LAPAROSCOPIC INSTRUMENTATION

LEARNING OBJECTIVES
1. Review the evolution of laparoscopic instruments
2. Discuss benefits, disadvantages and risks of minimally invasive surgical procedures
3. Describe types of procedures performed with laparoscopic instruments
4. Explain primary categories and components of laparoscopic instruments

LAPAROSCOPIC INSTRUMENTATION IS USED FOR A VARIETY OF minimally invasive surgical procedures. Typically laparoscopes are comprised of a handle with a long barrel and a working distal tip. Increasingly, these instruments have been adapted for use with robotic systems that enable precise surgical performance. When laparoscopic instrumentation is used, an endoscope is connected to a camera system that permits visualization of the surgical site after the device is inserted into the body.

OBJECTIVE 1: REVIEW THE EVOLUTION OF LAPAROSCOPIC INSTRUMENTS
Laparoscopic instrumentation has evolved over time. Original laparoscopic instrumentation could not be disassembled and was very difficult to clean. The next generation of instrumentation added irrigation ports to help make it easier to clean instrument lumens. The addition of ports improved the cleaning process, but the instruments were still very time consuming and difficult to clean, especially when manual cleaning methods were used.

Third generation laparoscopic instrumentation has evolved further, and they can be partially or fully disassembled for more efficient cleaning of lumens and small crevices. However, care is still needed to ensure that these parts are reassembled correctly and that the instrument functions properly after cleaning.

OBJECTIVE 2: DISCUSS BENEFITS, DISADVANTAGES AND RISKS OF MINIMALLY INVASIVE SURGICAL PROCEDURES
One or more small incisions made in the abdominal area allow laparoscopic instrumentation and endoscopes to be inserted into the abdominal cavity. An insufflator blows carbon dioxide (CO2) into the abdominal cavity at a pressure of 12-15 mm Hg.
Hg to extend it and allow the surgeon to view the patient’s internal organs.

**ADVANTAGES**

Laparoscopic surgical techniques create several advantages for patients. The small incisions result in less bleeding and reduce the number of blood transfusions traditionally needed for regular open abdominal procedures. Faster healing due to smaller incisions also results in shorter hospital stays; discharge can occur the day of surgery for many procedures. Shorter healing times promote overall quicker recovery times and a faster return to normal activities.

External and internal scarring is reduced, and this benefits patients who are prone to developing adhesions and improves physical appearance. Typically, smaller incisions also result in less pain and reduced need for pain medication. Because internal organs are not exposed to possible contaminants in outside air, there is less chance of internal surgical infections. Smaller wounds are also likely to result in fewer complications and infections.

Today, some laparoscopic procedures are performed with the assistance of robots utilizing computer-assisted techniques in open as well as minimally invasive surgical procedures. The surgeon sits at a console during robotic-assisted minimally invasive surgery. He or she performs the surgery with telemanipulator or computer controls that direct the robotic arms “holding” surgical instruments.

Robotic techniques allow the surgeon to be outside of the surgical suite, possibly many miles away. This is of special interest to military organizations because complex surgical procedures could be performed without exposing the surgeon to the dangers of the battlefield environment. In addition to the advantages cited for minimally invasive procedures above, robotic-assisted procedures allow for precision instrument manipulation that cannot be replicated by the human hand. For example, robotic surgery systems are programmed to compensate for hand tremors. If the surgeon’s hand trembles, the computer ignores it and keeps the mechanical arm steady. This, in turn, results in more precise surgery and fewer complications resulting from fatigue.

**DISADVANTAGES AND RISKS**

Although laparoscopic surgery has many advantages, there are also some disadvantages and risks. Some are common to all types of surgery including reaction to or problems from anesthesia, excessive bleeding, infections, and delayed healing caused by swelling, bruising, or co-morbidities. Note: Comorbidities occur when there is one or more coexisting medical condition or disease process in addition to the initial diagnosis. For example, a patient with diabetes may need to have his gallbladder removed because of gallstones. Maintaining a normal blood sugar level will be important to ensure proper healing from the gallbladder surgery.

Other complications that may occur are specific to laparoscopic surgery. For example, in traditional laparoscopic surgery, the surgeon has limited range of motion so it is difficult to maneuver the instruments, tissue, and organs. It is a challenge for the surgeon to perceive depth properly, and the surgical tool’s endpoints move in the opposite direction of the surgeon’s hands. Therefore, moving the instruments is not intuitive and takes more time to learn. Also, the surgeon has reduced or no tactile sensation, and this may cause him or her to use more force than needed which can cause tissue damage. It is also difficult for the surgeon to check tissue for tumors or other abnormalities and to tie off sutures.

There is a significant learning curve for surgeons to become proficient with traditional laparoscopic surgical procedures, and robotic-assisted minimally invasive surgery is intended to address some of these issues. For example, a three-dimensional view is provided to the surgeon which greatly improves depth perception. As a result, instrument manipulation is more closely related to the surgeon’s actual hand movements.

Many laparoscopic instruments have a cautery post to deliver electrosurgical energy to the instrument’s distal end. The instrument shaft is insulated to ensure that energy does not escape and cause unintended harm to non-affected tissue. Nicks and cuts to the insulation may enable the energy to escape and cause burns to tissue and organs in the abdominal cavity. This damage can go unnoticed because the surgeon is concentrating on the instruments’ operative tips, or the damage may occur outside his or her range of vision. In rare cases, the stomach or intestines may be perforated which can lead to peritonitis.

Infection inside the peritoneal cavity requires a follow-up open surgical procedure to repair the damage that caused the peritonitis. There is, therefore, a cascade effect of complications that increase pain, emotional distress for the patient and family, extended healing times, and negative financial consequences. If the patient survives the infection, several surgeries may be required to correct the damage that occurred.

It is recommended that the insulation on these instruments be checked after every use with a special device that detects current leakage. This is usually done by Central Service (CS) personnel as part of the inspection process after instrument cleaning and decontamination, and before assembly.

Trocar injuries can also occur to blood vessels or organs. Initially, the trocar is inserted blindly and, because of poor tactile sensation, it is possible that blood vessels may be nicked or organs may be perforated. These injuries can be significant if not
immediately recognized because hemorrhaging or peritonitis can occur.

Minimally invasive surgery can result in an increased risk of hypothermia due to exposure to cold, dry gases. The risk can be minimized by using heated and humidified CO2. At the end of the surgical procedure, there may be pockets of CO2 remaining in the abdomen which can cause pain when the gas rises and exerts pressure on the phrenic nerve. Pain may also be caused when breathing. As the CO2 is absorbed by the body’s tissues it will eventually be eliminated through respiration. Sometimes, a patient’s body may not tolerate insufflation, and this may create unstable blood pressure or respiratory difficulty. Should either problem occur, the surgery will need to be converted immediately to an open procedure.

**OBJECTIVE 3: DESCRIBE TYPES OF PROCEDURES PERFORMED WITH LAPAROSCOPIC INSTRUMENTS**

Laparoscopic surgical techniques are used for numerous gynecological, urological, thoracic, and general surgery procedures. The most common laparoscopic procedure is a cholecystectomy in which two to four 5-10 mm diameter sleeves (access ports) are inserted into the abdomen using trocars. The gall bladder (chole cyst) is detached from the underside of the liver using laparoscopic instruments that range from 23 cm to 36 cm in overall length. The organ is then excised and pulled out through the navel incision. (The trocar sleeve is removed prior to removing the gallbladder from the abdomen.)

Colectomies (removal of all or part of the colon) can sometimes be performed with laparoscopic techniques to treat Crohn’s disease, ulcerative colitis, diverticulitis, and cancer, among other diseases. Treatment of rectal prolapse (a condition in which the rectum is stretched and protrudes from the anus) is also possible with laparoscopic techniques. Laparoscopic appendectomies involve inserting a laparoscope and instruments in the abdomen to allow the appendix, a finger-shaped portion of the large intestine, to be cut and removed through a port incision.

Laparoscopic gastric banding or bypass surgeries are used to staple (close) and/or remove a portion of the stomach. Then the small intestine is rerouted to bypass a portion of the intestines where nutrient absorption takes place. This procedure restricts the amount of food ingested at one time and makes the patient feel full after consuming less food. The absorption of nutrients (calories) is then lessened, and this maximizes the potential for weight loss.

Laparoscopic fundoplication can be performed to treat gastroesophageal reflux disease (GERD). This procedure involves wrapping the upper portion of the stomach around the esophagus to strengthen the esophageal sphincter and prevent the stomach from bulging upward into the chest cavity. Laparoscopic hernia repair uses prosthetic mesh to reinforce the abdominal wall or repair the defect where the hernia occurred. An abdominal hernia allows the omentum (the layer of peritoneum surrounding abdominal organs) or intestines to bulge through the abdominal wall.

A variety of gynecological procedures can be performed with laparoscopic techniques. For example, diagnostic laparoscopy is used to view the abdominal cavity and all reproductive organs. These instruments can be used to remove abnormal organs or tissue or to cauterize affected areas.

Microlaparoscopic pain mapping can be used to determine the causes of abdominal pain. What may cause pain in one person may cause only mild discomfort in another person. Therefore, pain mapping allows the surgeon to ensure that he or she is addressing the actual cause of the problem (for example, pain on the right side of a woman may be caused by an ovary or the appendix).

Endometriosis, ovarian cysts, uterine fibroids, fallopian tubes, and ovaries can be removed laparoscopically. Adhesions (scar tissue) from previous, usually open, surgical procedures can also be removed. Laparoscopic uterine suspension can be performed for a retroverted (“tipped”) uterus. Polyps or small fibroids (tumors) inside the uterus can be treated by inserting a hysteroscope through the uterus and then either removing or vaporizing these growths. Hysterectomies (removal of the uterus and, sometimes, the ovaries) can be performed laparoscopically. The uterus and all tissue to be removed is disconnected from all supporting tissues and removed through the vagina. Smaller tissue specimens can be removed through a port incision.

Many procedures described above are now available as robotic-assisted laparoscopic surgeries. As noted above, robots allow surgeons to be more precise and better control the instrumentation compared with the use of traditional laparoscopic instruments and techniques.

**OBJECTIVE 4: EXPLAIN PRIMARY CATEGORIES AND COMPONENTS OF LAPAROSCOPIC INSTRUMENTS**

Broadly speaking, laparoscopic instruments can be divided into two major categories: equipment and instruments for access and exposure, and instruments used to perform the actual surgical procedures. Many instruments used to perform procedures are very similar to general hand-held surgical instruments and are classified in a similar way.

Equipment for access and exposure include the laparoscope, camera, light source, television or video monitor, insufflator, CO2 cylinder, suction irrigation machine, and ancillary equipment.
A laparoscope (telescope or endoscope) is used to view the surgical site. It is usually 5 mm or 10 mm in diameter, with a 25 cm long rod. Fiberoptic cables in the shaft conduct light to the surgical site. The proximal end contains an eyepiece which can be used for direct viewing or can be connected to a camera. The camera transmits a video image via cable to a video processing unit, and the signal is converted into an image that can be seen on a monitor that allows the surgeon to view the operative site.

A halogen or xenon light source is connected to the laparoscope with a cable. A fiberoptic cable made of glass rods transmits light to the laparoscope enabling the surgeon to see. Note: Fiberoptic cables can be easily broken, and care is needed to ensure they do not become tightly coiled or bent. If too many fiberoptic rods are broken, there will be insufficient light for viewing the surgical site.

The insufflator delivers CO2 from the cylinder to the abdominal cavity at a slow and controlled speed until the right pressure is reached. Then the abdomen will inflate, and the surgeon can see the internal organs without interference from the abdominal wall. The suction irrigation machine can be attached to an instrument with a suction tip to allow suctioning or irrigation as needed. A cautery machine and cable can be connected to an instrument enabling an electrical current to be used to cut soft tissue and stop bleeding from small vessels.

A variety of cables and tubes connect the different machines and device/instruments. The cables, cords, instruments, and equipment actually present on the sterile field must be decontaminated and sterilized between uses. Equipment that is not part of the sterile field remains in the surgical suite and is decontaminated as part of the room cleaning process.

Instruments used to perform laparoscopic surgery can be disposable or reusable, and the usage decision is made by each healthcare facility. Disposable instruments tend to be expensive but eliminate the need for cleaning and sterilization. Proper cleaning, maintenance, and sterilization are needed to ensure reusable instruments are safe to use. Proper cleaning requires an investment in time and resources needed to adequately maintain these instruments. Operating costs for cleaning and sterilization of laparoscopic instruments can be significant. Many facilities use a combination of reusable and disposable instrumentation.

The operating end of laparoscopic instruments may have several different configurations to perform different functions during the procedure. The six categories of general hand-held instruments are also found in their laparoscopic counterparts: scissors, needle holders, retractors, forceps (dissectors in laparoscopy), clamps (graspers in laparoscopy), and “other” instruments, which include probes, suction cannulas, and cautery devices.

IN CONCLUSION
The use of modern laparoscopic instrumentation has broadened the surgeons’ abilities to better serve their patients. However, these modern marvels can and do present significant cleaning challenges that must be consistently and effectively addressed by Central Service personnel. These challenges will likely continue in the future as the next generations of instruments become still more complex as a necessity to enable increasingly sophisticated procedures.

IAHCSMM acknowledges the assistance of the following two CS professionals who reviewed this quiz:

LISA HUBER, BA, CRCST, ACE, FCS; Sterile Processing Manager, Anderson Hospital, Maryville, IL
PAULA VANDIVER, CRCST, CIS; Orthopedic Specialist, Anderson Hospital, Maryville, IL

COMMUNIQUÉ