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Premier OR Grade Surgical Instruments:

Tips for Care

An Online Continuing Education Activity
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Premier OR Grade Surgical Instruments: Tips for Care

(An Online Continuing Education Activity)

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OVERVIEW

All members of the perioperative team share in the responsibility of providing safe care for patients undergoing surgical and/or invasive procedures. Surgical instruments, which are both durable and delicate, are used on daily basis in both routine and emergency surgical procedures. Surgical instruments also represent a major dollar investment for a facility. The primary concern regarding surgical instruments is that they are patient ready, ie, in good working order, clean, and appropriately free of microorganisms. In this regard, operating room and sterile processing personnel understand that instruments which are not properly cleaned and sterilized can lead to patient injury, infection, and potentially even death. Therefore, the overall "health" of surgical instruments is a key component in providing safe patient care and also in protecting a facility's investment; personnel can effectively maintain overall instrument health through proper care, cleaning, and handling. This continuing education activity will provide an overview of the clinical considerations related to proper care and handling of surgical instrumentation to protect their overall health, reduce the risk of infection, and subsequently promote safe patient care. It will provide a brief review of the implications of surgical site infections today, including the role of appropriate cleaning and sterilization of instruments as a risk reduction measure. The steps in instrument care, cleaning, and handling, according to current guidelines and professional recommendations will also be outlined.

LEARNER OBJECTIVES

After completing this continuing education activity, the participant should be able to:

1. Name two purposes of surgical instrument decontamination.
2. Identify two requirements for maintaining premier quality surgical instruments.
3. Discuss the value of correct packaging for surgical instruments.
4. List three clinical considerations for providing premier quality surgical instruments.

INTENDED AUDIENCE

This continuing education activity is intended for perioperative nurses, sterile processing personnel, and other health care professionals who are interested in learning more about maintaining overall instrument health through proper care, cleaning, and handling.

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INTRODUCTION

Many perioperative personnel have encountered clinical situations in which scissors do not cut; a needle holder does not grip properly; instruments are stained; or traces of bioburden remain on an instrument that has not been properly cleaned. All of these "health" issues can adversely affect safe care during surgery and subsequently patient outcomes. In addition, surgical instruments represent a major capital investment for a facility, and therefore must be properly maintained not only for patient safety, but also to protect this investment and maximize the instruments' usable life. Key components of overall instrument health include proper care, cleaning, handling, and processing to prevent the development of a surgical site infection (SSI); one measure for reducing the risk for SSI is to provide surgical items that are free of contamination at the time of use.[1]

Successful management of surgical instruments requires effective collaboration between surgeons, perioperative nurses, surgical technologists, and central processing personnel, each of whom shares the responsibility for their proper instrument care.[2] It is important therefore, that all personnel know and understand instrument "health" issues, as well as proper care and handling techniques to maintain the instruments' overall good health and thereby promote safe care and positive patient outcomes.

THE REALITY OF HEALTHCARE-ASSOCIATED INFECTIONS TODAY

Overview

Overall instrument health can be directly correlated with the surgical patient's health if examined in relation to achieving positive outcomes, primarily prevention of a postoperative SSI. Today, healthcare-associated infections (HAIs), including SSIs, have become common complications and as a result, represent a leading cause of postoperative morbidity and mortality for the patient and are also associated with enormous additional costs which may not be reimbursed for hospitals and health care systems.[3]

Healthcare-associated infections are infections caused by a wide variety of common and unusual bacteria, fungi, and viruses acquired during the course of receiving medical care; they are the most common complication of hospital care and one of the top 10 leading causes of death in the U.S.[4,5] Over 30 million surgical procedures are performed annually in the U.S.[6] Surgical site infections, which develop in up to 30% of all surgical procedures, are associated with significant morbidity and mortality for the patients, as well as extended lengths of hospital stays, and increases in hospital costs of 2- to 5-fold.[7] Approximately 300,000 SSIs are reported each year, which accounts for 17% of all HAIs, second only to urinary tract infections; furthermore, each SSI increases the length of postoperative hospital stay by 7 to 10 days; furthermore, mortality is 2 to 11 times greater for patients who develop an SSI and 75% of deaths among patients with SSI are directly attributable to the infection.[8] The average attributable per patient cost of a SSI, adjusted to 2007 dollars, is $11,874 - $34,670.[9] For example, preventing a single case of surgical site infection due to methicillin-resistant *Staphylococcus aureus* (MRSA) can potentially save a hospital as much as $60,000.[10] Furthermore, the Institute of Healthcare Improvement (IHI) has estimated that 40-60% of all SSIs are preventable.[11]

CMS and other third party payors no longer pay for care required as a result of some HAI's.

The Role of Proper Instrument Sterilization in SSI Prevention

One of the expected outcomes for every surgical patient is that he/she is free from signs and symptoms of surgical site infection (eg, pain, induration, foul odor, purulent drainage, and/or fever) through 30 days after the procedure.[12] Therefore, infection prevention for all surgical patients remains a key responsibility for every member of the perioperative team in order to prevent unnecessary morbidity and mortality associated with the development of a SSI.

Microbial contamination of the surgical site is a necessary precursor of SSI; while there are several patient factors that contribute to the development of SSIs that perioperative personnel cannot control, eg, remote site infections, diabetes, cigarette smoking, poor nutritional status, proper instrument sterilization is a procedure-related risk factor that *is* under the control of the perioperative personnel; furthermore, it is one which has the potential for a significant impact on the prevention of surgical site infections (see Table 1).[13]

Table 1 – Characteristics That May Influence the Risk of Surgical Site Infection Development

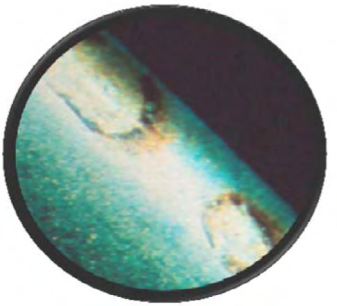
Patient-Related Factors	Procedure-Related Factors
• Age • Nutritional status • Diabetes • Smoking history • Obesity • Coexistent infections at a remote body site • Colonization with microorganisms • Altered immune response • Length of preoperative stay	• Duration of surgical scrub • Skin antisepsis • Preoperative shaving • Preoperative skin prep • Duration of operation • Antimicrobial prophylaxis • Operating room ventilation • *Inadequate sterilization of instruments* • Foreign material in the surgical site • Surgical drains • Surgical technique • Poor hemostasis • Failure to obliterate dead space • Tissue trauma

SURGICAL INSTRUMENTS: OVERALL HEALTH ISSUES

There are several overall "health" issues that can adversely affect the life and performance of surgical instruments and subsequently increase the patient's risk for SSI; many of these issues are the result of improper cleaning and/or handling, as outlined below.

Instrument Health Issue #1: Corrosion and pitting (see Figure 1).

Figure 1 – Pitting



Instrument Health Issue #2: Rust “seeds” on other instruments (see Figure 2) or is present on instrument jaws (see Figure 3).

Figure 2 – Rust Seeding on Other Instruments

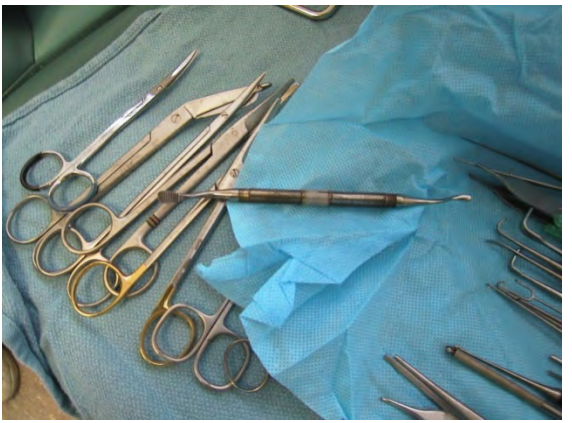
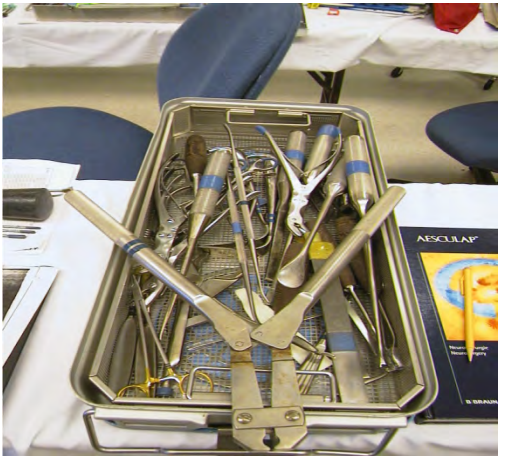


Figure 3 – Rust Present in Instrument Jaws

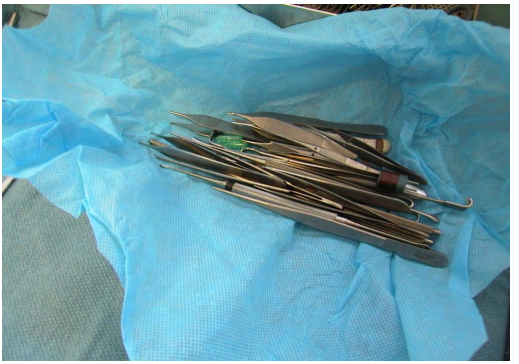


Instrument Health Issue #3: Coating is cracked (see Figure 4).

Figure 4 – Cracked Coating

Instrument Health Issue #4: Delicate instruments are wrapped without protection (see Figure 5).

Figure 5 – Instruments Wrapped Without Protection



Instrument Health Issue #5: Instruments are overcrowded in trays (see Figure 6).

Figure 6 – Overcrowded Instruments

Instrument Health Issue #6: Heavy items are wrapped with delicate items (see Figure 7).

Figure 7 – Heavy Items Mixed with Delicate Items

Instrument Health Issue #7: Instruments are returned improperly from the OR (see Figure 8).

Figure 8 – Improper Transport of Instruments from the OR

Instrument Health Issue #8: Instruments are stored improperly (see Figure 9 for example of Proper Storage).

Figure 9 – Proper Storage of Instruments

COMMON CAUSES OF INSTRUMENT STAINING AND CORROSION

- Water:
    - The quality of the water used to clean and sterilize instruments can contribute to staining and corrosion. Excessive concentrations of heavy metals, minerals and chlorides can adversely impact surgical instruments, as can very acidic or alkaline water. All water used in the cleaning and sterilization (steam) of surgical instruments should be monitored to ensure all major indicators of water quality fall within the established limits.

- Cleaning agents:
    - Surgical instruments are subject to attack by:
        - Highly acidic, caustic or abrasive cleaning agents;
        - Improperly rinsed or contaminated disinfectants or detergents;
        - Incorrectly diluted disinfectants or detergents; and
        - Improperly or inappropriately used cleaning solutions.
    - Instrument cleaners should be neutral pH, non-abrasive and used in strict accordance with the manufacturer's recommendations for use.
- Encrusted debris:
    - Surgical debris, including blood, pus, and secretions, iodine tinctures, and saline solutions can all have a corrosive effect on surgical instruments. To

prevent contaminants from encrusting and attacking the passive surface of instruments, the cleaning process should begin immediately after use with an enzymatic presoak. Each instrument should then be thoroughly cleaned, with special attention given to boxlocks, joints, and crevices where debris can become entrapped.

- Cleaning equipment:
    - Improperly maintained, uncalibrated or malfunctioning equipment can adversely affect the cleaning and sterilization process. All cleaning and processing equipment should be serviced and calibrated on a routine basis to ensure proper function.

- Inadequate lubrication:
    - Surface abrasions and fretting corrosion can result if excessive friction occurs between two moving instrument parts, such as boxlocks and blades. The abrasion eventually damages the passive coating of the instruments. Lubrication of all boxlocks, joints and moveable parts with a steam permeable instrument lubricant can prevent this type of corrosion.

- Metal transfer:
    - Contact corrosion can occur if instruments of different metallic compositions are in contact with each other and are simultaneously exposed to electrolytes (ie, chlorides in the water) resulting in an electrolytic reaction between the two metals. This reaction can result in the formation of rust rings at the contact points. Instruments with different material compositions or with damaged surface coatings should not be cleaned or processed together.

- Moisture:
    - Moisture trapped in certain parts of the surgical instrument, such as in the boxlock, ratchets or catches, for an extended period of time can promote surface deterioration and corrosion. Instruments should be completely dried prior to sterilization. Wet packs observed post-sterilization can also contribute to staining and corrosion. The autoclave and/or container manufacturer should be consulted for assistance in eliminating wet packs.
- Poor rinsing:
    - Mineral deposits, point of use sprays for foam, or cleaning agent residues that are not sufficiently rinsed off surgical instruments may become chemically active when exposed to the heat and pressure of an autoclave and may accelerate corrosion and surface deterioration. Rinsing with tap water with high concentrations of minerals, dissolved solids or heavy metals can impede thorough rinsing and leave additional deposits on the instruments. Critical water is required for rinsing critical devices.[14]

Malfunctioning rinse cycles and clogged spray jets can also inhibit complete rinsing. Use of critical water in properly functioning equipment can eliminate many of the problems associated with poor rinsing.

- Sterilization steam:
    - Improper boiler treatment can cause foaming and surging of the boiler water into the steam lines which can cause boiler additives, iron oxide, sludge and other contaminants to carry over into the sterilization steam and deposit on instruments, wraps, containers and on the walls for the autoclave. The boiler equipment should be properly maintained and the treatment process controlled to ensure only the highest quality steam is generated.

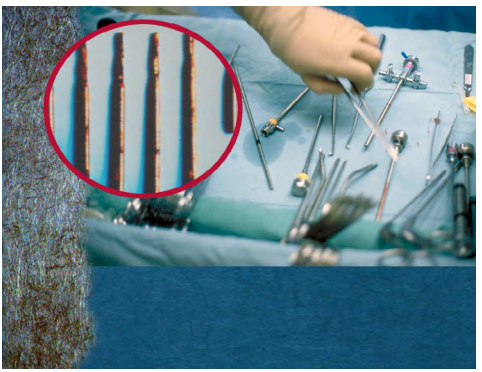
- Storage:
    - Inappropriate storage conditions can contribute to instrument staining, pitting and corrosion. Instruments should be removed from plastic packaging and stored in dry storage rooms open to the air. To prevent exposure to corrosive vapors, instruments should not be stored in cupboards or rooms in which chemicals are stored.

KEY STEPS IN ADDRESSING INSTRUMENT HEALTH ISSUES

As with other patient care activities, once assessed, appropriate interventions must be implemented to address these overall "health" issues to maintain the instruments' good working order and provide safe patient care. The proper steps in protecting the overall health of surgical instrumentation during and after a procedure are outlined below.

Step 1: Keep instruments clean throughout a surgical procedure. Instruments should be kept free of gross soil during surgical procedures.[15] Blood and body fluids can cause pitting of instruments and can be difficult to remove if left to dry (see Figure 10). If blood and body fluids are not removed, they can prevent adequate sterilization, which could be an avenue for transmission of other potentially infectious materials.

Figure 10 – Accumulation of Blood on Instruments during a Procedure



Key considerations in this step include:

- Instruments should be wiped as needed with sterile surgical sponges moistened with sterile water (saline causes deterioration of instruments) during the procedure to remove gross soil, ie, blood and body fluids, since these fluids, as well as saline, are highly corrosive. Corrosion, rust, and pitting occur when saline, blood, and debris are allowed to dry in or on surgical instruments. Because dried blood and debris is often difficult, if not impossible, to remove from all surfaces during the decontamination process, subsequent disinfection or sterilization may not be achieved.
- Instruments with lumens should be irrigated with sterile water as needed throughout the surgical procedure to prevent obstruction due to organic material. Irrigation with sterile water maintains hydration of the bioburden on surgical instruments, facilitates the cleaning of surgical instruments, and prevents tissue damage.
- The tips of an electrosurgical active electrode should be cleaned frequently, away from the surgical site, to remove eschar.

Step 2: Transport contaminated instruments to the decontamination area properly, in a timely manner. Contaminated instruments must be contained during transport and should be transported in a timely manner to a location designed for decontamination.[16] Proper containment of instruments reduces the potential for injury to personnel or their exposure to infectious organisms; it also prevents damage to the instruments during transport. The Occupational Safety and Health Administration's (OSHA) bloodborne pathogen standard requires that during transport to the decontamination area, contaminated instruments must be contained in a leak-proof container to minimize the risk of exposing personnel or patients to bloodborne pathogens and other potentially infectious organisms (see Figure 11).[17]

Figure 11 – Transportation of Contaminated Instruments

Step 3: Clean and decontaminate instruments as soon as possible after use.[18,19] Cleaning and decontamination should occur as soon as possible after instruments and equipment are used to prevent surface breakdown by NaCl (blood and saline). If cleaning and decontamination are not thoroughly accomplished, the disinfection and/or sterilization process may not be effective. In addition, all instruments that were opened in the operating or procedure room should be decontaminated, whether or not they were used.

For all reusable instrumentation, the first and most important step in decontamination is thorough cleaning, followed by rinsing. Effective cleaning is a multistep process that depends on several mutually dependent factors, such as the quality of the water; the quality, concentration, and type of detergent or enzymatic cleaner; an acceptable cleaning method; proper rinsing and drying; correct preparation of the items to be processed by the cleaning equipment. The device manufacturer's instructions should be consulted to determine the appropriate type of cleaning agent; the instructions from the cleaning agent manufacturer should then be followed.

Hand washing, ultrasonic cleaning and washer disinfectors are all important steps in the decontamination process. All must be used appropriately.

The appropriate cleaning method for a medical device depends on the device's characteristics and should be specified by the device manufacturer.[20,21] Cleaning may be accomplished by either manual or mechanical methods, or a combination of both. Whichever cleaning method is selected, it should be effective, should not affect the functionality of the device, and should be safe for the health care worker performing the task. It is the device manufacturer's responsibility to provide reprocessing instructions in their labeling; these instructions should include the recommended type of cleaning equipment and/or a specific cleaning agent. Before health care workers consider using alternative equipment and/or cleaning agents, they should consult the device manufacturer, as well as the manufacturer of the cleaning equipment or product.

- Manual cleaning. Any device should be able to be cleaned manually. Manual cleaning is often recommended for delicate or complex medical devices, such as microsurgical and lensed instruments as well as air-powered drills.
- Mechanical cleaning. Mechanical cleaning equipment removes soil and microorganisms through an automated cleaning and rinsing process. Some types of mechanical cleaning equipment incorporate thermal disinfection processes and/or chemical disinfectant rinses that are capable of destroying various numbers and types of microorganism. Mechanical cleaning is preferred because it removes soil efficiently and provides consistent washing and rinsing parameters during the process.

  Ultrasonic automated cleaners are designed for fine cleaning of medical devices, not for disinfection or sterilization. They are used to remove soil from joints, crevices, lumens, and areas that are difficult to clean by other methods. Ultrasonic cleaners should be used according to the manufacturer's operating instructions only after gross soil has been removed. Only instruments made of similar metals

should be combined in the ultrasonic cleaner unless specified otherwise in the instrument manufacturer's written instructions to prevent instrument etching and pitting from occurring due to the transfer of ions from one instrument surface to another. Instruments that should not be placed in an ultrasonic cleaner include chrome-plated instruments; power instruments; rubber, silicone, or plastic instruments; and endoscopic lenses. Instruments with lumens should be fully submerged and filled with cleaning solution to remove air from within the channel. The instrument manufacturer's instructions should be followed to verify that ultrasonic cleaning will not damage the item; since not all metals can be intermixed in the ultrasonic cleaning process, the device manufacturer should specify if there any restrictions. Ultrasonic process is critical for cleaning lumens such as suctions.

Ultrasonic cleaners should also be maintained as recommended by the manufacturer, ie, they should be emptied, cleaned, rinsed with sterile water, and the chamber wiped with alcohol or other disinfectant, when visibly soiled and at least daily.[22] The fluid in an ultrasonic cleaner can harbor gram-negative bacteria, the growth of which can result in the production of endotoxins; these endotoxins are heat-resistant, can survive steam sterilization, and can have serious patient consequences. For example, endotoxins from contaminated eye instruments have been shown to cause toxic anterior segment syndrome (TASS), an acute inflammation of the anterior segment of the eye.

Upon arrival in the decontamination area, surgical instruments that are composed of more than one piece or part should be disassembled according to manufacturer's instructions to expose all surfaces to the cleaning process; instrument box locks should be fully open and the instrument secured to prevent closing by using stringers, racks, or instrument pegs designed to contain instruments.[23,24] The device manufacturers' instructions for disassembly and reassembly of all processed items should be included in the procedure manual for the decontamination area. Hidden surfaces and crevices can prevent thorough cleaning; residual organic matter or large numbers of microorganisms can reduce the effectiveness of the subsequent microbiocidal processes. Personnel must wear appropriate personal protective equipment (PPE) when handling contaminated instruments and equipment (see Figure 12); they should also be vaccinated against the hepatitis B virus. Table 2 below outlines the attire and PPE required for all steps in the reprocessing of surgical instruments.

Figure 12 – PPE for Instrument Decontamination

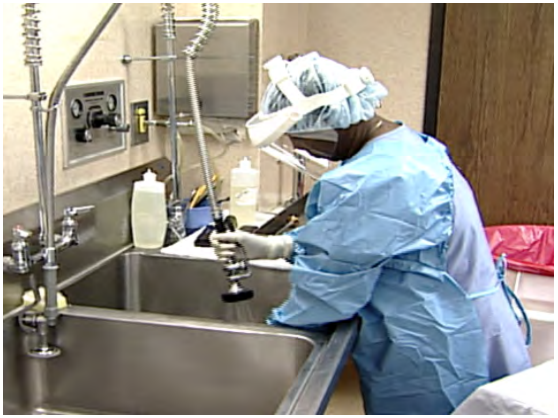


Table 2 – Attire and PPE Requirements for Instrument Care and Handling Processes[25]

Work Area	Scrubs	Head Cover	Gloves*	Gown or Apron#	Eye Protection+	Mask or Face Shield±
Decontamination	X	X	X	X	X	X
Preparation and Packaging	X	X				
Sterilization	X	X				
Sterile Storage	X	X				

***** Gloves should be waterproof, general-purpose utility, or heavy duty.
# Gowns must be liquid-resistant with sleeves. Aprons may be liquid-resistant but do not need to have sleeves.
+ Eye protection includes goggles/eye glasses with side shields or chin-length face shields.
± Masks should be fluid-resistant.

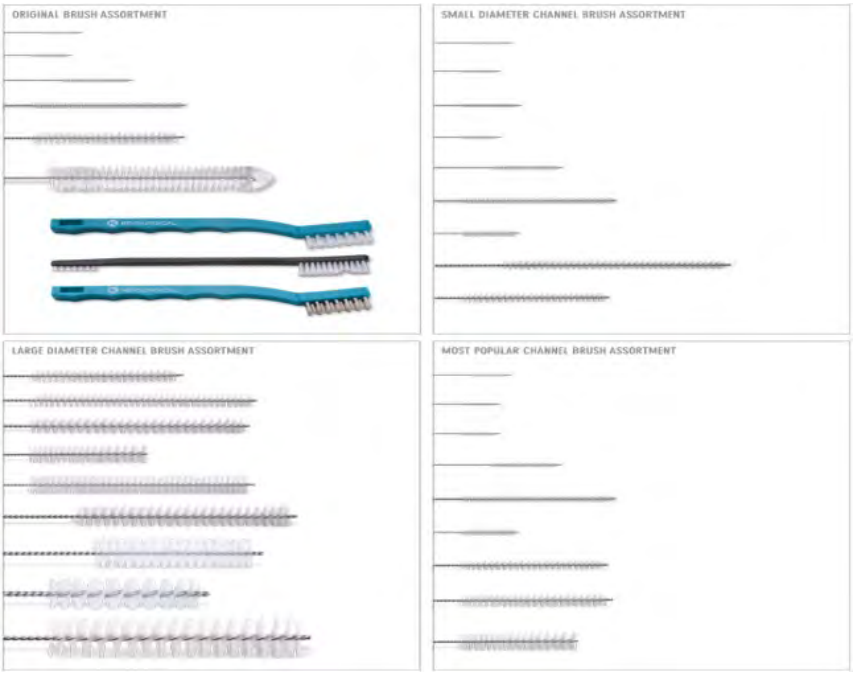
Delicate instruments should be protected from damage.[26] The weight of heavy instruments can easily damage delicate instruments, unless preventive measures are taken; therefore, lightweight instruments should be placed on top of heavier instruments or segregated into separate containers. Microsurgical instruments should also be segregated into separate containers. Heavy instruments should be placed on the bottom of storage containers or in a separate tray.

As noted above, proper water quality is critical for effective instrument cleaning. The type of water available for cleaning should be consistent with the manufacturer's written instructions and intended use of the equipment and cleaning agent.[27] Water quality is

affected by several factors, including conductivity; the presence of dissolved mineral solids, chlorides, and other impurities; and its acidity or alkalinity. Water quality also fluctuates over time. The optimum combination of chemicals used in a washer decontaminator is based on the hardness of the available water. Potable water should be used for manual or mechanical decontamination methods, unless contraindicated by instrument manufacturers' instructions. reverse osmosis or deionized water must be used for the final rinse, to remove all impurities and to maintain instrument surface health.

When cleaning lumens, the correct size and type of brush should be used. Since brushes are available in many sizes (see Figure 13), the correct size for the lumen of the instrument must be used. Additionally, metal brushes destroy the instrument surface, which leads to pitting and corrosion and also creates an irregular surface on which bacteria can reside; therefore, instruments should be cleaned with soft-bristle brushes.[28]

Figure 13 – Instrument Cleaning Brushes



The failure to properly disinfect and sterilize equipment carries not only the risk associated with breach of host barriers, but also the risk for person-to-person transmission and transmission of environmental pathogens; further, thorough cleaning is required before disinfection and sterilization because inorganic and organic materials that remain on the surfaces of instruments interfere with the effectiveness of these processes.[29] Three key issues related to instrument cleaning are:

- Cleaning plays a critical role in reprocessing. Research has shown that cleaning alone is effective in reducing the number of microorganisms from devices. For most surgical instruments, mechanical cleaning in a properly functioning washer-disinfector is highly effective in reducing the number of microorganisms. Studies have shown more that 80% of surgical instruments have less than 100 microorganisms and a washer sterilizer can remove all or nearly all of them.
- A neutral or near-neutral pH detergent solution is commonly used for instrument cleaning because this type of solution provides the best material compatibility profile and good soil removal. Enzymes are sometimes added to neutral pH solutions to aide in removing organic material. Alkaline-based detergent solutions may also be used for cleaning medical devices because they effectively dissolve protein and fat residues; however, they require a neutralizing rinse. Some data indicate that enzymatic cleaners are more effective than neutral detergents in removing microorganisms from the surfaces of instruments; however, more recent studies found no difference in cleaning efficiency between enzymatic and alkaline-based cleaners. Another study found no significant difference between enzymatic and nonenzymatic cleaners in regards to microbial cleaning efficacy.
- Cleaning tools such as brushes, must be cleaned at least daily. They can be put in a washer disinfector.

Step 4: Inspect surgical instruments for cleanliness and proper working order after decontamination.[30] Inspection is a critical step, not only for patient safety, but also for surgeon satisfaction, as instruments can become damaged during use or the decontamination process. Additionally, sterilization may not occur in the presence of soil or water. Inspecting instruments for sterilization before assembly of trays provides an opportunity to identify those instruments that require additional cleaning or repair before use. Visual examination of all instruments includes inspection for (see Figure 14):

- Cleanliness (testing for cleanliness of surfaces and lumens is recommended as a quality measure);
- Alignment;
- Corrosion, pitting, burrs, nicks, and cracks;
- Sharpness of cutting edges;
- Loose set pins;
- Wear and chipping of inserts and plated surfaces;
- Missing parts;

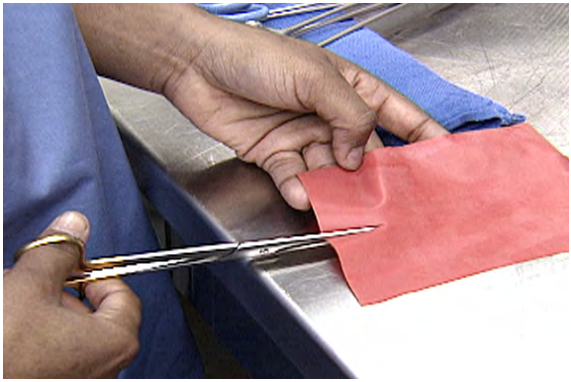
- Any other defects;
- Removal of moisture; and
- Proper functioning.

Figure 14 – Instrument Inspection

Visual inspection and function testing is required for all instruments; the use of a light with a magnifying glass is often recommended in checking for irregular surfaces, staining, fretting, pitting, the patency of lumens and cannulas, as well as insulated or coated instruments. Function testing parameters for specific surgical instruments are as follows:

- Scissors:
    - o Sharpness: Open the scissors one-half and close on either a test material or glove (see Figure 15); the cut should be smooth and clean.

Figure 15 – Function Testing, Scissors



- Pin set: Open the scissors, and then drop the handle gently; the scissors should close one-half to one-third.

- Needle Holders:
  - Inserts: Close the jaw one ratchet on aluminum foil to see the outline of jaw; if serrations – full jaw has serrations.
  - Approximation: Close the jaw one ratchet and hold up to light; light should not be seen through the jaws.
  - Pin set: Open the needle holder and drop the handle gently; it should close one-half to two-thirds.

- Clamps:
  - Approximation: Close on the first ratchet and hold up to light; no light should be seen passing through the jaws.
  - Approximation: Close on the first ratchet on paper, no tears or holes, other than a "toothed" end should result.
  - Box lock and surface: Check closely for hairline cracks.
  - Pin set: Open the clamp and drop the handle gently; it should close one-half to one-third.
  - Vascular clamps:
    - Close all ratchets; the jaws should close evenly.
    - Test the atraumatic "teeth" by using water in a zip lock bag:
      - Close clamp in the corner of the bag; the liquid should not flow into clamped corner.
      - Remove the clamp; there should be no perforations in the bag.

- Forceps:
  - Approximation: Tips should align properly.
  - Shanks should be even and straight.
  - Surface should be smooth and free of corrosion or pitting.
  - Pairs are matching.
  - Ratcheted instruments: These instruments should open completely; Ratchet should close and hold one ratchet at a time.
  - Approximation: Close one ratchet; tips should align properly.

- Curettes:
    - Sharpness: Test using a plastic rod or syringe barrel.
    - Cup: Profile – is there still a “cup”? Is it clean?
    - Surface: Should be free of nicks and/or burrs.
- Elevators (eg, cobbs, key): These instruments should be sharp with smooth edges and the correct shape.
- Rongeurs: The surface, screws, jaws, and action of these instruments should be inspected for signs of wear and proper functioning.
- Bone punches (eg, Kerrisons): The surface, screws, jaws, action and sharpness of these instruments should be assessed.
- Suctions: The surface, lumens (cleanliness and patency), and ends (burrs and/or irregularities) should be assessed.
- Insulated electrosurgical instruments: Insulated electrosurgical instruments should be inspected for small breaks in the insulation, as current can leak through insulation, even when breaks are not clearly visible.

After inspection, instruments should be thoroughly dried.[31] Elimination of moisture helps prevent rust formation during instrument storage. Furthermore, the presence of moisture can impede the sterilization process, as moisture on instrument surfaces alters the moisture content of steam and can pose a challenge for effective heating of the instrument. Ethylene oxide (EO) combines with water and creates ethylene glycol (ie, antifreeze), which is toxic and is not removed during aeration. Excess moisture also inhibits the hydrogen peroxide plasma sterilization process and can result in an aborted cycle.

Instruments in poor health, ie, in disrepair or with insulation damage, should be tagged or labeled and removed from service until repaired.[32] Identification of defective instruments facilitates segregation of these instruments from those to be used when assembling sets and prevents defective instruments from being used in patient care.

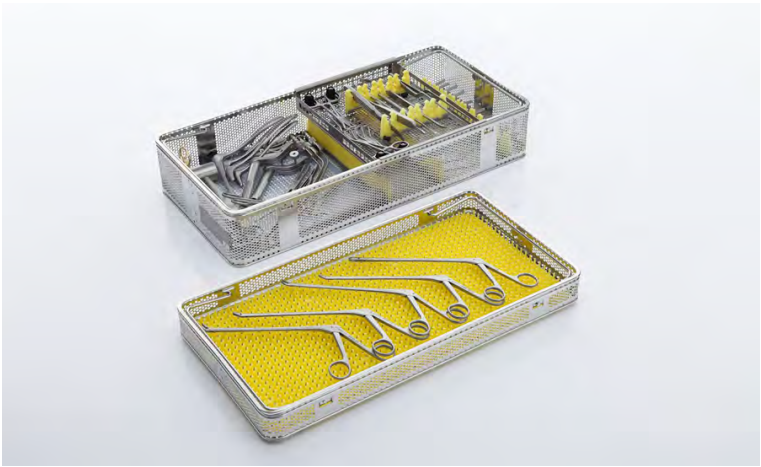
Instruments should be lubricated to decrease friction between working surfaces, after cleaning according to the manufacturer’s written instructions for the selection and appropriate use of lubricants.[33] Applying lubricants to soiled instruments can compound the problem of stiff joints and inhibit smooth movement. Some instruments do not require lubrication; however, cleaning, in particular ultrasonic cleaning, removes lubricants from instruments. Lubricants should be compatible with the method of sterilization to be used.

As noted, cracked or inconsistently applied coating is also an instrument health issue that presents several patient safety factors.[34] Continuous monitoring of the coating is prudent to detect any degradation. A process should be implemented for routine inspection and replacement of worn instrument coating to assist in resolving issues, thereby minimizing the risk to the patients.

Step 5: Organize cleaned surgical instruments for packaging in a manner to allow the sterilant to contact all exposed surfaces.[35,36] Proper organization will facilitate sterilant coming into contact with all surfaces, as well as adequate drying. All jointed instruments should be in the open or unlocked position, with ratchets not engaged. Instruments composed of more than one part or with sliding pieces or removable parts should be disassembled, unless the device manufacturer provides specific instructions, supported by test data, to the contrary (no longer recommended or required). Stylets should be removed from lumens to enable the sterilant to come into contact with the inside of lumens.

Proper placement is also critical to protect the instruments. Instrument stringers, racks, or instruments pegs designed to contain instruments are useful for organizing ring-handled instruments (see Figure 16). Organizing racks for osteotomes and bayonet-style instruments are also helpful. Tip protectors should be used to provide protection for delicate or sharp instrument tips. Tip protectors should be validated for use with the chosen method of sterilization, used according to manufacturers' instructions, and loose-fitting so that the sterilant can contact the surface to be sterilized.

Figure 16 – Proper Instrument Organization



Instruments should be placed in a container tray or basket that is large enough to evenly distribute the metal mass in a single layer and in a manner that protects the instruments from damage and prevents puncturing of the sterilization wraps, if used. Overloading trays can cause wet packs because an increase in metal mass in the tray results in more condensate, which requires additional drying at the end of the cycle. Heavy instruments should be positioned on the bottom of trays. The appropriate chemical indicator or integrator must be placed in the package or container.

Only validated containment devices (see Figure 17) should be used to organize or segregate instruments within sets. All packaging material/devices should only be used for their approved, intended purpose and should be appropriate for the sterilization method used. As with all medical devices and supplies, the manufacturer's instructions for use must be followed.

Figure 17 – Rigid Sterilization Container

Step 6: Sterilize instruments after cleaning and decontamination. As noted above, a key measure in reducing the risk for SSI is to provide surgical items that are free of contamination at the time of use; this is accomplished by cleaning and decontaminating the items, followed by a subjecting them to a sterilization process, as sterilization provides the highest level of assurance that surgical items are free of viable microbes.[37] Several sterilization methods are used in various surgical practice setting, including steam, ethylene oxide (EO), low-temperature hydrogen peroxide gas plasma, peracetic acid, ozone, and dry heat. Steam is usually the preferred method of sterilization for stainless steel instruments. The water / steam should be of good quality. Sterilization processes and parameter should follow facility guidelines, professional recommendations, and the instrument/device manufacturer's instructions.

Step 7: Transport sterile items in a controlled manner.[38] Sterility is event-related and depends on the amount of handling, conditions during transportation and storage, and the quality of the packaging material. Sterile items should be transported in covered or enclosed carts with solid-bottom shelves to protect sterile items from exposure to environmental contaminants during transportation.

Step 8: Store sterilized items properly.[39] Limiting exposure to moisture, dust, excessive light or handling, and temperature and humidity extremes decreases potential contamination of sterilized items. The shelf life of a packaged sterile item should be

considered event-related, that is, an event must occur to compromise the sterility of the package contents. Events that may compromise the sterility of a package include, but are not limited to:

- Multiple handling that leads to seal breakage or loss of package integrity;
- Moisture penetration; and
- Exposure to airborne contaminants.

Sterile packages should be stored under environmentally controlled conditions. Controlled conditions reduce the risk of contamination. The temperature in the sterile storage areas should not exceed 24°C (75°F). The storage area should have at least four air exchanges per hour. Relative humidity should be controlled, not to exceed 70%. Traffic should be controlled to limit access to those trained in handling sterile supplies. Supplies should be stored in a manner that allows adequate air circulation, ease of cleaning, and compliance with local fire codes. Sterile items should be stored at least eight to 10 inches above the floor, at least 18 inches below sprinkler heads, and at least two inches from outside walls (see Figure 18).

Figure 18 – Storage of Sterilized Items

SUMMARY

Instruments are used on daily basis in surgical patient care. The primary concern regarding surgical instruments is that they are patient ready, ie, in good working order, clean, and appropriately free of microorganisms; therefore, instruments that are not properly cleaned and sterilized can lead to patient injury, infection, and potentially death. Effective management of surgical instruments requires collaboration between surgeons, perioperative nurses, surgical technologists, and central processing personnel, all of whom share the responsibility for proper instrument use and care. All personnel should know and understand instrument "health" issues, as well as proper care and handling techniques to effectively maintain overall instrument "health" and promote safe care, positive patient outcomes, and protection of this valuable asset.

Your instruments must be functioning properly and free from bioburden when opened for use to achieve optimal patient outcomes and high surgeon satisfaction at your facility.

GLOSSARY

Bioburden	The number of microorganisms (ie, microbial load) with which an object is contaminated.
Biofilm	A thin coating containing biologically active organisms that have the ability to grow in water, water solutions, or in vivo and that coat the surface of structures (eg, inner surfaces of catheters, tubes, instruments). Biofilms contain viable and nonviable microorganisms that adhere to the surface and are trapped within a matrix of organic matter (proteins, glycoproteins, carbohydrates), which prevents antimicrobial agents from reaching the cells.
Bloodborne Pathogens	Pathogenic microorganisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to, hepatitis B virus (HBV) and human immunodeficiency virus (HIV).
Contamination	The presence of potentially infectious pathogenic microorganisms on animate or inanimate objects or surfaces.
Cleaning	The removal, usually with detergent and water or enzyme cleaner and water, of adherent visible soil, blood, protein substances, microorganisms and other debris from the surfaces, crevices, serrations, joints, and lumens of instruments, devices, and equipment by a manual or mechanical process that prepares the items for safe handling and/or further decontamination.
Critical Water	Water that is extensively treated (usually by a multistep treatment process that could include a carbon bed, softening, DI, and RO or distillation) to ensure that the microorganisms and the inorganic and organic material are removed from the water; a final submicron filtration could also be part of the treatment process. This water is mainly used for the final rinse or steam generation.

Decontamination	The use of physical or chemical means to remove, inactivate, or destroy pathogenic microorganism on a surface or item to the point where they are rendered safe for handling, use, or disposal.
Endotoxin	A toxin produced by certain bacteria, and released upon destruction of the bacterial cell.
Enzymatic Cleaner	A cleaner that uses enzymes to remove protein from surgical instruments.
Eschar	Charred tissue residue.
Exposure Incident	A specific eye, mouth, other mucous membrane, non-intact skin, or parenteral contact with blood or other potentially infectious materials that results from the performance of an employee's duties.
Healthcare-Associated Infection (HAI)	An infection acquired by patients during hospitalization, with confirmation of diagnosis by clinical or laboratory evidence. The infective agents may originate from endogenous or exogenous sources. HAIs, which are also known as nosocomial infections, may not become apparent until the patient has been discharged from the hospital.
Infection	The invasion and multiplication of microorganisms in body tissues that cause cellular injury and clinical symptoms.
Infectious Agent	A parasite (eg, bacterium, fungus, virus) that is capable of producing an infection.
Microorganism	An organism that is too small to be seen with the naked eye and requires a microscope. Bacteria, viruses, fungi, and protozoa are generally called microorganisms.
Occupational Exposure	Reasonably anticipated skin, eye, mucous membrane, or parenteral contact with blood or other potentially infectious materials that may result from the performance of an employee's duties.

Other Potentially Infectious Material	Refers to the following human body fluids: semen, vaginal secretions, cerebrospinal fluid, synovial fluid, pleural fluid, pericardial fluid, peritoneal fluid, amniotic fluid, saliva in dental procedures, any body fluid that is visibly contaminated with blood, and all body fluids in situations where it is difficult or impossible to differentiate between body fluids.
Package Integrity	Unimpaired physical condition of a final package.
Pathogen	A microorganism that causes disease.
Personal Protective Equipment (PPE)	Specialized clothing or equipment worn by an employee for protection against a hazard. General work clothes (eg, uniforms, pants, shirts or blouses), not intended to function as protection against a hazard, are not considered to be personal protective equipment. PPE is used by health care workers and others whenever it is necessary to protect themselves from the hazards of processes or environments, chemical hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact.
Reusable Rigid Sterilization Container	Specifically designed heat-resistant, receptacles used to package items, usually surgical instruments or medical devices, for sterilization. The lids and/or bottom surfaces contain steam- or gas-permeable, high-efficiency microbial filters.
Shelf Life	The period of time during which a sterilized medical device is considered safe to use.
Sterile	The state of being free from all living microorganisms. In practice, usually described as a probability function, eg, as the probability of a microorganism surviving sterilization being 1 in 1,000,000.

Sterilization	A validated process that removes or destroys all viable microorganisms, including bacterial spores, to an acceptable sterility assurance level, usually 1 in 1,000,000. In a sterilization process, the presence of microorganisms on any individual item can be expressed in terms of probability. Although this probability can be reduced to this very low number, it can never be reduced to zero.
Toxic Anterior Segment Syndrome (TASS)	A complication of ophthalmic surgery involving a severe, noninfectious inflammation of the anterior segment of the eye, caused by various contaminants in solutions, medications, steam, and residue on surgical instruments and supplies.
Ultrasonic Cleaner	A processing unit that transmits ultrasonic waves through the cleaning solution in a mechanic a process known as cavitation. Ultrasonic cleaning is particularly effective in removing soil deposits from hard-to-reach areas.
Utility Water	Water as it comes from the tap that might require further treatment to achieve the specifications. This water is mainly used for flushing and washing.

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