

The Care and Handling of Rigid Endoscopes



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The Care and Handling of Rigid Endoscopes - Study Guide #05

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Description of Study Guide Topic

Rigid endoscopy has become increasingly popular today as new minimally invasive techniques are being introduced and accepted. Instrumentation is becoming more sophisticated and patients are demanding less invasive procedures. To ensure patient safety and provide cost-effective, high-quality services, healthcare professionals must understand rigid endoscope technology and the reprocessing of these devices.

Overall Purpose of the Study Guide

This study guide will discuss the evolution and trends driving endoscopy today, the types and components of rigid endoscopes, and the care and handling of these devices.

Objectives

Upon completion of this study guide program, the participant should be able to:

1. Review the major components of rigid endoscopes.
2. Discuss the proper care of rigid scopes when reprocessing.

Intended Audience

This study guide is a self-study program intended for use by endoscopy suite nurses, endoscopy staff members, perioperative nurses, surgical technologists, central service staff members, infection prevention nurses and other healthcare professionals interested in this topic.

Introduction

Endoscopy has evolved and matured so rapidly during the past few decades that many procedures formerly using an open technique can now be successfully performed using less invasive approaches. Physicians no longer need to make large incisions to access body organs or structures. Instead, a natural body orifice or small incisions are used to introduce instruments to the surgical site.

Endoscopy is the inspection of a body organ or cavity by means of an endoscope, which consists of a tube and optical system (Ball, 1997). Endoscopic technology continues to be refined. Diagnosis and treatment can be performed in a less invasive manner compared to an open technique. The rapidity of endoscopic advancements has challenged healthcare providers to master this technology and adapt their practices to provide patient safety and high quality, cost-effective care in a minimally invasive manner.

The art of endoscopy has become part of the education included in medical schools and residency programs today; therefore, more physicians are appreciating the value, benefits and advantages of this amazing tool called the endoscope. With this increased popularity and growing expertise in endoscopy, the volume of rigid endoscopic procedures continues to steadily climb. Older, established endoscopic techniques are being refined, while new and innovative endoscopic methods are being introduced.

History of Endoscopy*

The curiosity to look inside body cavities or canals began many years ago. During the time of Hippocrates II (460-375 BC), physicians were able to examine the rectum with a speculum. Other speculums were then designed to look into other body areas, such as the vagina. In 1012 AD, an Arab named Abulkasim used a mirror to deflect light into the vagina. This was the first time light was used for this type of examination.

In 1585, Tulio Caesare Aranzi designed an endoscopic light to look into the nasal cavity. A light source was created by reflecting solar rays through a small opening; focusing was accomplished by using a spherical glass flask filled with water.

As time progressed, physicians and researchers were intent on viewing the internal structures of organs. In 1805 in Frankfurt, Germany, an obstetrician named Bozzani visualized the internal urethra using a tube as an endoscope and candles for the light source. The medical community quickly censored him for being too inquisitive. A French physician named Segalas continued this quest in 1826 by refining this instrumentation. He added an obturator to provide easier insertion along with a series of mirrors to deflect the light into the urethra for better visualization.

Desmoreau, who is credited as being the "Father of Endoscopy," designed the first true cystoscope and urethroscope around 1835. He used a kerosene lamp light reflected through a mirror system as the light source. In 1869, Commander Pantaleoni of England refined the Desmoreau endoscope and then looked inside the uterus and cauterized a hemorrhagic growth with silver nitrate. This event marked the birth of hysteroscopy.

A German physician named Nitze created the first crude optical system within an endoscope by adding a lens system to the scope in 1877. Advancements continued after Edison's introduction of the incandescent light bulb in 1880 when Dittel, in 1887, added a small incandescent light bulb to the end of a cystoscope to provide more direct illumination. By the end of the 19th century, endoscopic procedures such as cystoscopy, proctoscopy, esophagoscopy and laryngoscopy were offered in almost all major healthcare facilities.

Throughout the twentieth century, a flurry of advancements in endoscopy were witnessed. Some highlights of this century are listed below:

Early 1900s: A gynecologist named Petrograd developed a procedure called "ventroscopy" that looked inside the abdomen. A small incision was created in the abdomen to introduce a speculum. A head mirror was then used to reflect light into the area. Also during this time, a German named Kelling performed a procedure that he called "coelioscopy," which viewed the inside of the abdomen using a cystoscope. A pneumoperitoneum was established by passing filtered air through a needle inserted into the abdominal cavity, thus marking the first performance of a closed endoscopic procedure.

1912: Nordentoft of Copenhagen was the first to place the patient in the Trendelenburg position to enhance visualization of the abdominal organs.

1918: Takagi of Japan performed the first successful endoscopy of the knee joint on a cadaver.

1924: Zollikofer of Switzerland described the use of carbon dioxide for insufflation of the abdomen as the gas of choice due to its rapid absorption.

1929: A German named Kolk (known as the Father of Modern Laparoscopy) developed a foreoblique (135°) viewing system for enhanced visibility. He also introduced the second hole puncture technique for a more controlled liver biopsy.

1933: Laparoscopic applications expanded from diagnostic to actual operative treatments when Fervers lysed abdominal adhesions and biopsied different tissues under direct visualization.

1941: Powers and Barnes (University of Michigan) first described fulgurating fallopian tubes to provide sterilization using an electrical current with a device passed through an endoscope.

1952: Fourestier, Gladu and Valmiere developed a method to transmit light along a quartz rod through an endoscope. With increased light, pictures now could be taken of the different structures.

1967: A British physicist named Harold Hopkins designed a sophisticated ocular system that incorporated a series of large, rod-shaped quartz lenses for brighter, clearer images.

- 1970: Steptoe and Edwards described the laparoscopic retrieval of oocytes for advanced in-vitro fertilization techniques.
- 1973: Shapiro and Adler removed an ectopic pregnancy through the laparoscope.
- 1977: Kurt Semm introduced the first carbon dioxide pneumoautomatic insufflator to replace the manual introduction of CO₂ through a needle.
- 1985: Dr. Jack Lomano described photocoagulation of pelvic endometriosis using the Nd:YAG laser through a laparoscope.
- 1985: Dr. Leonard Schultz performed the first laparoscopic cholecystectomy on a canine in a laboratory in Columbus, Ohio.
- 1987: Dr. James Perez performed the first successful presacral neurectomy through the laparoscope. Dr. Harry Reich described the first laparoscopic use of bipolar electrocautery for the management of large vessel hemostasis.
- 1989: Dr. Harry Reich reported performing the first laparoscopic hysterectomy.

21st century: Laparoscopy has become extremely sophisticated today as major surgeries are being performed through small rigid endoscopes. Physicians not only have mastered the art of performing surgery by looking at a monitor, but are also able to perform telepresence surgery incorporating the use of robotics to actually manipulate surgical instruments at a distant site. Advancements are expected to continue to revolutionize rigid endoscopy technology in the future.

(*Note: The references for the history of rigid endoscopes are Ball, 1997; Gruendemann and Fernsebner, 1995; and White and Klein, 1991.)

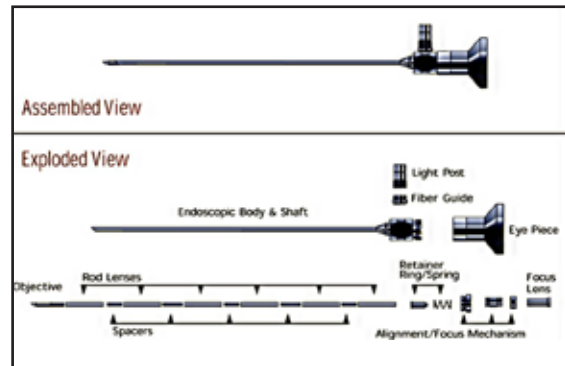
Anatomy of a rigid endoscope

Rigid endoscopes are complex instruments. Advancements in rigid endoscopy have rapidly progressed this technology into the next level of sophistication. Complex endoscopes and accessories have expanded the capabilities of performing surgery and treatments in a less invasive manner.

When examining a cross-section of a rigid endoscope, the internal intricacies are evident. These sophisticated structures consist of optical lenses, an eye piece and possibly a lumen to pass biopsy forceps or other instrumentation through. Often, the complexities of a rigid endoscope are not appreciated or even realized by healthcare professionals. By understanding the components of an endoscope, proper care and handling can be promoted and troubleshooting can be performed in a logical, analytical manner. The five major components of a rigid endoscope are:

- > Eye piece
- > Body
- > Light guide connector
- > Shaft
- > Distal end

Each of these components are described in more detail individually.



Eye Piece

The eye piece houses an ocular lens, which is positioned at the end of the "lens chain." Some manufacturers add a visible color-coded O-ring that signifies the degree of the lens angle so the endoscope can be identified easily.

The functionality of the eye piece lens can be assessed by looking through the eye piece to check its consistency. The surface of the eye piece lens must not be touched by bare fingers; skin oils can be deposited on the lens causing smudging that can lead to image distortion. If the endoscope is dropped, the eye piece may crack and need to be repaired.

A video camera can be connected to the eye piece to project the image on a monitor and/or facilitate taping of procedure. Before cameras were utilized during endoscopy, assistants used eye piece extensions to obtain a view similar to the surgeon's view. Tubelike cameras were introduced in the 1960s and provided an image that the entire surgical team could observe. Since then, cameras have become very sophisticated, smaller and capable of many things.

In 1975, video camera technology was drastically changed when the charged coupled device (CCD) was first introduced. A CCD consists of an arrangement of light sensitive pieces of silicone or metal oxides called pixels (picture elements). Light is transmitted from the distal end of the endoscope to the pixels where electrical impulses or charges are generated proportional to the amount of light that hits the surface of the chip. The CCD changes these stored charges into a signal that is sent to the camera control unit for decoding. The camera control unit then prepares the information for output to a video monitor, printer, tape recorder, or other device.

Today's rigid endoscope cameras have one to three chips. The chip is the small silicone wafer on which electronic components are deposited to fabricate the video circuits (CCDs). Single-chip cameras are smaller and cost less, while the three-chip cameras produce better-quality image with enhanced color. Newer single-chip cameras are being developed that have digital processors that boost resolution by incorporating the three-chip quality into a single-chip.

Body

The body of a rigid endoscope houses the mechanism to consolidate the image. The spring mechanism, also located in the body, keeps the lenses and spacers together. These items are in the adjacent shaft and are merely placed there, not glued together. This is important for repair information. The body of the endoscope also provides the connection for the light guide cable.

Light Guide Connector

The light guide connector consists of light cabling that connects the rigid endoscope to the light source. Light enters the light guide

connector at the endoscope body and illuminates the target at the end of the distal tip, allowing the image to be seen through the eye piece.

Light cables consist of thousands of tiny glass fibers, even finer than a strand of hair, that conduct light energy. If these light fibers are traumatized, they can fracture, thus decreasing the amount of light provided to illuminate the target area. Ultrasonic cleaners must not be used on fiberoptic light cables as the minute vibratory motion can fracture the tiny glass fibers or misalign the rods.

There will be diminished light output:

- > If the light cable is damaged
- > If there is debris on the ends of the light cable
- > If mixed brands of adapters are used that are not compatible
- > If the wrong adapter for the light cable is used
- > If the light bulb is old or dirty
- > If the wrong light bulb is used in the light source

When disconnecting the light cable from the light source, a firm hold of the actual connector and not the cable itself is vital. If force is used to remove the cable, the tiny glass fibers can fracture, diminishing the light output.

Handling and maintenance of the light cable requires continual inspection to ensure proper functioning. The light cable should be discarded and replaced if more than 1/3 (33%) of the fibers are broken. Conduction of the light through the light cable can be assessed by holding one end of the cable to the light and observing the other end for black dots. These black dots represent broken fibers. The light cable ends should always be protected and cleaned routinely. The light cable should never be severely bent or stretched because the bundles of glass fibers could fracture.

To prevent fires and burns, the light source should never be turned on unless the cable is securely attached to the endoscope. Since the end of the light cable can get very hot, any drapes, supplies, or even the patient should not come in contact with the light cable end when it is disconnected and still conducting light.

The three types of light sources that are most commonly used today are xenon, metal halide and halogen.

Xenon: Xenon light bulbs cost about twice as much as halide bulbs but last twice as long. Xenon is the preferred light source for video endoscopy because higher-wattage bulbs can be used that generate more consistent light intensity. The xenon light can be focused down to a small area, which is needed for smaller-lumened endoscopes.

Metal halide: Metal halide bulbs are less expensive and have a shorter life span than xenon bulbs. These bulbs also are easy to handle and replace and do not require large fans for cooling.

Halogen: Halogen light sources are popular in physicians' offices, but do not offer the light intensity usually needed for endoscopy and some video processors. They are generally not preferred for video endoscopy because they produce a yellow cast and only have a 150-watt capacity.

Bulbs within a light source should be changed by an experienced person following manufacturer's instructions. Most light bulbs are located in the light assembly drawers making them readily accessible. It is recommended to use a cloth or a 4 x 4" sponge to remove and replace the bulb. This protects against burns and keeps oils from hands off the new bulb, thereby extending its life. If a newly replaced bulb still does not work, the problem may be in the light source itself. A light source should ideally have a lamp life status monitor and adjustable brightness modes.

Shaft

The shaft is the next component of a rigid endoscope. The shaft extends from the eye piece to the distal tip. The outer tube of the shaft consists of stainless steel, while the inner tube houses the optical system (objective lenses, rod lenses and spacers).

The rod lenses and spacers are positioned inside the shaft. When first introduced, the rod lenses were short while the spacers were long. Depending on the size of the endoscope, some rod lenses are smaller than a single strand of spaghetti, making them very fragile. Advancements in optical technology developed systems with much better imaging capabilities that consist of long rod lenses with short spacers. Other lenses help transmit the light and image at a certain angle (depending upon the lens) so that the target can be visualized more completely.

Since the shaft houses the majority of the optical system, care must be taken not to bend the shaft as the lenses would be subjected to undue stress and strain. The shaft must never be held at the very distal end because the weight of the rest of the rigid endoscope can put undue stress on the shaft. A rigid endoscope should be held by supporting the eye piece and body of the endoscope.

Since rigid endoscopes are expensive, care must be taken to prevent accidents from happening. Some rigid endoscopes can roll off the surgical table if positioned near the edge. The weight of heavy instruments inadvertently being placed on or near these devices can easily damage a rigid endoscope shaft. This can happen during a cystoscopy when the durable and somewhat heavy urethral dilators are accidentally placed on top of the shaft of a cystoscope.

The shaft may also house a lumen for the passage of instrumentation or provide irrigation and suction capabilities. Lumens come in a variety of sizes depending on the outside diameter of the endoscope shaft. Care must be taken during reprocessing to ensure that lumens are thoroughly cleaned as microorganisms can easily be harbored inside this area.

Distal End

The final component of a rigid endoscope is the distal end. The distal end houses more of the lenses in the endoscope optical system. One lens, called a negative lens, is concave and collects reflected light from the object in the field of view. A prism lens provides for the desired lens angle (15°, 30°, 45°, 70°). A 0° scope would not need a prism lens. The objective lens creates the image and is positioned at the distal end of the optical chain.

Handling Suggestions

Proper handling of rigid endoscopes is vital in minimizing repair bills. Repair companies have reported that almost 95% of endoscope repairs are caused by poor handling before, during and after the rigid endoscopic procedure. An objective lens can be damaged from laser energy, dropping the endoscope, autoclaving it too long, leaving it in glutaraldehyde for too long, or soaking the endoscope in glutaraldehyde that is too concentrated. A broken or misaligned rod lens may be caused by laying heavy objects on the outer

sheath, by not pulling the endoscope straight out of the cannulae, or by improper spring-loading of the lenses by the repair company technician.

Listed below are some common repair problems and suggested solutions to prevent this type of damage to rigid endoscopes:

- > Broken or cracked eye piece - The eye piece is very fragile. Abrupt or sharp hits must be avoided
- > Bent light guide connector post - Many times the light guide connector post can be bent by the weight of other instruments during reprocessing if not arranged properly
- > Broken or misaligned rod lens - Heavy objects must not be placed on the shaft of an endoscope



- > Blurred or cloudy objective lens systems - The endoscope must not be steam sterilized too long or overheated as the glue on the objective lens may disintegrate
- > Cracked, foggy distal end - The distal tip must always be protected during procedures. The endoscope must be inserted and pulled straight out of the cannulae to avoid misalignment of the lenses or fracturing of the seams that would cause leakage into the endoscope. Many anti-fog agents cannot be applied to the lenses before autoclaving
- > Faulty repairs - A reputable company must be used for endoscope repairs

Reprocessing a Rigid Endoscope

In today's healthcare arena, managed care and capitation are becoming the controlling forces for reimbursement and survival. Healthcare professionals are challenged to provide cost-efficient and cost-effective services. Less invasive procedures, such as endoscopic applications, are usually more economic, but require a capital expenditure outlay for the equipment, instrumentation and ongoing operating expenses. Proper care and handling of endoscopes and endoscopy equipment minimizes the expense of repairs and prolongs the life of endoscopic devices and accessories.

The bottom line is that by keeping endoscopes in the proper and ideal working order, patient safety is promoted along with cost efficiency. The cost of a healthcare-associated infection caused by an endoscope inadequately reprocessed or the expense of a patient injury from a damaged endoscope can become exorbitant. These unnecessary expenses and injuries can be easily avoided.

Reprocessing an endoscope requires a skill level and knowledge base not only of the endoscope components, but a thorough understanding of reprocessing practices and hazards. Improper reprocessing can compromise patient safety and can damage and actually destroy an endoscope. The endoscope manufacturer must provide detailed instructions on proper reprocessing.

Cleaning

Precleaning the endoscope always takes place wherever the endoscopic procedure is being performed. When the scope exits the body, gross debris is wiped off the outside surface while fluid is pulled through the channels. Decontamination should begin immediately as dried debris will be more difficult to remove.

There are some unique environmental conditions that may cause bioburden to be more of a challenge for thorough cleaning. For example, during laparoscopic procedures, instruments are used in a pressurized area within the abdomen. This pressurization can drive debris and liquid contaminants up into the endoscope and instrument channels, which can solidify during and after the procedure. Therefore, special attention to keeping the lumens flushed during the procedure becomes extremely important.

Contaminated rigid endoscopes and accessories should be transported to the reprocessing area covered or in a closed container. A damp towel can be used to cover the contaminated instruments so debris will not begin to dry on the surfaces.

In the reprocessing area, the healthcare worker must wear the appropriate personal protective attire to minimize the transmission of pathogens. Decontamination or cleaning of contaminated devices requires a large wash basin or sink, proper detergents and cleaning solutions and appropriate cleaning devices. Brushes must be suitable in size to fit down lumens so they will not damage the working ends of delicate instruments or the lenses of a rigid endoscope. When brushing the lumens of an endoscope or accessory, the device must be submerged under water so aerosolization will not occur. Endoscopic devices usually are submerged in water after a procedure to loosen debris. A presoaking solution with an enzyme may be added for more effective precleaning action. Contaminated instruments should not be soaked in solutions for prolonged periods of time, as mineral deposits and water impurities can stain the instruments.

The endoscope manufacturer's written instructions will provide details on acceptable solutions for cleaning endoscopes and accessories. The most common types of soils found on rigid endoscopes and accessories are blood, fat, peritoneal fluid, or synovial fluid. Detergents or enzymatic solutions must be chosen depending upon the soil being found. Product labels must be read to determine this appropriateness. A low sudsing detergent should be used that can be completely rinsed off so that no detergent debris is left on the instrument. A detergent with a very high or low pH can cause staining and pitting of instrument surfaces. Abrasives, such as steel wool, can also damage the surface of a device. Contaminated instruments should never be exposed to alcohol because alcohol will bind protein, making it even more difficult to remove during cleaning.

The design of some of the endoscope accessory instrumentation can provide quite a challenge during reprocessing. Some healthcare workers do not even realize that these devices can be taken apart. Removable parts of the endoscope and accessories must be disassembled before cleaning can begin.

Instruments with hinged joints must be completely disassembled too. A rigid grasper is a good example of a device with a hinged joint mechanism. The area in the control handle provides a hinged joint, which usually is joined by a variety of methods, such as a ball on the end of a slide rod that goes into the handle. At the working end, another hinged joint is found, which comes in a variety of configurations for different functions.

Ideally, the hinged joint instrument needs to be disassembled or taken down to its smallest parts. The handle is taken apart by removing the pin assembly. The push rod that goes down the length of the grasper can then be pulled out, giving better access to the ball joint and the pivot point at the end of the control handle. The internal lumen of the grasper can be flowed for thorough cleaning. The design of this device often presents a challenge as the instrument must be carefully reassembled with the proper tension on the assembly screws so the instrument works properly.

Stopcocks must also be disassembled completely for thorough reprocessing. Some manufacturers have designed stopcocks so that the inner part of the stopcock can be accessed for cleaning without being disassembled. When the handle is rotated to the cleaning position, the tapered part of the handle assembly lifts up a few thousandths of an inch and allows a flow of cleaning and sterilants through the device.

Some endoscopic accessories (according to the device manufacturer's instructions) can be placed in an ultrasonic machine for cleaning after gross debris has been removed. Ultrasonics work through cavitation as sonic waves are produced that make tiny bubbles on the surfaces of the instruments. The bubbles expand until they become unstable and then collapse or implode. The resulting implosion produces very localized vacuum areas responsible for dislodging soil from surfaces. The soils are literally sucked off the instruments. Fiberoptic light cables and some rigid endoscopes must not be placed in the ultrasonic cleaner as vibratory motion can damage them. Some delicate fiberoptic and lensed devices cannot be exposed to ultrasonic cleaning, automatic cleaning, or harsh chemicals. Manufacturer's recommendations may require that these instruments be manually cleaned.

Some heat-sensitive devices cannot be placed in an automatic washer/decontaminator. The medical device manufacturer's written instructions will recommend automatic or manual cleaning. All o-rings must be visually examined before cleaning, no matter what method is chosen, so that exposure to moisture will not damage the internal workings of the instrument.

After manual or automatic cleaning, the endoscopes and instruments must be thoroughly rinsed, especially the internal lumens, to remove any detergent residues that could affect disinfection or sterilization. Distilled, deionized water may be recommended for the final rinse because the chemicals and minerals (such as iron, calcium, or magnesium) present in most tap water can damage instruments. If distilled water is unavailable, then tap water can be filtered to remove these contaminants.

Endoscopes and accessory instrumentation should be thoroughly dried after rinsing is completed. A soft, lint-free cloth, a blow dryer, or a pneumatic air gun can be used to dry surfaces and internal lumens. If devices are allowed to drip dry, spotting may occur. Accessories may be lubricated at this time. Usually an antimicrobial, water-soluble instrument lubricant can be used for instrument dipping (not soaking) to form a thin protective film on the surfaces. Instrument lubricants should allow for sterilant contact and must be compatible with the method of sterilization used.

Thorough cleaning removes most of the bioburden. According to Dr. Earl Spaulding, an instrument or device cannot be sterilized or disinfected without first performing adequate and complete cleaning (Spaulding, 1972). If bioburden is left on a device, even if it's thought to be sterile, this soil can act as a foreign body if deposited in the next patient. This "sterile dirt" can increase adhesion formation, increase the immune response, produce a pyrogenic action and even delay healing.

Inspection

After the endoscope or instrument has been thoroughly cleaned, rinsed and dried, inspection must be performed to ensure the integrity of the device. The person reprocessing the device must look for signs of rust, stains, corrosion, pitting, cracks, chips, nicks, or burrs. Crevices and seams must be inspected also. These juncture sites are where two parts of the device join other sections of the instrument. For example, a seam could exist where the shaft of a rigid scope joins the body of the scope. If these seams or crevices have weakened, debris can enter the device causing damage, thus becoming a safety hazard. If damage is detected early on an instrument or endoscope, expensive repairs or replacement may be avoided.

Eye pieces of rigid endoscopes must be cleaned and prepared according to the manufacturer's instructions. Some anti-fogging agents cannot be added to the eye piece after cleaning and before sterilization as the sterilization process (especially steam sterilization) may cause the lens to become cloudy. Endoscope manufacturers will recommend methods for defogging that are appropriate for specific rigid endoscopes.

Endoscopes and accessories must remain disassembled during the disinfection or sterilization process for appropriate reprocessing to occur.

Spaulding's Classifications

The next step in the reprocessing cycle is to determine what is appropriate - disinfection or sterilization. Dr. Earl Spaulding developed a classification system for patient care items based on the risk that is present when the instrument is used. Spaulding's classifications are as follows: (Ball, 1997)

- > Critical items - Devices that enter sterile tissue or the vascular system (contact blood). Examples of critical devices are laparoscopic scissors, snares and biopsy forceps. These items need to be sterilized
- > Semi-critical items - Devices that come in contact with intact mucous membranes. An example of a semi-critical device is a cystoscope that is used for diagnosis only. The preferable choice of reprocessing is sterilization, but high-level disinfection is acceptable since the device will only be touching intact mucous membranes. If a biopsy is to be performed, the cystoscope would then be classified as a critical device and must be sterilized since the vascular system would be entered
- > Non-critical items - Devices and equipment that come in contact with intact skin but not with mucous membranes. Examples of non-critical items are bed pans, blood pressure cuffs and stethoscopes. The choice of reprocessing is decontamination or cleaning

Disinfection

For years, glutaraldehyde has been an acceptable method of reprocessing for high-level disinfection. Glutaraldehyde, however, is a protein tissue fixative and will harden and cement any leftover debris within the lumens or on the surfaces of the endoscope. With repeated processings, this debris becomes more difficult to remove.

Before immersion in glutaraldehyde, the device must be dry so that excess water on the surfaces and in the lumens does not dilute the glutaraldehyde solution. There are test strips that should be used to determine the glutaraldehyde concentration at least daily, but preferably before each use.

In the early 1990s the FDA recommended glutaraldehyde manufacturers label their products, requiring a 45-minute soak time with the solution being heated to 25° C (77° F). This recommendation was based on research showing that some pathogens could only be destroyed at this soak time and temperature (this study was based on uncleaned devices). Professional organizations have contested this recommendation and have written guidelines suggesting that devices be soaked for 20 minutes at room temperature if the devices have been meticulously cleaned. The FDA's response is that devices are not always meticulously cleaned and there is no way to validate that appropriate cleaning has been performed. This controversy continues and, because of this debate, many healthcare facilities have totally eliminated glutaraldehyde and have switched to the liquid chemical sterilization method. Most recently there have been published reports of certain waterborne species of Mycobacterium that can grow at the final disinfectant use dilution, which makes the controversy even more active today. (McDonnell et al., 2009)

Many hazards have been associated with glutaraldehyde including:

- > Skin and mucous membrane hazards (If glutaraldehyde is accidentally splashed in an eye, the eye must be immediately and copiously flushed with water. Glutaraldehyde bonds protein together, therefore, the protein within the cornea can be quickly coagulated after a splash occurs if not thoroughly flushed.)
- > Ingestion hazards
- > Chronic exposure hazards
- > Respiratory hazards

Respiratory hazards are such a concern that the following levels of glutaraldehyde exposure have been set:

- > 0.04 ppm-odor is detected
- > 0.2 ppm-exposure level (set by OSHA)
- > 0.3 ppm-the glutaraldehyde fumes become an irritant
- > 0.4 ppm-occurs when mixing, pouring, or breaking the surface tension of the glutaraldehyde solution when immersing devices to soak (this is twice the exposure level permitted by OSHA). OSHA does not mandate glutaraldehyde exposure monitoring but can penalize facilities if the breathing areas exceed the exposure level for glutaraldehyde

The area where the glutaraldehyde basin is located is extremely important. Many times a glutaraldehyde basin is transported from one surgery or treatment room to another, thus exposing everyone in the vicinity to high levels of glutaraldehyde vapors. Glutaraldehyde soaking bins must be centralized. At least 10 air exchanges per hour are recommended in the reprocessing area. The glutaraldehyde tub should be positioned near the ventilation outlet (that connects with outside air and is not recirculated). For more detailed information, the AAMI document ST58, "Safe Use and Handling of Glutaraldehyde-based Products in Health Care Facilities," can be referenced.

Alternative chemical solutions have gained acceptance for high-level disinfection of devices in recent years. Different preparations that may include hydrogen peroxide, other aldehydes, phosphoric acid, or a dilute peracetic acid have been placed on the market to provide

high-level disinfection. Manufacturer's written instructions must be clearly followed when these products are used.

Sterilization

Many healthcare facilities have switched to sterilizing their rigid endoscopes since therapeutic modalities (cutting, ablation, excision, coagulation, etc.) are often performed during endoscopic procedures. If the blood system is invaded during a biopsy or excision of a lesion, according to Spaulding's classifications, the endoscope should be sterile. There are four acceptable and common sterilization methods that are appropriate for rigid endoscopes today, including steam, ethylene oxide, low temperature liquid chemical sterilization and gaseous hydrogen peroxide sterilization.

Steam Sterilization

Steam sterilization is a popular method of sterilization for the newer rigid endoscope models. There are two main types of steam sterilization cycles. One is a gravity displacement cycle that operates by steam displacing the air through gravity as the steam is slowly injected into the chamber. The other is a prevacuum cycle, in which the air is removed mechanically while the steam is injected via alternating pressure/vacuum pulsations into the chamber.

Some advantages of steam sterilization include:

- > Low cost
- > Convenient, dependable
- > Popular method of choice for sterilization for years
- > Rapid heating and penetration
- > Brief exposure times
- > Non-toxic with no residues

A limitation of steam sterilization includes:

- > Not for use with heat- or moisture-sensitive devices

Steam sterilization depends on the parameters of temperature, pressure and time. For example, sterilization of unwrapped, metal, non-porous instruments in a gravity displacement sterilizer requires an exposure time of three minutes at 270° F (132° C) at about 30 psi.

Steam must be able to contact all of the surfaces of the endoscope and accessories for sterilization to take place. Steam coagulates cellular protein to kill all of the microorganisms. Air is the greatest enemy to steam sterilization as trapped air will not allow for proper heating and penetration of the steam. This is the reason that all lumens must be flushed with water (distilled water is usually recommended) so the internal channels can be sterilized adequately too.

Flash sterilization is steam sterilization using the unwrapped method for immediate reuse of the device. This definition has been altered today as there now are flash sterilization containers and single-wrap methods for flash sterilization. These containers and wraps have been introduced to ensure that the items sterilized by flash sterilization will not be contaminated during transport to the sterile operative field.

CDC, AAMI and AORN recommendations state that implants should never be flash sterilized, as verification of sterilization efficacy cannot immediately be assessed the same day (as the

biological indicator needs to be incubated before results can be determined). For more detailed information about flash sterilization, refer to the AAMI document ST79, "A Comprehensive Guide to Steam Sterilization and Sterility Assurance in Health Care Facilities."

It is important to allow instruments that have been flash sterilized to cool down before being used on a patient. Surgical team members often wear double gloves when handling devices that have been taken immediately out of the steam sterilizer. Research has shown that when a surgical team member wearing double gloves touches an instrument heated to 195° F for five seconds, it only feels like 92° F. An instrument at 195° F touched by a double-gloved hand for 30 seconds feels like 130° F (Adoumi et al., 1991).

Mechanical (physical) monitoring involves real-time assessment of a sterilization cycle. This can be done by noting the parameters that are recorded on gauges, round charts, or computer printouts. Chemical monitoring indicates exposure to the sterilization process, but does not verify sterility. External chemical indicators, such as chemical indicator tape used to secure an outer wrapper, signal whether or not the package has been processed. Chemical indicators that are placed inside a pack or basin set are also available. Internal indicators should be placed in an area most difficult to be reached by the sterilizing agent. Chemical monitors are inexpensive and are usually used with each wrapped pack or set being steam sterilized.

Biological monitoring is performed to document the efficacy of the wrapped goods steam sterilization cycle. Routine biological monitoring should be done with a full load at least weekly with daily monitoring being preferred. A test pack containing a biological indicator (BI) should be placed on the lower shelf over the drain, as this is the coldest part of the sterilizer and will present the greatest challenge for sterilization.

After installation of a sterilizer or after major repairs, three consecutive test packs should be run with nothing else in the chamber. *Geobacillus stearothermophilus* is the biological monitor agent of choice as it is very resistant to being killed by the steam sterilization process and will not cause disease in humans. The BI manufacturer's written instructions should be followed and attention should be paid to the time and temperature requirements for incubation. A control biological indicator should be used to assess the viability of biological indicators from the same package.

New enzyme indicators are available today that provide a rapid read-out of the results. The enzyme indicator activity mimics the action of biological indicators. This activity, however, should not be confused with the action of biological indicators.

A test (Bowie-Dick type) is used to determine the efficacy of the mechanical air removal and to detect air leaks on the prevacuum steam sterilizer cycle. Bowie-Dick test packs may be constructed by the healthcare facility per AAMI ST79 guidelines or commercial residual air testing packs can be used. The residual air test manufacturer's recommendations should be followed closely. For example, the instructions may recommend that this test be done daily before the first processed load in an empty chamber with four minutes exposure time at 273° F (134° C). At installation and after any major repairs, three residual air testings should be done to ensure proper air removal with prevacuum systems.

For more detailed information on steam sterilization and sterility assurance, refer to the AAMI document ST79.

Ethylene Oxide (EO) Sterilization

Ethylene oxide has been the sterilization method of choice for

years for heat and moisture sensitive medical devices. Even though ethylene oxide is a very effective method of sterilization, misunderstandings about this type of sterilization have led some hospitals to remove all of their EO systems. Accurate information about EO must be realized beginning with the historical perspectives of ethylene oxide.

1859: EO was discovered and was found to be very useful for fumigation.

1929: The blend of EO/CO₂ was patented for insecticide and microbial use.

1930: EO began to be used as a fumigant for spices, gums and cereals.

1940: 100% EO was patented for use as an agriculture fumigant.

1949: EO was first identified as a sterilant at Fort Detrick.

1950: 100% EO was first used to sterilize heat sensitive medical devices.

1962: The blend of EO/CFC (chlorofluorocarbons), which is a mixture of 12/88 - or 12% EO and 88% CFC was patented (A blended mixture of EO with CO₂, CFC, or HCFC makes the EO less flammable).

1980s: Safety issues were imposed by OSHA for personnel exposure levels (for example, the permissible exposure level (PEL) of 1 ppm in an eight hour time-weighted average (TWA) in a breathing zone was set.

1986: Countries throughout the world became very concerned about the progressive destruction of the ozone layer and global warming. At a 1986 meeting in Montreal, Canada, the UN industrialized countries signed a treaty of agreement (Montreal Protocol) to phase out compounds that were destroying the ozone. The treaty declared a ban on CFC to be instituted fully by the year 2000.

1989: In the United States, a high excise tax was imposed by Congress on certain CFCs, which resulted in quadrupling the cost of the 12/88 blend by 1995. This tax was intended as an incentive to force the development of alternatives to blended mixtures involving EO.

1995: Environmental issues became more recognized and the CFC phase-out plan began. HCFC (Hydrochlorofluorocarbon), a gas with less ozone damaging properties than CFC, began to be added to EO.

Today: 100% EO has become very popular as an alternative to the blended mixtures as it does not contain environmentally hazardous compounds. 100% presents no ozone depletion problems.

Industrialized countries throughout the world continue to address the need to preserve the ozone layer by phasing out other ozone-depleting compounds. This phase-out does not include EO as it is not ozone-depleting. Only those compounds that EO was being mixed with to minimize flammability are targeted for the phase-out.

Ethylene oxide is a colorless gas that readily permeates medical devices, diffuses rapidly, is sporicidal and non-corrosive and is flammable and combustible at high concentrations and high volumes. EO effectively sterilizes heat sensitive rigid endoscopes or flexible endoscopes without lumen restrictions.

In preparation for EO sterilization, devices must be thoroughly cleaned, rinsed and dried. Since lumens must be rinsed thoroughly to remove any cleaning solution residue, the challenge is to make sure the lumens are completely dry before EO sterilization. If devices or lumens are not dry, hazardous compounds will be produced. When residual water combines with EO, ethylene glycol or antifreeze is developed. When saline combines with ethylene oxide, ethylene chlorohydrine, a carcinogen, is formed.

Many different types of instrument and pack wrapping and packaging materials are compatible with ethylene oxide sterilization, including muslin, textiles, polypropylene, Tyvek and paper/plastic peel pouches, to name a few.

The rate of EO sterilization depends on several factors, including gas concentration, relative humidity, temperature and contact time. A relative humidity of at least 35 to 85% is required for sterilization to be effective. Humidity is necessary to allow the EO to penetrate through the cellular membranes. This moisture will swell the microbial cell, which enhances EO penetration and aids in the killing of microbes.

Ethylene oxide sterilization progresses through several phases including preconditioning, exposure and detoxification or aeration. Aeration is critical to remove the toxic EO so the instruments and devices can be used or stored. It is extremely important to ensure that all of the residual ethylene oxide is removed so that contact irritation or chemical burns do not occur to the user or the patient. For employee safety, environmental monitors and personnel monitors should be used to determine the level of EO in the air around the sterilizers, aerators and the worker's breathing zone.

There are several methods employed to provide quality assurance for an EO sterilization cycle. These include:

- > Physical monitors (noting if the sterilization parameters have been met, such as temperature and humidity)
- > Chemical monitors (produce a response to time, temperature, EO concentration and humidity should be placed within and on each pack)
- > Biological monitors (biological indicators (BIs) contain *Bacillus atrophaeus*, which is considered the most difficult spore to kill by EO and thus offers the best challenge to an EO sterilizer. The Association for the Advancement of Medical Instrumentation (AAMI) states that a BI test pack is to be placed in each EO cycle)
- > Record-keeping (records should be filed that note the results of all of the quality assurance reports for EO sterilization)

The advantages of EO sterilization include:

- > Effective sterilization for heat and moisture sensitive devices
- > EO readily diffuses at low temperatures
- > No lumen restrictions
- > Compatible with most materials

- > Low cost

The disadvantages of EO sterilization include:

- > Cycle length and aeration (longer than other methods of sterilization)
- > HCFC causes ozone depletion (This EO/HCFC blend will be phased out in the future.)
- > Cost of EO blend mixtures is high
- > Installation requirements and recommendations (OSHA, AAMI) must be followed to ensure the containment of EO so it will not become a hazard to employees
- > Flammability of the EO
- > Toxicity of the EO
- > Environmental monitoring required

Low Temperature Liquid Chemical Sterilization

In 1987, a low temperature liquid chemical sterilization system utilizing peracetic acid (PAA) was introduced for sterilization of heat sensitive items. Liquid chemical sterilization has become very popular because it provides a rapid method of reprocessing that produces sterile devices. The sterilization cycle takes about 30 minutes to complete, thus helping to minimize surgical scheduling conflicts.

Rigid endoscopes and metal instruments that are fully immersible can be safely sterilized in these types of liquid chemical sterilization systems. Some rigid endoscopes have internal ports that may need to be attached with special connectors to allow for continual purging of the lumens throughout the processing cycle.

Because peracetic acid oxidizes organic materials such as protein bonds, debris buildup is prevented. To prepare for peracetic acid sterilization, the devices must be pre-cleaned and placed in the tray/container that fits the instruments and endoscopes properly.

Each sterilization cycle requires a single use dosage of peracetic acid to be dispensed during the cycle. After the lid of the processor has been closed and the cycle started, the sterilant concentrate is automatically mixed with sterile water (prepared internally) to form the appropriate use dilution. This use dilution works to oxidize biological materials and sterilize the devices. After an exposure period, the devices are rinsed with sterile water during four separate rinse cycles. The total sterilization cycle takes approximately 30 minutes. The system provides a standardized cycle and documentation that is controlled by a microprocessor. The sterilization cycle will abort if parameters such as concentration or temperature are not met.

Monitoring of the sterilization cycle can be done by reviewing the printout of the cycle to note if all parameters have been met. Chemical indicators (indicates presence of the active ingredient - peracetic acid) and biological indicators (*GeoBacillus stearothermophilus* provide the greatest challenge to determine the efficacy of the sterilization cycle) are available for use.

The sterilized instruments are removed from the system at the end of the cycle and can be immediately transported to the procedural area for use. Liquid peracetic acid sterilization has become extremely popular today as it provides a rapid sterilization method for rigid endoscopes and other instruments.

The advantages of PAA sterilization include:

- > Standardized cycle
- > Short cycle times
- > Sterile instruments are ready for use immediately after sterilization is complete
- > Trays and containers to accommodate a variety of endoscopes
- > Connectors allowing sterilization of small lumens
- > Microprocessor-controlled, diagnostic cycle
- > Special ventilation is not required for this type of closed system
- > Non-toxic end-products (The end-products of the sterilization process, which are acetic acid, water and oxygen, are safely disposed of in the normal sanitary sewer system)

The limitations of PAA sterilization include:

- > Variable cycle time (depending on incoming temperature, pressure and condition of water)
- > Items must be immersible
- > No shelf life with processed devices

Gaseous Hydrogen Peroxide

In 1993, a technology was introduced that used gaseous hydrogen peroxide for sterilization. Sterilization takes place at a low temperature (40-56° C or 104-133° F), making it a suitable sterilization method for heat sensitive devices. The process takes approximately 28-75 minutes, which is significantly less than the time required for ethylene oxide sterilization.

Hydrogen peroxide is a widely used biocide for disinfection, sterilization, and antisepsis. It demonstrates broad spectrum efficacy against viruses, bacteria, yeasts, and bacterial spores. Hydrogen peroxide is an oxidizing agent. Its mode of action is based on its ability to oxidize target molecules that make up microbial life, which includes proteins, lipids, and nucleic acids.

Gaseous hydrogen peroxide can be used to sterilize instruments with diffusion-restricted spaces (e.g. hinged portion of forceps and scissors), medical devices with a single channel stainless steel lumen, and single channel flexible endoscopes with a polyethylene or Teflon (polytetrafluoroethylene) lumen. The Indications For Use (IFU) vary by model so it is important to check with the manufacturer to ensure which model should be used to sterilize a particular device.

After the devices are cleaned, dried, and packaged, they are placed in the sterilizer chamber. A deep vacuum is created in the chamber and a hydrogen peroxide vapor is injected into the chamber. The hydrogen peroxide vapor penetrates the items to be sterilized and is held for a period of time after which the chamber pressure is increased. This process is repeated up to three times. After completion of the last hydrogen peroxide vapor hold period, the load is aerated in the sterilizer. The only by-products are water vapor and oxygen; there are no toxic residues or harmful emission and no special venting is required. The sterile items can be immediately used or stored for future use.

Some gaseous hydrogen peroxide sterilizers (often referred to as gas plasma sterilizers) generate plasma during the cycle. It is unclear what role the plasma plays in sterilization (Krebs et al, 1998); the manufacturer indicates it plays a role in the overall process to ensure patient safety (i.e. to remove residuals).

Monitoring of gaseous hydrogen peroxide sterilizers can be done by reviewing the printout of the cycle to note if all parameters have been met. Chemical indicators and biological indicators (*Geobacillus stearothermophilus*) are also available for use.

The advantages:

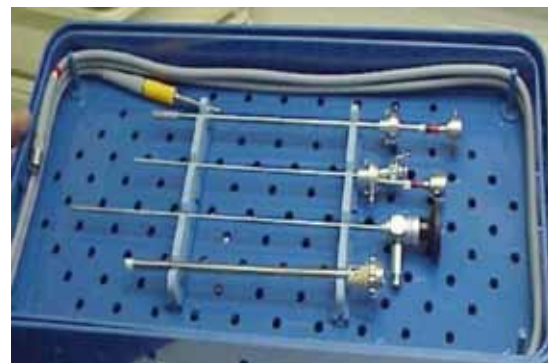
- > Short cycle time compared to EO
- > No aeration time
- > Simple installation
- > Non-toxic, environmentally-friendly
- > Special ventilation and environmental monitoring not required
- > Self-contained sterilant cartridge

The limitations:

- > Cycle has tendency to abort if excess moisture is detected
- > Cannot process cellulose or paper products
- > Limitations on length and inner diameter of lumens than can be processed
- > Flexible scope processing is limited to two scopes per load with nothing else in the chamber

Storage of Endoscopes

The proper storage of rigid endoscopes is extremely important to prevent endoscope damage or pathogen growth. If rigid endoscopes are stored in foam packing and the scopes are minutely wet, bacteria or other pathogens can begin to grow and colonize in the endoscopes and foam packing. Rigid endoscopes should not be stored on cloth towels as the detergent residue from the cloth towel washings can cause staining or discoloration of the endoscope. Rigid endoscopes should be stored in a place that secures the endoscopes so they cannot roll off of the storage area. Rigid endoscopes must not be stored in any area where other instruments can be placed on top of them.



Preventive Maintenance

Preventive maintenance is extremely important for routine assessment of rigid endoscopes. Some endoscope repair companies will provide free preventive maintenance to their customers. Preventive maintenance usually involves checking the cosmetic appearance of the endoscope, the lens system, the lumen and the light cable. By routinely assessing the endoscope, minor damage or defects of the scope can be repaired before a major service is needed.

Any preventive maintenance and service should be documented so that the life expectancy of the endoscope can be predicted by

following the endoscope's repair history. These trends will also be very beneficial when budgeting for capital expenditures to increase the number of or replace defective endoscopes.

Troubleshooting

Everyone who uses or reprocesses a rigid endoscope should understand troubleshooting. Many times troubleshooting can quickly identify a malfunction, prevent major repairs and promote optimal functioning of the endoscope. This in turn often decreases the procedure time, thus benefitting the patient. When troubleshooting a rigid endoscope, the various components can be assessed in a logical and organized manner to determine the problem.

The owner's manual provides a great source for troubleshooting tips, reprocessing details, operating recommendations and care and handling suggestions. For example, if the image appears cloudy, the distal end may need to be carefully cleaned to remove any smudges or debris. A cloudy image can be very frustrating to the surgeon and very dangerous for the patient if an accident happens because of poor visualization. A cloudy image can also be caused by anti-fogging agents left on the eye piece before sterilization. Other handling tips by the manufacturer may include:

- > Hold the endoscope by the eye piece and distal end to avoid bending the shaft
- > Routinely inspect the endoscope to make sure it has not been damaged during use or processing
- > Clean the lens surfaces to keep them free from debris
- > Regularly inspect the lenses for chips, cracks and scratches

Returning an Endoscope for Repair

A malfunctioning endoscope can be sent to the original manufacturer or a reputable repair company for service. The criteria for selecting an appropriate repair company include the following:

- > Component inventory on hand
 - What type, quality and amount of components does the repair company have in its inventory?
 - Are these different components readily available do you have to wait while these components are ordered?
- > Technical skill
 - What is the skill level of the technicians who will be doing the repairs? (Are they "master" technicians?)
- > Types of repairs offered
 - What type of repairs are done - major and minor?
 - If both minor and major repairs are done, are the minor repairs done by the company and the major repairs outsourced to yet another company?
 - Are the types of glues and bonding materials used for repairs able to withstand the various methods of reprocessing?
- > Representatives in the field
 - Are the field representatives educated on endoscope repair?
 - Are they attentive to specific endoscope repair needs?

- Do they help ship the endoscopes out that need repair?
- > Turn around time
 - How long does the repair company take to repair and return an endoscope?
- > Tracking of repairs
 - Does the repair company help track repairs on every endoscope? This information will help note any repair trends for the endoscopes.
- > Warranty return rate
 - What percentage of endoscopes do you have to send back to the repair company with the same problems while the warranty is still in effect? The warranty return rate should be less than 5%.
- > Value-added services
 - Does the repair company offer educational sessions on the proper care and handling of endoscopes to minimize repairs?
- > Pricing
 - Is the pricing competitive with the other companies who do similar quality work?
- > Full service
 - Does the repair company perform repairs on rigid endoscopes only or on both flexible and rigid endoscopes?
 - What brands and models of endoscopes can the company repair?
- > Reputation
 - What is the reputation of the repair company?

If a rigid endoscope needs repair, it must be properly packaged for shipping to the repair company. The best packaging system includes the foam padding and box that the endoscope was shipped in when it was first purchased. This packing has been designed to firmly hold that endoscope model in place.

Before placing the endoscope in the shipping package, it must be decontaminated and dried thoroughly. The original shipping box with padding provides a durable container system for transporting the endoscope to the repair facility. A mailing label is placed on the outside of the outer container with the appropriate repair company address and the return address information.

If the endoscope cannot be cleaned before shipping, it must be sent as biohazardous material, by being placed within two containers (with one container being leak and puncture resistant). The outer package needs to be labeled "biohazardous" so that the receiver knows that special handling is necessary when unpacking the contaminated device. The company shipping the package needs to be informed that the package contains biohazardous material and then asked if there are any further instructions required for shipping. The U.S. Postal Service and Federal Express are two carriers who will handle biohazardous packages, but their specific instructions must be followed. The cost to ship biohazardous material is greater than the cost of normal shipping.

The specific steps for handling biohazardous materials are not recommendations, but are laws within the Department of Transportation (DOT) and Postal regulations. If contaminated materials are not handled according to these laws, a hefty fine and even imprisonment can be levied. Other agencies that deal with the handling of biohazardous materials are OSHA, CDC, AAMI and the

FDA. Some of their recommendations are mandated, while others are suggestions in handling biohazardous materials.

Documentation needs to accompany the endoscope needing repair. Complete documentation is extremely valuable to the repair company. This should include:

- > Date of cleaning or reprocessing
- > Reprocessing of the scope (Was the scope cleaned, disinfected, or sterilized? Sometimes endoscopes are actually sterilized before sending for repair.)
- > Name of the person who reprocessed the endoscope? (Who actually cleaned the endoscope?)
- > Procedure being performed when the endoscope malfunctioned and any suspected damage to endoscope (For example, during a cystoscopy, an electrosurgery probe was used to coagulate a biopsy site that could have damaged the distal end lens causing the image to be cloudy.)

The healthcare worker sends the securely packed endoscope with completed documentation to the shipping department, or sends the endoscope directly to the repair company. Some repair companies will contact the department that owns the endoscope to discuss any needed services and to obtain the repair purchase order. After the repair is completed, a warranty usually will be extended depending on the type of repair. When the endoscope is returned from repair, the endoscope should be examined immediately to make sure no damage has occurred during shipping.

Summary

Even though rigid endoscopy requires the art and talents of skilled healthcare professionals, this technology can be relatively simple and easily mastered. If the various components of an endoscope are understood and the care and handling of the endoscopes and accessories are realized, then rigid endoscopy will become an opportunity instead of a challenge. The future of rigid endoscopy depends on the dedication of the endoscopy team members, including the physician, nurse, technologist, reprocessing technician and other healthcare professionals, to provide optimal care and handling of endoscopes to promote safety, minimize hazards and maintain the health of the endoscope. Given the continual and substantial advancements predicted for rigid endoscopy in the future, the passion and enthusiasm for this technology will only intensify.

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Review Questions

- The components of a rigid endoscope include:
 - Control body, shaft, light guide connector, distal end
 - Eye piece, body, light guide connector, shaft, distal end
 - Eye piece, shaft, distal end
 - Lenses, spacers, eye piece, connector
- To prevent fires, the light source should never be turned on unless the cable is securely attached to the endoscope.
 - True
 - False
- Since light cords contain bundles of tiny glass fibers and are quite delicate, they should be cleaned in ultrasonic cleaners.
 - True
 - False
- The light cable should be discarded and replaced if more than _____ of the fibers are broken.
 - 1/3
 - 3/4
 - 2
 - 85%
- _____ is the preferred light source for videoendoscopy because it generates a more consistent light intensity.
 - Halogen
 - Xenon
 - Metal halide
 - Incandescent
- A(n) _____ lens provides for the desired lens angle (15°, 30°, 45°, 70°).
 - Objective
 - Prism
 - Negative
 - Rod
- A cystoscope that is used to biopsy a bladder tumor would be classified as a _____ device (according to Spaulding's classifications).
 - critical
 - semi-critical
 - non-critical
 - sterilized
- According to the FDA recommendations for high level disinfection, a device should be soaked in glutaraldehyde for _____ minutes at _____ degrees Centigrade.
 - 20 minutes, room temperature
 - 25 minutes, 25°
 - 45 minutes, 25°
 - 45 minutes, room temperature
- OSHA does not mandate glutaraldehyde exposure monitoring but they can penalize facilities if the breathing areas exceed the exposure level for glutaraldehyde which is 0.2ppm.
 - True
 - False
- What information pertains to the liquid chemical peracetic acid sterilization of rigid endoscopes?
 - 35% peracetic acid is diluted to form a 0.2% use dilution
 - Four sterile rinse cycles
 - Exposure to the sterilant is 12 minutes
 - All of the above

- B (Anatomy of a Rigid Endoscope)
- A (Light Guide Connector)
- B (Cleaning)
- A (Light Guide Connector)
- B (Light Guide Connector)
- B (Distal End)
- A (Spaulding's Classifications)
- C (Disinfection)
- A (Disinfection)
- D (Low Temperature Liquid Chemical Sterilization)

Answers to Review Questions & Section Sources:

Evaluation Form

Study Guide #5: The Care and Handling of Rigid Endoscopes

Last Name

First Name/M.I.

RN/LPN/LVN License Number (Circle one: RN - LPN - LVN)

Non-RN: License or Social Security Number

Health Care Facility

Health Care Facility Street Address City State ZIP Code

Current Home Street Address City State ZIP Code

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Rate on a scale of: 1=low 5=high

To what extent did the study guide meet the 2 stated objectives below?

- | | | | | | |
|--|---|----------------------------|----------------------------|----------------------------|----------------------------|
| 1. Review the major components of rigid endoscopes. | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 |
| 2. Discuss the proper care of rigid scopes when reprocessing. | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 |
| 3. To what extent is this learning method easy-to-use? | <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input type="checkbox"/> 5 |
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I have completed all the requirements for this entire activity (please sign and date).

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