiple CIs may need to be used if there are multiple areas that could pose a challenge for sterilant penetration. Multi-level trays should have a CI placed in the most difficult area for sterilant penetration on each level of the tray.

Commonly-used internal CIs include:

- Class 5 integrating indicators are designed to react to all critical parameters and to be equivalent to or exceed performance requirements, over a specified range of sterilization cycles. When used inside a **process challenge device (PCD)**, non-implant loads may be released with the appropriate results indicated on the CI.

- Class 6 emulating indicators, also called verification indicators or cycle specific indicators, are designed to react to all critical parameter of a sterilization cycle. Class 6 indicators are designed to be run within one specific cycle (e.g., 270°F, four-minute exposure). This is the only cycle this specific indicator may be used. If a 275°F, three-minute exposure cycle is to be run, an emulator specifically made for that cycle must be used.

Note: It is important to use the appropriate indicator for the intended method of sterilization and cycle.

Process challenge device (PCD) Object that simulates a predetermined set of conditions when used to test sterilizing agent(s).

BASIC PACKAGING PROCEDURES

Once items have been cleaned, inspected and assembled, they are ready to be sterilized. In order to maintain their sterility, items must be packaged before they are sterilized. That packaging helps maintain the integrity (sterility) of the sterile items until they are opened and used.

The following sections discuss packaging selection and application.

Overview of the Sterile Packaging Process

CS technicians must select the appropriate packaging material and apply it correctly to create a pack that can be sterilized successfully and maintain sterility until it is opened.

One can draw some comparisons between food packaging and sterile packaging. Both types of packaging must protect items and keep them from becoming contaminated before they are used. Both can be compromised in a way that affects the package's contents and makes them unsafe for use.

Sterile packaging is designed with **tamper-evident seals,** so users can tell if the package has been opened. (See **Figure 12.28**) Many food products use these tamper-evident seals on their packaging for the same reason. There are several packaging options for food products and sterile items, and not all types of packaging are appropriate for all items and processes. For example, soup could not be packaged in aluminum foil, carried to work and heated in a microwave oven. Sterile item packaging must also consider the sterilization process that will be used.

CS technicians must be familiar with the various packaging materials available for sterilization and they must be able to select the packaging, which is most appropriate for the item to be packaged and the sterilization process to be used. CS technicians must also be able to apply the selected packaging in a manner that facilitates the sterilization process and protects the package contents during the storage and handling that follows sterilization.

Tamper-evident seals Sealing methods for sterile packaging that allow users to determine if the packaging has been opened. Tamper-evident seals allow users to determine if packages have been opened (contaminated) and help users identify packages that are not safe for patient use.

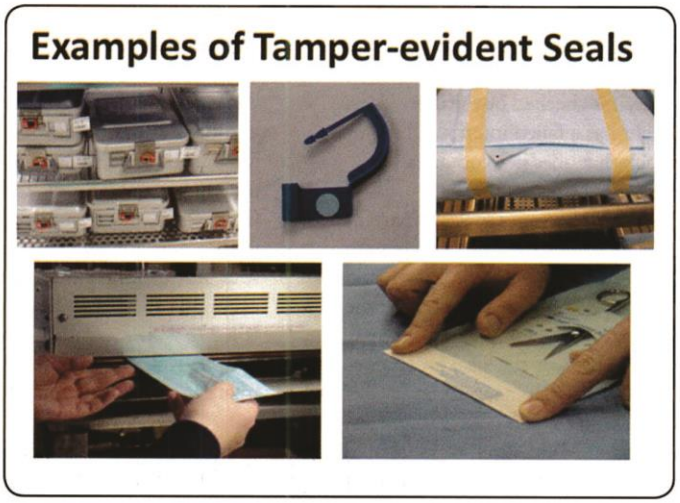


Figure 12.28

Objectives of the Packaging Process

There are three primary objectives for any sterilization packaging system. It must:

- Allow penetration of the chosen sterilant and be compatible with any other requirements of the specific sterilization process, such as drying.
- Maintain the sterility of the package contents until the package is opened.
- Create a package that can be opened aseptically (without contaminating the contents) by the user.

Packaging systems must also:

- Have a sealing method that is tamper evident
- Be nontoxic
- Be nonlinting
- Be easy to use
- Be cost effective

The FDA classifies sterilization packaging as a Class II medical device (a device that presents a potential risk). The consequences of using a nonsterile item during a surgical procedure can be life-threatening. In addition to selecting and applying the appropriate packaging material, CS technicians must also be able to construct packages that allow the sterilization process to be successful and protect the package contents from contamination.

Selecting the Appropriate Packaging Material

The first step in the packaging process is to select the appropriate type of packaging material and method. Different types of packaging are needed for alternative sterilization methods, and styles of packaging may vary based on package contents.

CS technicians must make good packaging choices. Since there is no single packaging material for all situations, CS technicians must select the material that is best suited for the sterilization process to be used. Only materials specifically designed for sterilization packaging and approved by the FDA are acceptable. In addition, there are other special concerns based on the sterilization method that will be used:

- Packaging used for steam sterilization must be capable of withstanding high-temperatures of 250°F to 275°F (121°C to 135°C). The packaging must allow air removal and steam penetration to the contents, and permit drying of the contents and packaging material.
- Packaging choices for ethylene oxide (EtO) sterilization must allow adequate penetration of the gas sterilant and removal of the residual gas (aeration).
- Packaging choices for hydrogen peroxide sterilization must tolerate a deep vacuum draw without absorbing the sterilant, interrupting the cycle or damaging the contents. Packaging must also be cellulose free.
- Packaging choices for ozone sterilization should be cellulose free, such as spunbond-meltblown-spunbond and spunbond polyolefin (both of these products are discussed later in this chapter).

In addition to selecting the appropriate packaging material, CS technicians must understand how to use sterilization packaging appropriately to achieve the desired results, sterilant penetration, barrier effectiveness and aseptic opening.

Packaging systems used in healthcare facility-based sterilization are generally classified into reusable packaging and disposable (single use) packaging materials. Each packaging system has advantages and limitations. The following sections provide some basic information about common packaging systems and their application.

REUSABLE PACKAGING MATERIALS

There are two basic types of reusable packaging material: woven fabric and rigid containers.

Woven Fabric Materials

Before the early 1980s, woven textiles were the reusable packaging material of choice; however, new technologies have increased the choices for sterilization packaging. The standards for manufacturing today's packaging materials have been based on penetration and microbial barrier capability measurements for a minimum of 140-thread count (threads per square inch) **muslin**.

Muslin, Type 140 cotton, calico, and barrier cloth are common names for fabrics made of 100% unbleached, loosely-woven cotton fibers. Muslin wrappers are generally made of two-ply (double thickness) fabric fastened together as one wrap. (See **Figure 12.29**).

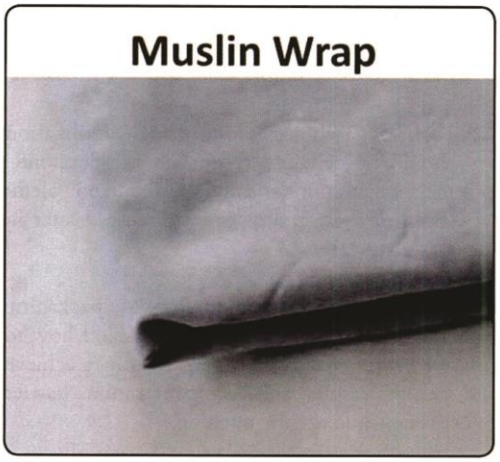


Figure 12.29

Other woven fabrics used in sterilization are:

- Duck cloth
- Twill
- Treated barrier fabrics

Note: Canvas is not recommended as a packaging material because its tight weave impedes steam penetration and drying.

Muslin Broad term describing a wide variety of plain-weave cotton or cotton/polyester fabrics with approximately 140 threads per square inch.

Textile packaging is still the packaging method of choice for some healthcare facilities. The selection of reusable textiles is often impacted by costs and/or environment sustainability concerns (the desire to reduce the waste generated by disposable packaging materials). Some facilities contract with off-site companies to pick up used textile wraps and then launder, inspect and return them to the facility for reuse.

Textile packaging requires more labor because it must be laundered and inspected to ensure that there are no tears, punctures, worn spots or stains from previous use. That inspection is performed using a light table that has a light source built into the tabletop to help spot small holes and punctures. As the wrap is passed over the lighted table top, light shines through small holes and punctures making them easier to identify.

If holes, punctures or worn spots are discovered, the linen wrap must be repaired using a heat-sealed patch designed to cover the hole. The size of the surface area covered by heat-sealed patches on reusable fabrics should be considered before the fabric is reused. (See **Figure 12.30**)

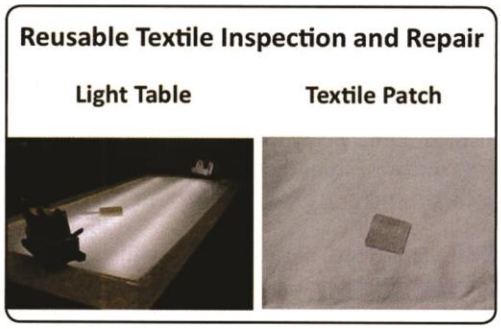


Figure 12.30

Reusable materials with approved heat-sealed patches can be effectively sterilized; however, the limit (the percentage of exposed area that can be patched) depends on the method of sterilization, positioning in the sterilizer, number of layers of patched fabric and type of fabric patch. Some patching materials are not fully steam penetrable, but are surface sterilized only. Although the sterilant entering through unpatched areas may be sufficient to sterilize the pack contents, excessive use of non- or semi-permeable patches may hinder the sterilization process. A facility's Infection Prevention and Control Committee should investigate the use of patched wraps to establish an "accept/reject" standard for the total surface area of patch that is permitted for use within the facility.

If stains are discovered, the wrap should be re-laundered. If stains cannot be removed, the wrap should be removed from service.

Textiles must also be de-linted as needed to minimize the risk of lint entering the sterile pack and, ultimately, the sterile field. (See **Figure 12.31**) Reusable textiles can be a significant source of lint. If lint enters a patient's incision, it may cause negative effects.

De-linting Reusable Textiles

Figure 12.31

When assembling linen packs, their size is limited to 12" (height) x 12" (width) x 20" (length), and they are not to weigh more than 12 pounds. Maximum density must not exceed 7.2 pounds per cubic foot because higher densities may reduce sterilant access to all contents.

Linen wrappers should be securely applied without compressing package contents. Contents must be packaged with sufficient spacing to enable the sterilant to reach all surfaces.

Tight packaging will not allow for fiber swelling (expansion); when expansion occurs the sterilant will not penetrate the material. It is possible to wrap even a small pack so tightly that its density will be too great for adequate sterilant penetration. Muslin-type wrappers must always use a sequential type wrapping process. *Note: This topic is discussed later in this chapter.*

Rigid Container Systems

Rigid container systems are box-like structures with sealable and removable lids. They are made of anodized aluminum, stainless steel, plastic or a combination of these materials. Rigid containers have lids and filters that allow sterilant penetration while providing a microbial barrier. Filters may be disposable (a synthetic spunbond product) or reusable (with ceramic filters or a valve system). Rigid containers consist of an inner basket to hold the instruments and an outer container that acts as a protective barrier. Both the inner basket and outer container have handles for ease of carrying.

Figure 12.32 identifies the common components of a rigid sterilization container system's outer container.

Some manufacturers of rigid container systems recommend that times for instrument sterilization, drying and aeration be extended when using their containers. It is important to consult the specific container manufacturer's IFU before using a rigid container system. Rigid containers are regulated by the FDA, and containers are required to have a 510(k) premarket submission certifying they will perform as an effective packaging material.

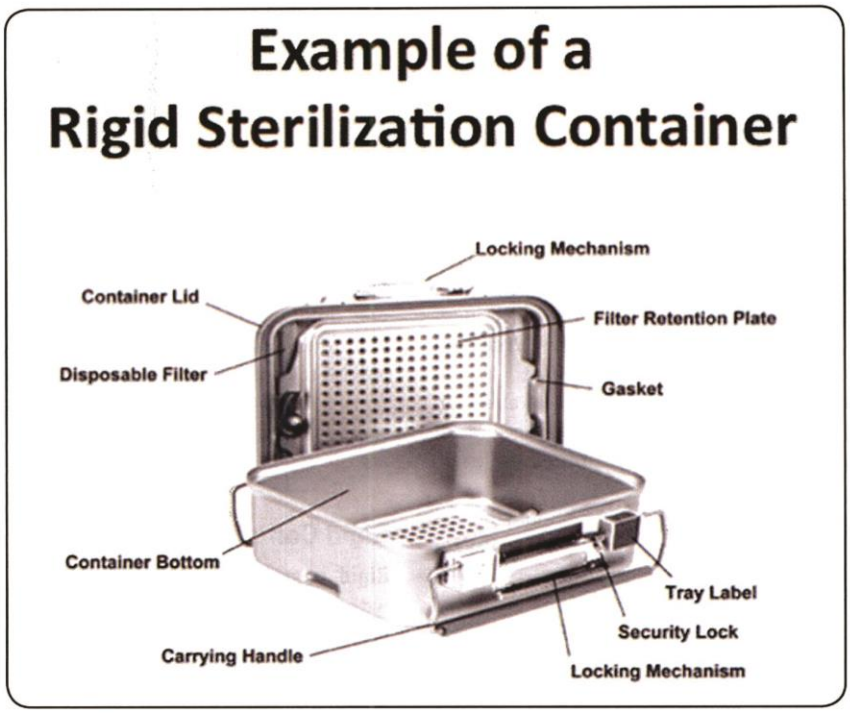


Figure 12.32

Advantages and Disadvantages

There are several advantages of rigid sterilization containers. They:

- Provide an excellent barrier to microorganisms.
- Are easy to use.
- Eliminate torn wrappers.
- Help protect instruments from damage during processing, storage and transport.

Rigid container system Instrument containers that hold medical devices during sterilization and also protect devices from contamination during storage and transport.

There are also potential disadvantages to the use of these systems, including:

- Safety concerns linked to ergonomics. Some large (12"x23"x6") empty containers weigh approximately seven to nine pounds. This requires CS technicians to use good body mechanics when lifting and moving containers. *Note: Loaded instrument baskets must be added to this base weight, and employees should be able to comfortably carry a container or instrument set at waist height.*
- Additional cycle time may be required to thoroughly dry the container. Sterilization efficacy is also impacted as a container's weight increases because of excess condensation. **Wet packs** have been noted and discussed for many years. While it is difficult to generalize about specific causes of wet packs, it is known that heavier sets and those with greater metal mass are more likely to experience this problem, especially when instruments are not properly disbursed in the container.

Wet pack Package or container with moisture after the sterilization process is completed.

- Plastic containers may require longer dry times because they lack metal, which produces heat by conduction to help drying.
- Additional space may be needed to store those containers that are larger than traditional wrapped containers. (See **Figure 12.33**)

Rigid Sterilization Container Storage

Figure 12.33

- Additional labor may be required since the containers must be cleaned between uses. This may also affect washer loads if a mechanical washer is used. (See **Figure 12.34**)
- Latching mechanisms on containers create potential problems. When latches and welds break, the containers cannot be used. Also, sharp edges can injure employees.

Rigid Sterilization Containers Should be Cleaned Between Uses.

Figure 12.34

- Filter retention plates may become dislodged and contaminate instruments. *Note: Some manufacturers have addressed this potential problem by modifying or changing the design of the container's filter retention plate.*

Cleaning and Inspection Procedures for Rigid Containers

To clean a rigid sterilization container, first remove its disposable filters or release its filter protector/holder. Valve-type closures must be cleaned according to the manufacturer's written instructions. Interior baskets must be removed and cleaned. Dividers/pins may need to be removed if they interfere with the cleaning process.

Cleaning and rinsing instructions provided by the container manufacturer should be followed. Particular attention should be given to the type of detergent used. For example, some containers cannot be exposed to certain chemicals, such as high alkaline solutions.

Inspection should also focus on the top and bottom valve or filter mechanism and the latching mechanism. For example:

- The filter retention plate should be intact and not bent; the retention plate should seat over the filter and securely lock into place.
- The retention post should be secure and not move.
- If using disposable filters, they should be checked for holes prior to placing in the container. (See **Figure 12.35**) Filters should fit the space allotted, with no folding or crimping of edges. Filter material must be approved for the type of sterilization to be used.

Figure 12.35

- If using reusable valves, they should be clean and debris free, with no breaks or chips in the valve mechanism. (See **Figure 12.36**) Valves should fit securely and not move once seated.

Figure 12.36

- The lid gasket should be clean and free of cracks and nicks. There should be no ridges on the gasket. *Note: Ridges are caused by a tight fit between the top and bottom of the container.* (See **Figure 12.37**)

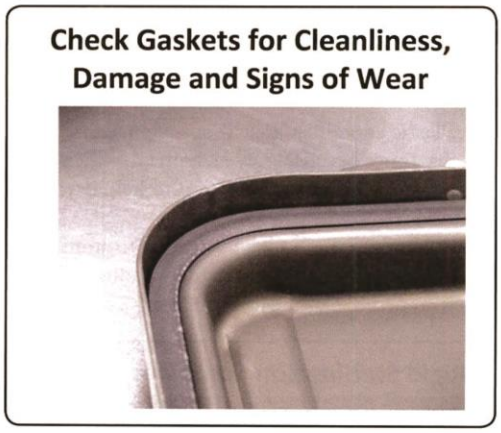


Figure 12.37

- Rivets in the handle area should be checked to ensure that they are secured and not separating from the container. If loosened, they can become a safety hazard and a pathway for entry of bacteria.

- Handles should move up and down easily. Ensure the latch springs are in place. (See **Figure 12.38**)

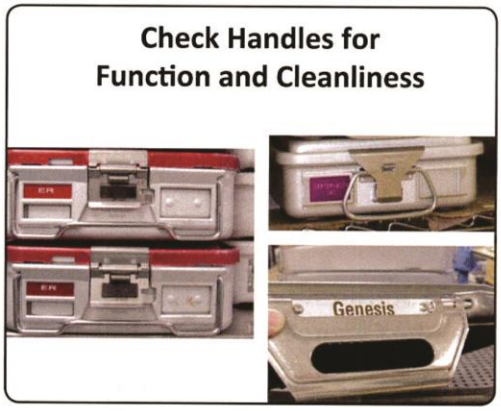


Figure 12.38

As noted earlier, the weight of instruments placed in the container is an important concern. The number of instruments placed in the tray must not exceed the quantity that can be effectively sterilized and dried.

Kraft-type papers (medical grade) are generally smooth surfaced, and they are available in sizes to accommodate many medical devices, and porous or soft-good items. Pouches of medical-grade papers specially formulated for sterilization are also available. Pouches with both sides consisting of Kraft-type paper can be used to hold small parts and instruments inside the instrument sets. (See **Figure 12.40**)

Example of Kraft-type Paper Pouches

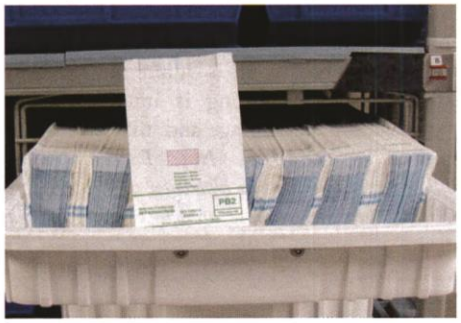


Figure 12.40

Kraft-type papers (also known as crepe paper) can also be purchased as flat wraps. These products may be utilized in steam and EtO sterilization but cannot be used with hydrogen peroxide or ozone sterilization.

Paper/plastic and spunbond polyolefin-plastic combinations (called peel packs or peel pouches) are the most commonly-used packaging materials for small instruments and lightweight items. (See **Figure 12.41**) They are called peel-pouches because after they are sealed, they must be peeled open for aseptic opening.

There are two basic types of combination peel pouches:

- Paper/plastic combinations – These are typically acceptable for use with steam and EtO sterilization processes.

Example of a Peel Pouch

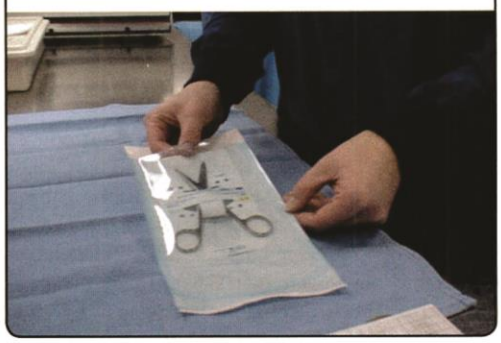


Figure 12.41

They are not compatible with hydrogen peroxide or ozone sterilization. As suggested by their name, they have a paper side and a plastic side. The plastic side allows visibility of the package contents, and the paper side allows sterilant penetration. *Note: Sterilant cannot enter through the plastic side, so proper positioning is important to achieve sterilization.*

- Spunbond polyolefin-plastic combinations (Sometimes referred to as Tyvek® pouches) - These are used for hydrogen peroxide and ozone sterilization. Like paper/plastic combinations, they have a plastic side, so package contents are visible. The other side is composed of polyolefin that contains no cellulosic materials and is, therefore, compatible with hydrogen peroxide and ozone sterilization processes.

Important Note: Use Caution When Selecting Peel Pouches.

Paper/plastic and spunbond-polyolefin packages look alike. Paper/plastic combinations are not compatible with hydrogen peroxide and ozone sterilization and spunbond-polyolefin combinations will melt in high-temperature processes, such as steam sterilization.

Flat wraps are another commonly-used packaging material. Instead of inserting objects into a ready-made pouch and sealing it, flat wrap requires the user to "create" a barrier package using specific folding techniques. (See **Figure 12.42)**

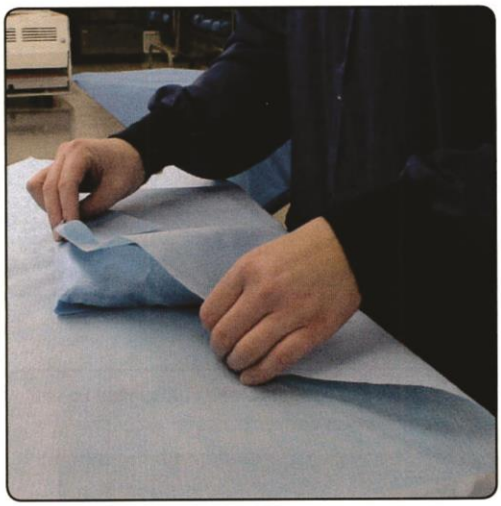


Figure 12.42

One nonwoven packaging material, spunbond-meltblown-spunbond (SMS), is a popular flat wrap. It is made by a process in which polyolefin layers (synthetic materials softened by heat and hardened by cooling) are exposed to high heat and are pressure-bonded together to form sheets. Flat wrapping products constructed of nonwoven SMS fabrics for sterilization wrapping are designed as single-use disposable products, and must never be reused. These materials are available in a range of weights and a wide variety of sizes. Flat wraps are also available as single- or double-sheet wraps that are bonded together.

The use of each packaging material has advantages and disadvantages. CS technicians must ensure that they select the type of packaging most suitable for the item(s) being packaged and the type of sterilization selected. CS technicians can then begin preparing the package contents for packaging and the sterilization process to follow.

WRAPPING TECHNIQUES

Peel Pouching Techniques

Peel pouches are usually used for smaller, lightweight items. They are also useful when it is important to see the contents of the package, such as when a description of the contents is difficult to view on the label. Peel pouches are available on rolls that allow CS technicians to cut off the length desired for each package, and they are also available in precut sizes. Inserts or tip protectors help to protect a pouch's contents from damage and prevent the tips from penetrating the package. If inserts or tip protectors are used, ensure that the material is appropriate for the type of sterilization method to be used, and that it is nontoxic and free of non-fast dyes. (See **Figure 12.43**)

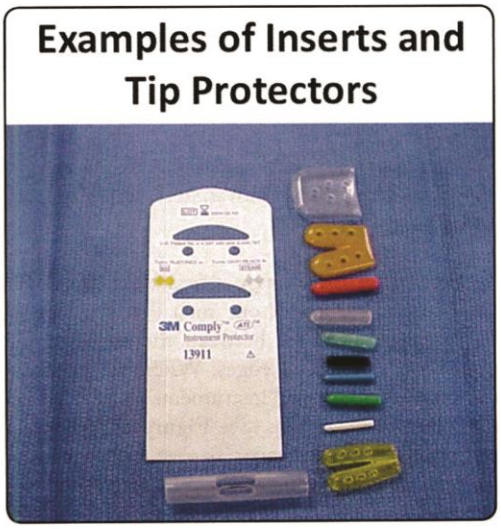


Figure 12.43

Before placing items in the peel pouch, carefully inspect the pouch to ensure there are no tears or holes. Items should be placed in the pouch, so the end of the item to be grasped during presentation (i.e., Finger rings of an instrument) will be presented first when the package is opened at the point of use. *Note: This is the chevron end for pre-made pouches.* **Figure 12.44** illustrates the chevron end of a pre-made pouch. It is designed in a manner that makes it easier to open. This reduces the risk of product contamination during aseptic opening.

Instrument tips should always face the plastic side of the package to avoid penetrating the paper side and contaminating the contents.

Hinged instruments must be packaged in a manner to keep the instrument open for sterilization. This can be accomplished by using commercially-purchased products.

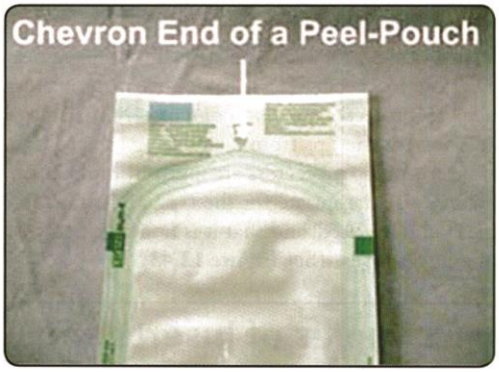


Figure 12.44

Pouches must be sized and applied properly to allow for adequate air removal, sterilant penetration and drying.

To allow space for package contraction and proper circulation, leave about one inch (1/4" per side of the package) of space between the items in the pouch and the sealed edges. When packaging is too small, the packaged instruments cause stress on the sides of the pouch. (See **Figure 12.45**) Stress compromises the package's barrier and will likely rupture the side seams of the package during the harsh air removal and heat-up phases of the steam sterilization process, or the high vacuum phase of the hydrogen peroxide sterilization process. Items placed in packages that are too small can also rupture the seams during normal handling and transportation. Pouches should not be too large because movement of the items inside the pouch may result in the contents sliding from end to end or side to side. The excessive movement of the contents could break seals or puncture the pouch's paper. (See **Figure 12.46**) Pouches should not be over-filled because this can cause the paper to tear, or the seals to rupture during sterilization or handling. (See **Figure 12.47**)

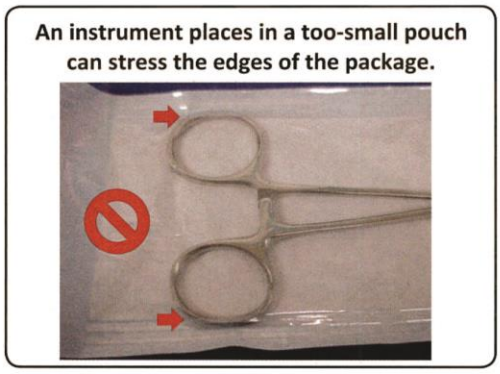


Figure 12.45

Figure 12.46

Figure 12.47

Trapped air acts as a barrier to heat, moisture and sterilant penetration, so it is important to remove as much air as possible before sealing. To remove trapped air, gently push the pouch's top and bottom layers together just prior to sealing. *Note: Applying too much pressure can damage the pouch.*

Paper/plastic pouches must only be labeled on the plastic side or on areas specifically provided by the manufacturer (e.g., on fold-over paper flap seals). Writing on the paper side of the pouch will cause damage to the package, which may not be noticeable, but which may compromise the barrier protection. Use only pens approved for writing on the plastic surface and approved for the sterilization method to be used. Using the wrong type of pen such as a ballpoint pen can damage the packaging.

Pouches must be closed using a tamper-evident seal, so there is no danger of packages being opened and resealed for later use. After a sterile package is opened, it is contaminated, and may not be resealed and reused.

Common ways that paper/plastic and polyolefin-plastic packages can be used to meet specific packaging needs include:

- Wrap within a pouch – Sometimes (usually to accommodate unique sterile presentation issues) it is desirable to place a single wrapped package into pouch. The initial wrap is done using the flat wrap packaging and wrapping method. It is not necessary to seal the wrapped item. The wrapped item is then inserted into the appropriately sized pouch. The pouch should be sealed and labeled. *Note: The manufacturer's IFU for both the peel pouch and the flat wrap must be reviewed to see if this process is approved. Using this method if not approved by both manufacturers could result in an unsterile product.*

- Double pouches – While double pouching is not necessary for sterility maintenance, it may be required for aseptic presentation of multiple items or for instruments having more than one part. Double pouches are prepared by placing the item(s) into one paper/plastic pouch and sealing it. This pouch is then placed inside another slightly larger pouch and sealed. (See **Figure 12.48**) Care is needed when selecting the appropriate sequential sizing. The same rules apply for the inside peel pouch as for pouching instruments (leave about one inch—1/4" per side of the package). Never fold the inner pouch because this can interfere with air removal and sterilant penetration. (See **Figure 12.49**) Place the smaller inner package paper side to paper side and plastic side to plastic side to help ensure sterilant penetration, drying and content visibility.

Example of Double Peel Pouching

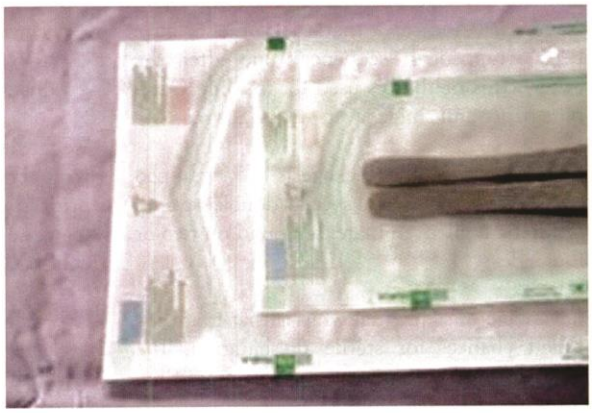


Figure 12.48

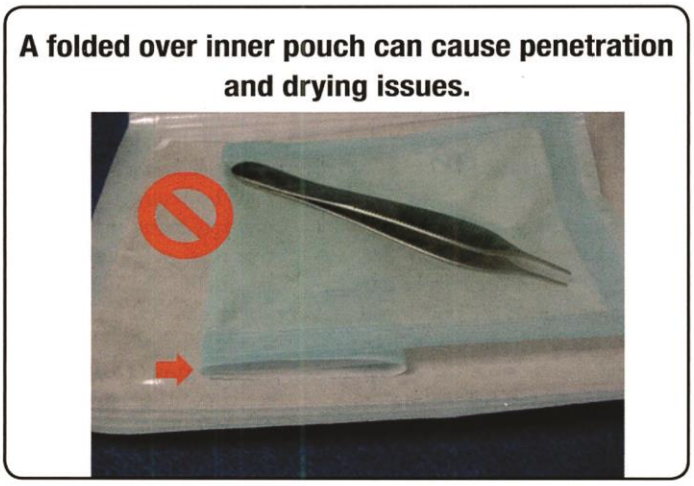


Figure 12.49

Flat Wrapping Techniques

Flat wrapping procedures are primarily used for large packages, but they may also be used for smaller items. They involve use of either reusable woven textiles (linens) or disposable nonwoven wraps.

There are two methods of using flat wrapper packs:

- Sequential – The package is wrapped twice and is "a package within a package." The term "sequential" indicates that the contents have been wrapped in sequence (one after the other). This method is used for muslin, Kraft-type paper and single layers of SMS wraps.
- Simultaneous – The package is only wrapped once, but it requires a special double-layered synthetic nonwoven material bound on two or four sides.

The advantage of sequential wrap is that it affords a "second chance" for sterile presentation. The disadvantages: sequential wrap requires more time for wrapping and unwrapping.

The advantage of simultaneous wrap is reduced labor costs and increased output in the CS and OR. The disadvantage is that the absence of the second layer removes the "second chance" aspect during aseptic opening/presentation.

There are also two techniques for wrapping packages and both are used with the sequential and simultaneous wrap methods:

- Square fold – This is also called the in-line or parallel fold; it is most frequently used for larger packs and instrument trays.
- Envelope fold – This is more commonly used for individual items, small packs and most instrument sets.

Regardless of the packaging system used, flat wrappers should be inspected for holes and tears prior to use. Wraps must be free from holes, tears, abrasions or any other deviations that could allow bacteria to enter the package.

CS technicians are responsible for creating a package that will protect the contents, allow for sterilization and allow for aseptic opening from flat sheets of wrapping material. This requires that every package be created according to specific protocols. The following photos illustrate the proper techniques for sequential and simultaneous wrapping in both the envelope and square styles.

Figures 12.50 through **12.60** illustrate sequential wrapping techniques using the envelope style. In this method, flat wraps are applied one after the other (in sequence).

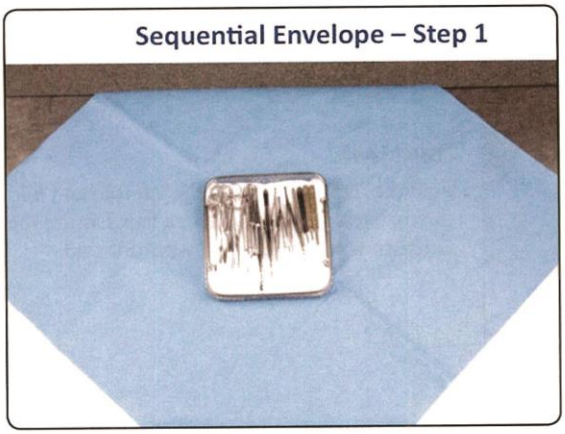


Figure 12.50

With the sequential envelope technique, the wrap is placed on the table to form a diamond shape. The item to be wrapped is placed in the center of the wrap, parallel with the edge of the table.

Figure 12.51

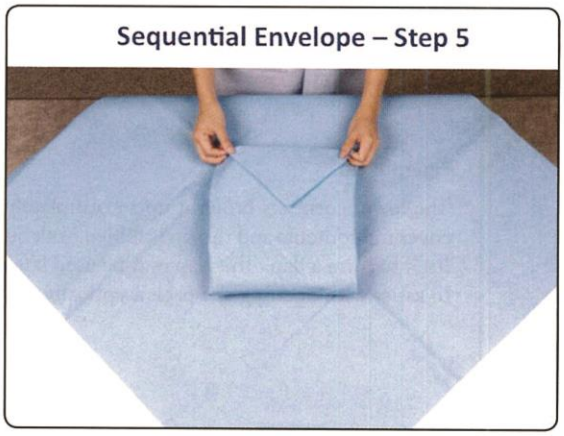
The lower corner is brought up to completely cover the contents and the tip is folded back on itself to form a flap. This flap may be used later to assist with opening the pack aseptically.

Figure 12.52

Fold the left corner over the contents and fold the tip back to form a flap. Ensure the entire tray/pack is covered with this fold.

Figure 12.53

Fold the right corner over the left fold and fold the tip back on itself to form a flap. Ensure the entire tray/pack is covered with this fold.



Insert Figure 12.54

Bring the top corner down over the contents and tuck the corner under the right and left folds, leaving a small tab visible for easy opening.

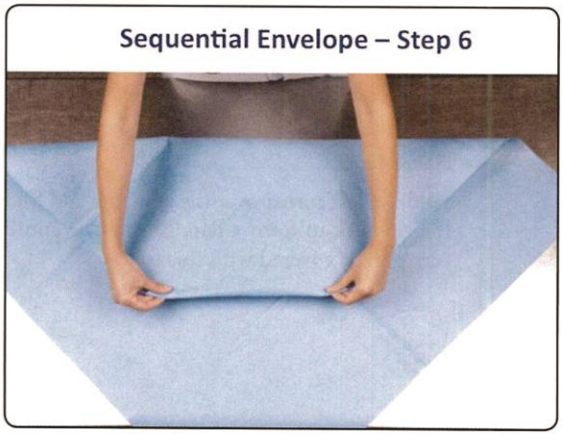


Figure 12.55

The second wrap is applied by placing the single wrapped item into the center of the remaining wrap and then repeating the wrap sequence to form a package within a package.

The lower corner is brought up to cover the single wrapped item and the tip is folded back on itself to form a flap.

Sequential Envelope – Step 7

Figure 12.56

Fold the left corner over the single wrapped item and fold the tip back to form a flap. Ensure the entire tray/pack is covered with this fold.

Sequential Envelope – Step 8

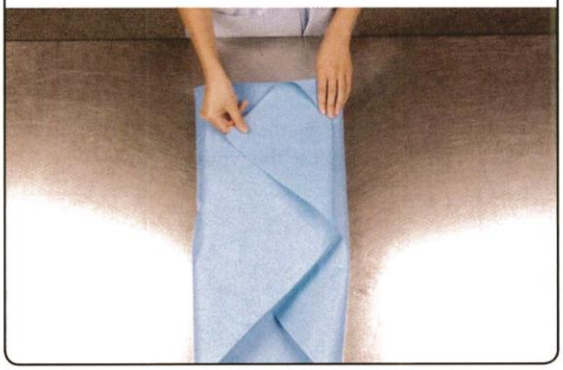


Figure 12.57

Fold the right corner over the left fold and fold the tip back on itself to form a flap. Ensure the entire tray/pack is covered with this fold.

Sequential Envelope – Step 9

Figure 12.58

Bring the top corner down over the single wrapped item.

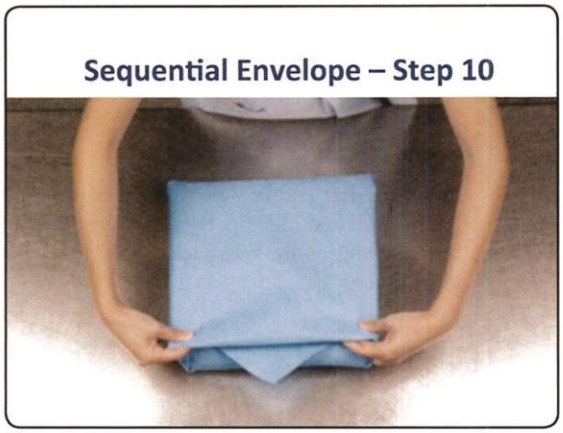


Figure 12.59

Tuck the corner under the right and left folds, leaving a small tab visible for easy opening.

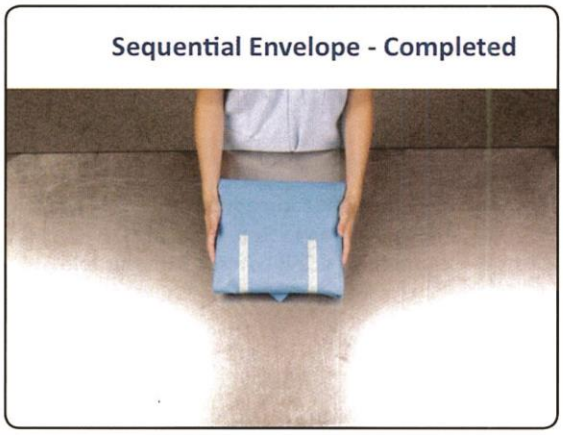


Figure 12.60

The package is then secured with indicator tape to complete the wrap process.

Figures 12.61 through **12.70** illustrate sequential wrapping techniques using the square style. This method is primarily used for large packs.

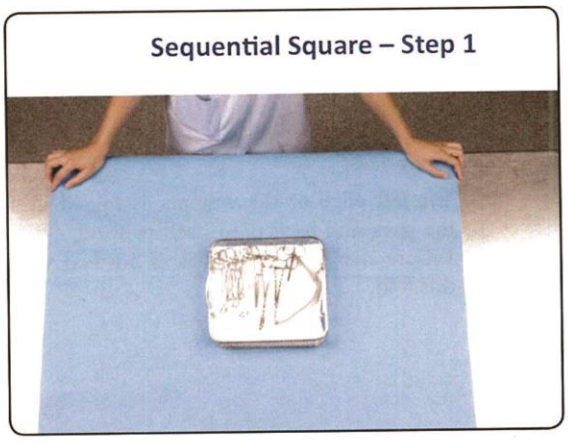


Figure 12.61

The edge of the wrapper is placed parallel with the table.

The instrument tray is placed square in the center of the wrapper parallel with the edge of the wrapper.

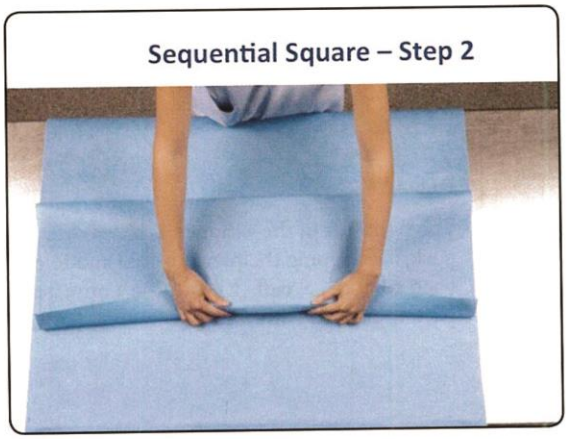


Figure 12.62

The edge of the wrapper is folded over the top of the contents. The edge is then folded over itself to form a cuff. This cuff will facilitate aseptic opening of the pack when used. Ensure the entire tray/pack is covered with this fold.

Figure 12.63

The upper edge of the wrap is brought down over the contents and folded back on itself to form another cuff overlapping the original cuff. Ensure the entire tray/pack is covered with this fold.

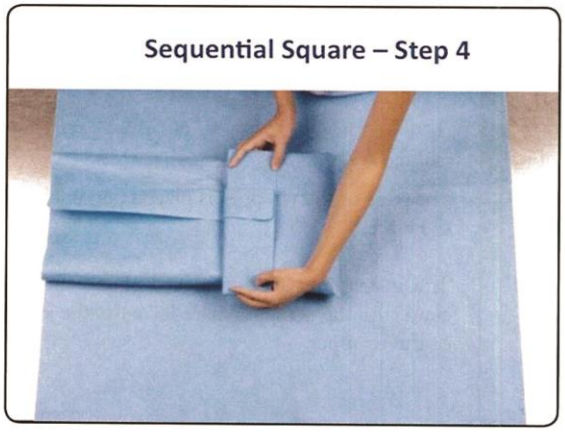


Figure 12.64

The left edge of the wrapper is folded over the pack and back onto itself to form a cuff. Ensure the entire tray/pack is covered with this fold.

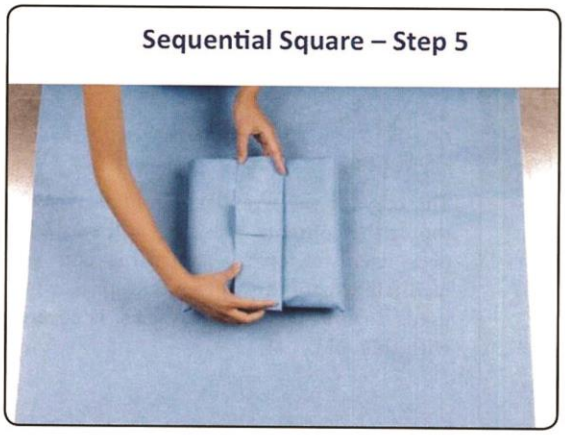


Figure 12.65

The right side of the wrapper is folded over the pack, overlapping the previous fold and folded back to form a cuff. Ensure the entire tray/pack is covered with this fold.

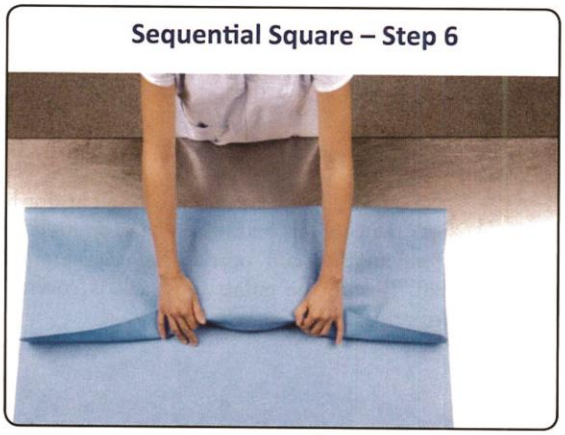


Figure 12.66

The second wrap is applied by placing the single wrapped item into the center of the wrap and repeating the steps performed for the first wrap to create a package within a package.

The edge of the second wrapper is folded over the single wrapped item. The edge is then folded back over itself to form a cuff. Ensure the entire tray/pack is covered with this fold.

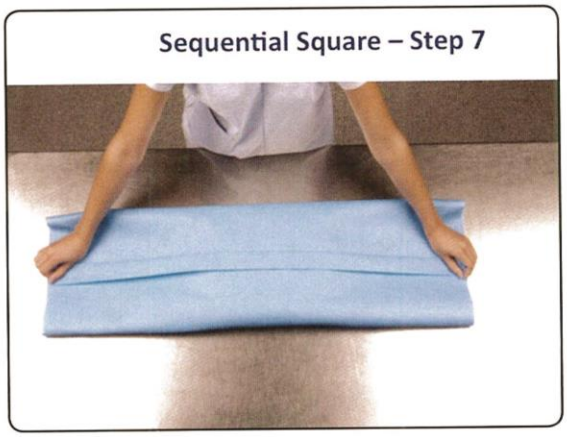


Figure 12.67

The upper edge of the wrap is brought down over the single wrapped item and folded back onto itself to form another cuff overlapping the original cuff. Ensure the entire tray/pack is covered with this fold.

Figure 12.68

The left edge of the wrapper is folded over the pack and back onto itself to form a cuff. Ensure the entire tray/pack is covered with this fold.

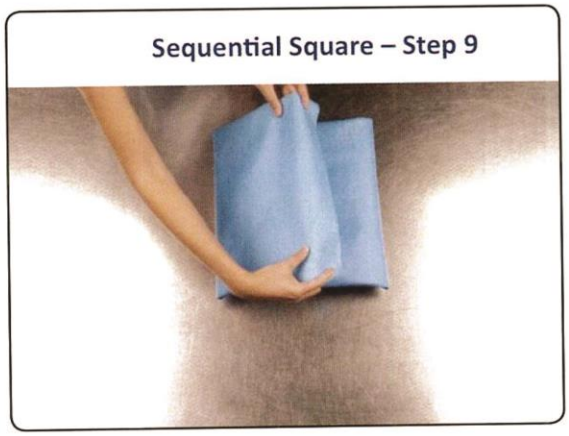


Figure 12.69

The right side of the wrapper is folded over the pack overlapping the previous fold and folded under. Ensure the entire tray/pack is covered with this fold.

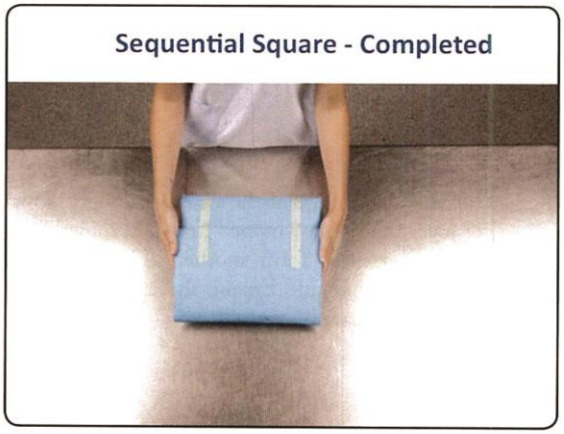


Figure 12.70

The package is secured with indicator tape.

Simultaneous wrapping uses two layers of synthetic nonwoven material, such as SMS bound on two or four edges. Since the material is already double layered, the contents are only wrapped once. Both methods are acceptable, although one may be more appropriate for specific situations.

Figures 12.71 through **12.77** illustrate simultaneous wrapping techniques using the envelope style. In this method, flat wraps are applied together.

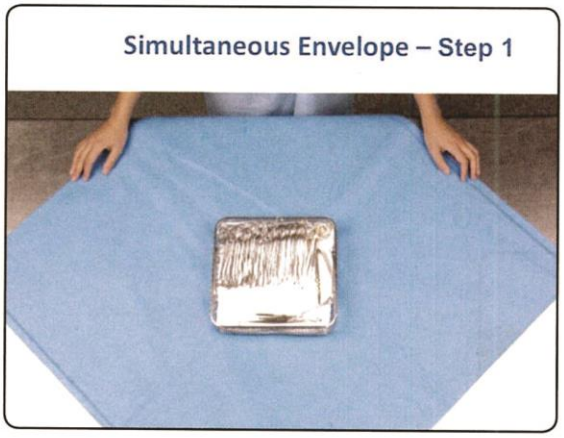


Figure 12.71

With the envelope simultaneous technique, one application of simultaneous wrap is placed on the table surface in diagonal or diamond format. Simultaneous wrap is two sheets of wrap bonded together.

Center the instrument tray between the right and left edges of the wrap.

Figure 12.72

Bring the bottom corner of the wrap up and over to completely cover the instrument tray.

Fold the tip back onto itself to form a flap. This flap is used later to assist in opening the pack aseptically.

Figure 12.73

Fold the left corner over the contents and fold the tip back to form a tab. Ensure the entire tray/pack is covered with this fold.

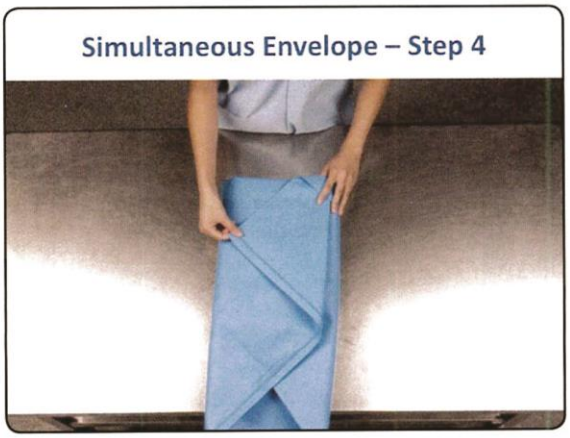


Figure 12.74

Fold the right corner over the left fold and fold the tip back onto itself to form a tab. Ensure the entire tray/pack is covered with this fold.

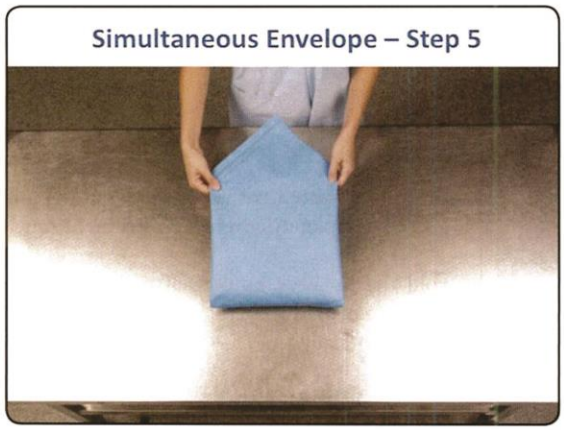
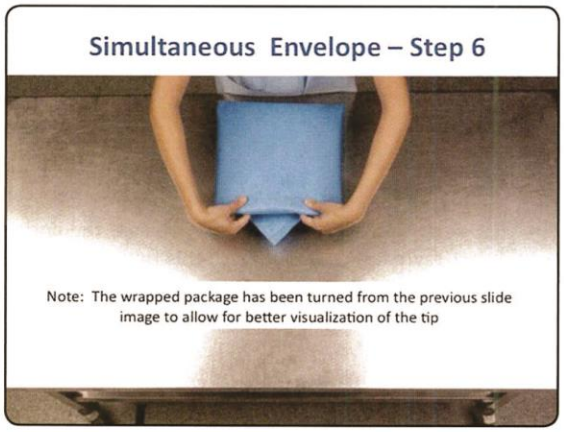


Figure 12.75

Bring the top corner down over the contents and fold it toward the body.



Insert Figure 12.76

Tuck the corner under the right and left folds. A small tab may be incorporated for easy opening.

Ensure the wrap is not too tight or too loose; either way compromises the effective sterilization of the package contents.

Figure 12.77

The package is then secured with indicator tape to complete the wrap process.

Figures 12.78 through **12.83** illustrate simultaneous wrapping techniques using the square style. This method is primarily used for large packs.

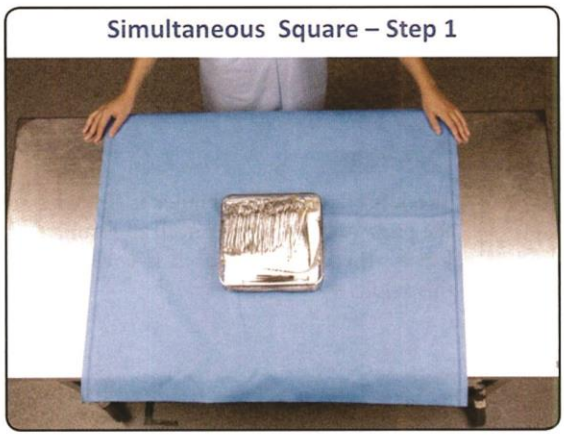


Figure 12.78

With the simultaneous square technique, place one application of simultaneous wrap—that is, two sheets of wrap specially bonded together —on the table surface in a rectangular- or square-shaped format.

Center the instrument tray between the left and right edges of the wrap.

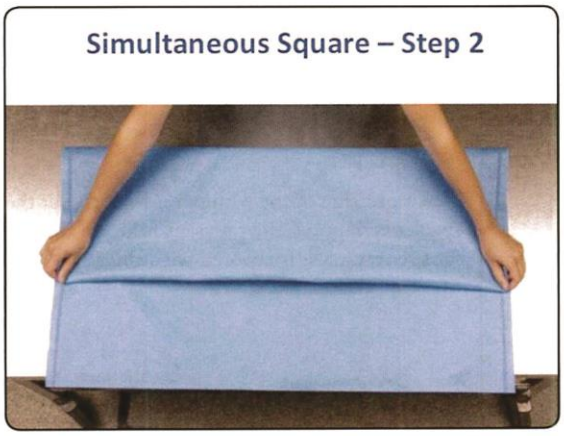


Figure 12.79

The edge of the wrapper is folded over the top of the contents covering the entire item. The edge is then folded back over itself to form a cuff. This will facilitate aseptic opening of the pack when used.

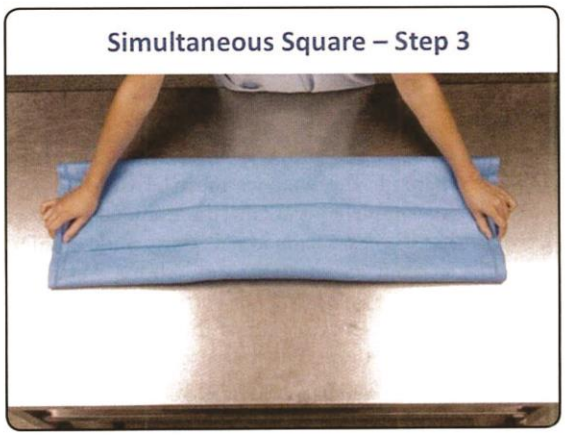


Figure 12.80

The upper edge of the wrap is brought down over the contents and folded back onto itself to form another cuff over lapping the original. Ensure the entire tray/pack is covered with this fold.

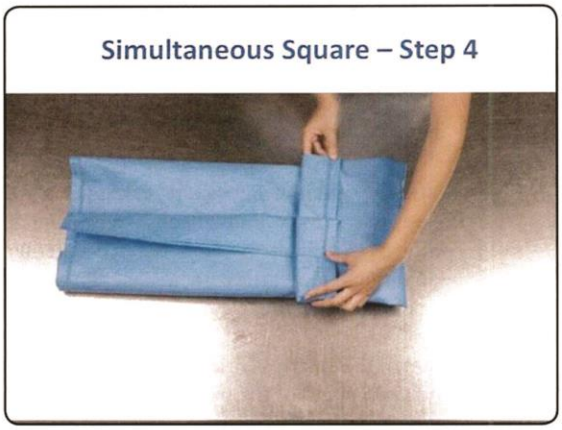


Figure 12.81

The left edge of the wrapper is folded over the pack and folded over itself to form a cuff. Ensure the entire tray/pack is covered with this fold.

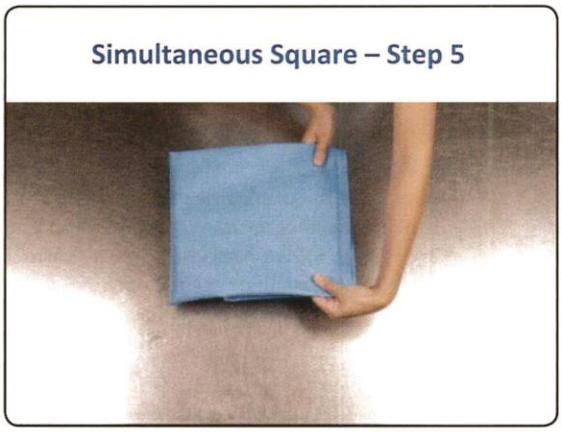


Figure 12.82

The right side of the wrapper is folded over the pack overlapping the previous fold. Ensure the entire tray/pack is covered with this fold.

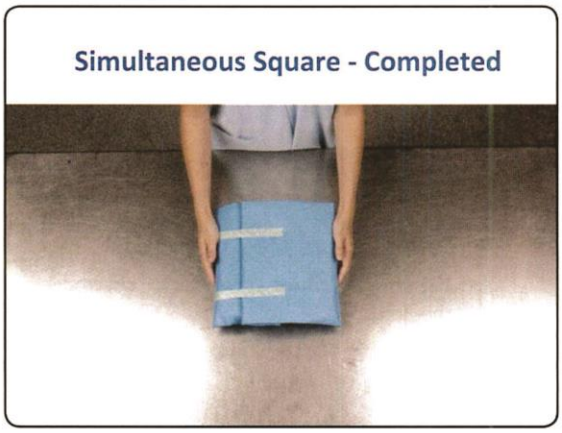


Figure 12.83

To complete the wrap process, the final fold is tucked under and secured with indicator tape.

Choose the properly-sized wrap for either method. The wrapper must be large enough to completely contain the contents without leaving excess material that could inhibit sterilant penetration and release. Wrappers must be snug, but not so tight as to impede sterilant entry or exit. If the wrapper will also be used to create a sterile field, it must be of sufficient size to extend at least six inches below the edge of the surface being covered.

> **Important Note: Be Consistent**
>
> Wrap folding must always be done in the same sequence. This allows the individuals opening sterile packages to establish a pattern, which conserves time and reduces the possibility of error.

METHODS OF PACKAGE CLOSURE

Overview

The purpose of a package closure is to seal the package securely, maintain the sterile integrity of the contact area during transport and storage, and prevent resealing if the package is opened or the seal is compromised.

Only approved closure methods should be used to seal a sterile package. There are several types of package closures and CS technicians must ensure they use the appropriate packaging method.

Acceptable Closure Methods

Several methods of package closure are acceptable for use:

- Tapes designated as "indicator tapes" are considered best practice because they are made specifically to withstand sterilization, and change color after being exposed to the sterilization process. They do not, however, provide proof that adequate sterilization of package contents has occurred. Indicator tapes or indicator stickers that change color after exposure should be used on every package to avoid mixing processed and unprocessed packages. (See **Figure 12.84**)

Figure 12.84

- Specially manufactured elastomer bands or similar closures are only acceptable if the manufacturer of the wrap material explicitly recommends their use. If recommended, care

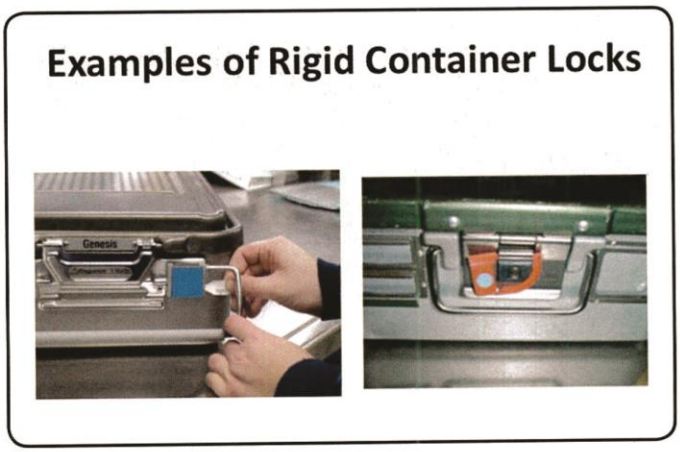


Figure 12.85

is needed to select the properly-sized bands that allow a snug fit, without creating excessive wrinkles or folds in the fabric that may reduce the effectiveness of sterilant penetration. If bands are used, the label or indicator stickers should be placed in a way that any attempt to remove the band will damage the band and reveal the compromised status of the pack. *Note: Band applications are designed for specific packaging methods and should only be used as recommended by the specific manufacturer.*

- Rigid container systems have tamper-evident seals, which are secured to the outside of the container and lock the top and bottom of the container together. (See **Figure 12.85**) Ensure the locks are securely in place prior to sterilization. Rigid container seals are designed to break when the seal on the container has been broken. The most common types are plastic components that lock in place and must be broken to open the container. Small bands that tighten as they react to heat during sterilization can also be placed on certain types of rigid containers and these will break when the seal of the container is broken.

- Heat sealing is a peel pouch closure method. There are several varieties of heat sealers available. (See **Figure 12.86**) The manufacturer of the sealer and/or pouch material must verify that the two are compatible. If they are not, the seal may not bond, or there may be burn-through; both actions will compromise the seal. Multiple-band or wide-band heat sealers should be used to reduce the possibility of an incomplete seal. The manufacturer's instructions for temperature settings, applied pressure and contact times should be written into procedures and always be followed.

  The package is placed inside the jaws of the heat sealer, and the two sides are fused together. Be sure to follow the heat sealer and packaging manufacturers' instructions to ensure appropriate exposure times and temperatures. Inadequate exposure times or temperatures may cause inadequate seals and those that exceed recommendations may cause package damage. CS technicians should use extra caution when operating heat sealers to avoid burns.

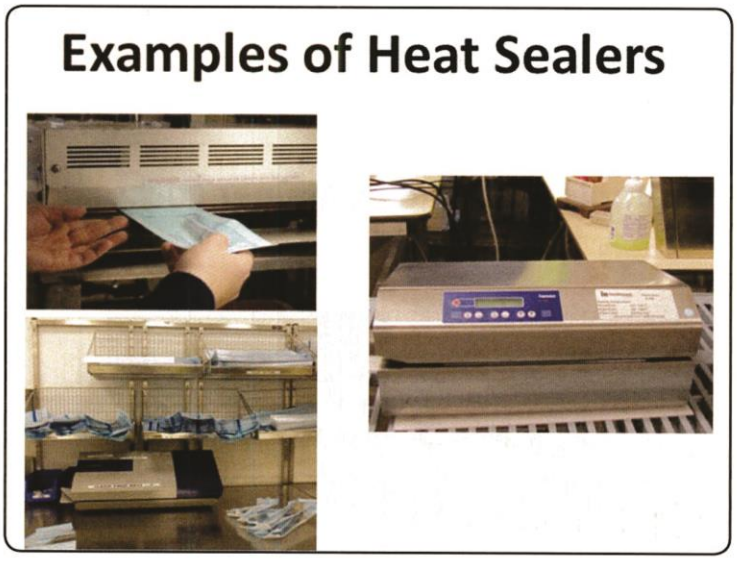


Figure 12.86

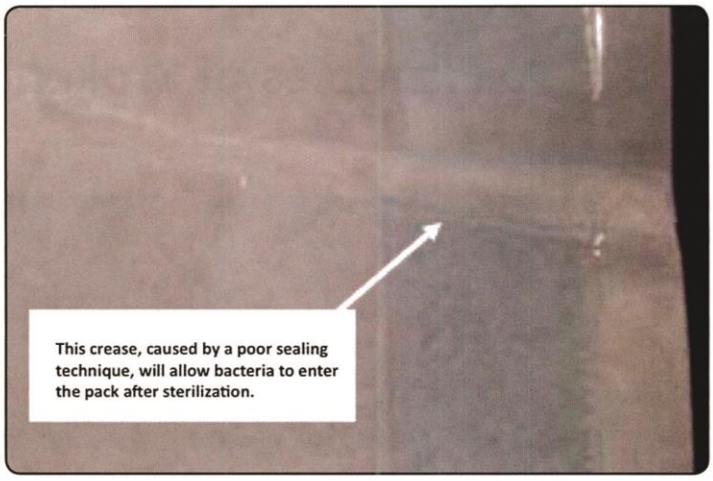


Figure 12.87

Heat seals must be observed for bubbles and creases. (See **Figure 12.87**) Seals that are not smooth and complete will allow bacterial contamination after sterilization.

- Self-adhesive seals. Some paper/plastic and polyolefin-plastic packages contain self-adhesive seals that do not require heat. An adhesive portion is covered with a removable strip at one end of the self-adhesive sterilization pouch. When it is removed, that portion of the seal should be carefully folded over the opening of the package. **Figure 12.88** shows a CS technician sealing a self-adhesive sterilization pouch. Care must be taken to avoid gaps, wrinkles or creases which compromise the seal integrity for both heat-seal and self-seal closure systems.

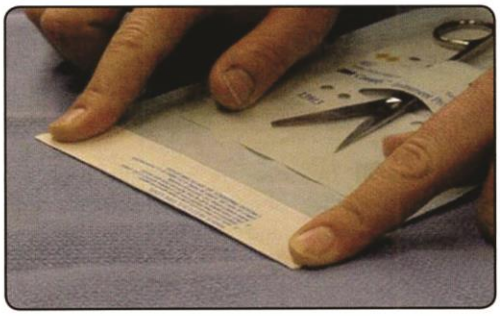


Figure 12.88

- Sealing tape is sometimes used to secure pouch openings. Care is needed to ensure that the seal is secure, without compromising gaps. Proper taping technique includes the folding of corners, so the side edges of the top corners are parallel to the bottom edge of the pouch. Ensure that the plastic is folded onto the plastic (not paper-to-paper), so sterilant access is not impeded. Then fold the open bottom edge over the folded corners. Seal with tape overlapping the edge of the pouch by about 1/4 inch. Observe carefully to ensure that there are no gaps, creases or wrinkles, and that the tape has completely covered the pouch's open edge and is securely attached to the plastic.

Do Not Use!

Several package closure methods are never appropriate:

- Do not use safety pins, staples or other sharp objects to seal packages. Punctures create holes that allow contamination. Even the smallest space (hole) is large enough to allow bacteria to pass.
- Do not use paper clips or binding clips. They can be removed and replaced without evidence of barrier compromise.
- Avoid using tapes that are not designed specifically to withstand the rigors of sterilization.

CS technicians must use closure methods specifically designed for the packaging material that is chosen. They must also check the seals on all packages before dispensing them to user units. Any seals that appear to have been broken or opened should not be issued or used. (See **Figure 12.89**)

Figure 12.89

PACKAGE LABELING

It is essential that all packages be labeled before sterilization. The label must be complete and accurate to ensure that the correct packs are selected and opened.

Label information should include the following:

- Description of package contents.
- Initials of package assembler/packager.
- Lot control number.
- Identification of sterilizer and cycle to be used.
- Date of sterilization (unless contained in the lot control number).
- Assigned storage location.
- The requesting department or the surgeon's name may also be included on the label for special request items.

Standardized abbreviations and terms help avoid confusion. Slang terms and nicknames should not be used. Labeling is necessary for the end user and also for sterilization processing, quality assurance, stock rotation and inventory control purposes. Correct labeling is also critical in the event of a sterilization load recall.

CS technicians with the responsibility for labeling packages must use clear, legible handwriting and accurate descriptions. Confusion caused by an illegible or inaccurate package label can compromise patient safety because items may be misplaced, or the label may be misread and incorrectly dispensed. Either situation can cause a delay in patient care and treatment.

Labeling should be documented on label-sensitive tape; flat wraps and peel pouches; commercially-available, pre-printed, adhesive labels; in-house computer-generated labels (See **Figure 12.90**); or on the plastic side of a peel pouch.

Note: Do not write directly on flat wrap packaging material.

For pouches, the labels or written information should not be placed on the paper or spunbond polyolefin side, as they may inhibit the microbial barrier properties.

Approved felt tip pens are generally used for marking, but they should be indelible, non-bleeding, nonfading and nontoxic, and able to withstand the sterilization method used.

Printed Pack Labels

Computerized instrument systems generate labels that are easy to read and contain barcodes for tracking.

Figure 12.90

Examples of Peel Pouch Loading Racks

Figure 12.91

Special Packaging Concerns

Several basic packaging concerns require special mention:

- All packaging materials should be held at a temperature between 68°F to 73°F (20°C to 23°C), and at a relative humidity ranging from 30% to 60% for a minimum of two hours prior to sterilization. This will permit adequate sterilant penetration and prevent super heating of the product during sterilization.

- Packaging procedures should be performed only by the department responsible for sterilization. Other departments (e.g., OR, Delivery Room, Emergency Department, and X-ray) whose personnel might prepare and package their own instruments and supplies before sending them to CS for sterilization should be discouraged from this practice. Often, CS technicians do not know about all items in the package, and it could be processed inappropriately. Also, supplying packaging materials to each of these departments is not cost effective. If a facility does allow instrument preparation outside the CS department, personnel must receive training on the proper methods of processing those devices.

- Paper/plastic pouches should be positioned in the sterilizer standing on edge in loading racks, or they should be placed in baskets specifically designed for these packages. They can also be held on edge by an alternate means (e.g., a peel pouch rack or tray pins), (See **Figure 12.91**) and they must be properly spaced. Pouches should be loosely spaced in the basket to ensure the sterilant can reach the breathable paper side of each pouch, as the plastic side is not penetrated by air, steam or other sterilants. Arrange the pouches paper-to-plastic in a perforated or mesh bottom tray.

- Paper/plastic pouches should not be placed inside wrapped trays or containers.

- All packaging systems must be handled with care. Although they provide protection and a barrier for medical devices, they are not impenetrable and can be compromised by rough handling and contact with sharp surfaces. There are several devices on the market to help protect larger trays from damage, such as tears in wrap. Facilities may choose to use those devices if they are experiencing issues with wrap integrity. (See **Figure 12.92**)

- Observe pouch contents and outside packaging of flat wrap or containerized instruments for moisture after sterilization and again prior to storage. Remember: Steam condenses on a metal's surface when heat is transferred to the metal. This condensation can allow contamination of the contents. Prevention of

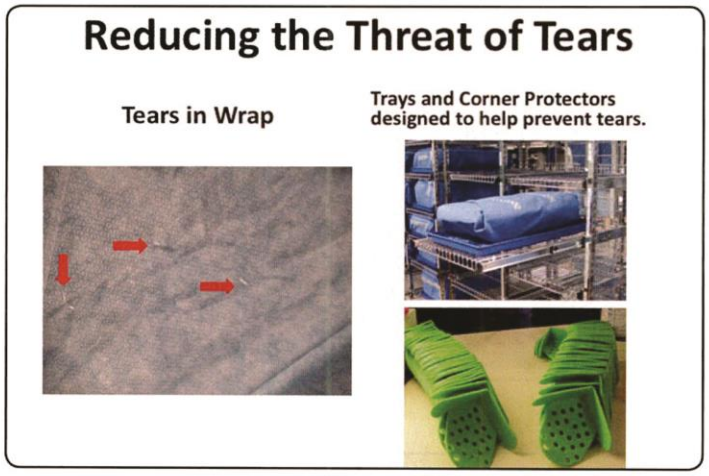


Figure 12.92

condensation is only possible when sterilizers with heated dry cycle capabilities are used; however, limiting sterilizer contents and following good loading practices can usually prevent the problem.

- All sterilized packages, whether sterilized by the facility or purchased as sterile, ready-to-use products, should be inspected to ensure the packaging material and/or the seals have not been compromised prior to placing into sterile storage, prior to dispensing and prior to opening the package.

Sterility Maintenance

Sterilized packages must maintain their content sterility until opened.

Traditionally, the sterility of a package has been thought of as "**time-related**." That is, the package was considered sterile until a specific expiration date was reached. Then the package was taken out of inventory and processed. The Joint Commission (TJC) and the Association of periOperative Registered Nurses (AORN) now recognize sterility as "**event-related**."

The concept of event-related sterility acknowledges that microbial contamination of a sterile package is caused by an event, such as improper handling or transport, rather than by time alone. For example, one may purchase a carton of milk at the grocery store with an expiration date that is several days away; however, if he/she forgets to put the carton of milk in the refrigerator, it will become warm and sour. Even though the milk had an expected shelf-life, an "event" happened that caused its shelf life to be shortened.

Event-related sterility depends on the quality of the wrapper material, handling procedures, storage and transport conditions, and the number of times the package is handled before use.

By closely controlling the environment and events to which a sterile package is exposed, rather than just the time the package is in storage, the probability of package contamination can be minimized.

Note: Expiration dates on commercial products must be adhered to as they reflect product usability or stability, rather than sterility of the contents. Packages that contain dated products must be labeled with the earliest expiration date.

Event-related sterility will be fully discussed in Chapter 16.

Sterility (time-related) A package is considered sterile until a specific expiration date is reached.

Sterility (event-related) Items are considered sterile unless the integrity of the packaging is compromised (damaged) or suspected of being compromised (damaged), regardless of the sterilization date. This is sometimes referred to as ERS.

Sterility Maintenance Covers

Protective plastic overwraps (called dust covers or sterility maintenance covers) can be applied to packages after sterilization to protect the package from dust, moisture and other contaminates. (See **Figure 12.93**) The plastic material should be at least 2 to 3 mil thick. Steam-sterilized items must be thoroughly cooled and dried, and EtO-sterilized items must be aerated before they are overwrapped in plastic. The seal of the dust cover should be secured with either a heat seal or security-tape sealing process. The overwrap should be clearly marked as a "dust cover" or "protective overwrap" to prevent its use as part of the sterile field. Protective overwraps are not to be placed in the sterilizer; they should be placed over properly cooled, presterilized items only.

Figure 12.93

There are basic protocols for applying a dust covercover; however, specific manufacturer instructions should always be followed:

- Perform hand hygiene prior to handling the sterile package.
- Dust covers must be applied as soon as the package is cool enough to do so. Placing items in dust covers after an extended period of time may place potential contaminates in a perfect environment for microbial growth.
- Select a dust cover slightly larger than the item to be packaged.
- Carefully place the sterile item inside the dust cover; ensure the sterile package label is visible. Gently compress the package to remove air and seal the dust cover.

Note: The expiration date of any item in a dust cover is not extended by placing the item in a dust cover.

CONCLUSION

Medical devices and supplies used in patient treatment and care are made of various materials and configurations. No single assembly method or packaging system meets all requirements for packaging and sterilization of all devices. Central Service technicians must understand assembly and packaging concepts, and follow best work practices for preparing packages to help ensure that devices dispensed for patients are functional and safe.

RESOURCES

Association for the Advancement of Medical Instrumentation. *ANSI/AAMI ST79:2013. Comprehensive guide to steam sterilization and sterility assurance in healthcare facilities. Sections 8, 10.5 and 10.6.*

Association of periOperative Registered Nurses. *Recommended Practices for Cleaning and Caring for Surgical Instruments and Powered Equipment.* Standards, Recommended Practices, and Guidelines. 2014.

Association of periOperative Registered Nurses. *Guidelines for PeriOperative Practice: Packaging Systems.* Guidelines for PeriOperative Practice. 2015

Truscott W. *SSI Prevention Pointers from Industry.* Infection Control Today. 2010.

Chapter 12

CENTRAL SERVICE TERMS

Assembly area

Super heating

Wicking materials

Chemical indicators (CIs)

Process challenge device (PCD)

Tamper-evident seals

Muslin

Rigid container system

Wet pack

Sterility (time-related)

Sterility (event-related)

REFERENCES

1) Hoffbrand's Essential Haematology, A. Victor Hoffbrand, Eighth Edition
2) Essentials of Haematology, Shirish M Kawthalkar, First Edition
3) District Laboratory Practice in Tropical Countries Part 2, Monica Cheesbrough, Second Edition
4) Medical Parasitology, Rohela Mahmud Yvonne Ai Lian Lim • Amirah Amir, first edition
5) Website of Institute of Blood Transfusion Service Punjab.gov.pk. https://ibts.punjab.gov.pk
6) website punjab blood transfusion authority.https://pbta.punjab.gov.pk › sop for blood bank, 2014