The Role of the Perioperative Registered Nurse in Minimally Invasive Surgery
AORN INDEPENDENT STUDY ACTIVITY
STUDY GUIDE WITH VIDEO

Disclaimer
AORN and its logo are registered trademarks of AORN, Inc. AORN does not endorse any commercial company’s products or services. Although all commercial products seen in this online course is expected to conform to professional medical/nursing standards, inclusion in this online course does not constitute a guarantee or endorsement by AORN of the quality or value of such product or of the claims made by its manufacturer.

No responsibility is assumed by AORN, Inc. for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any standards, recommended practices, methods, products, instructions, or ideas contain in the material herein. Because of rapid advances in the health care sciences unparticular, independent verification of diagnoses, medication dosages, and individualized care and treatment should be made. The material contained herein is not intended to be a substitute for the exercise of professional medical or nursing judgment.

The content in this publication is provided on an “as is” basis.

TO THE FULLEST EXTENT PERMITTED BY LAW, AORN, INC. DISCLAIMS ALL WARRANTIES, EITHER EXPRESS OR IMPLIED, STATUTORY OR OTHERWISE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, NON-INFRINGEMENT OR THIRD PARTIES RIGHTS, AND FITNESS FOR A PARTICULAR PURPOSE.

This publication may be photocopied for noncommercial purposes of scientific use or educational advancement. The following credit line must appear on the front page of the photocopied document:

Reprinted with permission from The Association of perioperative Registered Nurses, Inc.

Copyright © 2010
All rights reserved by AORN, Inc.
2170 South Parker Road, Suite 300
Denver, CO 80231-5711
(800) 755-2676 • www.aorn.org

Video produced by Cine-Med, Inc.
127 Main Street North, Woodbury, CT 06798
Tel (203) 263-0006 • Fax (203) 263-4839 • www.cine-med.com

To order other videos, call Cine-Med at 1-800-633-0004.
# TABLE OF CONTENTS

Overview & Objectives ........................................................................................................................................................ 1
Historical Perspectives: Laparoscopic Surgery ........................................................................................................................ 1
Historical Perspectives: Robotic Surgery ................................................................................................................................ 2
Other Related Advances ........................................................................................................................................................ 3
Definitions .............................................................................................................................................................................. 3
Preoperative Considerations .................................................................................................................................................. 4
Anesthesia ............................................................................................................................................................................... 5
Preparation of the OR Procedure Room and Instrumentation ................................................................................................ 6
Intraoperative Monitoring and Troubleshooting .................................................................................................................... 10
Documentation ...................................................................................................................................................................... 13
Postoperative Considerations & Communication ................................................................................................................. 13
Summary ............................................................................................................................................................................... 14
References ..............................................................................................................................................................................14
Post-test ................................................................................................................................................................................. 16
Answer Sheet........................................................................................................................................................................... 17
OVERVIEW AND OBJECTIVES

In the past, laparoscopy was reserved for minor procedures performed by gynecologic and urologic surgeons but has now developed into a specialty in its own right known as minimally invasive surgery (MIS). Use of MIS has now become main stream and is a part of almost every perioperative registered nurse’s daily activities. Some benefits of MIS include:

- reduced postoperative pain,
- reduced use of opioids and associated side-effects,
- earlier return to normal activity, and
- improved cosmesis.

Although these present significant benefits for the patient, MIS procedures also present unique challenges to the surgeon and perioperative team in ergonomics, visual challenges, and room environment. The perioperative registered nurse faces the challenge of developing and maintaining the knowledge and skills to competently perform in this rapidly advancing technological environment.

After reviewing the video, reading the study guide, and completing the post-test, the participant will be able to:

- Minimize risks to the perioperative team and patients during minimally invasive surgery (MIS).
- Describe fundamental principles of laparoscopic surgery.
- List troubleshooting skills and strategies to address common MIS equipment issues.

HISTORICAL PERSPECTIVES: LAPAROSCOPIC SURGERY

Physicians throughout history have looked for less invasive ways to diagnose and treat disease. As early as 460—375 B.C. Hippocrates described examination of the rectum using a speculum. The Greeks and Arabs improved on Hippocrates use of speculums by using reflective light to examine the cervix. However, early instrumentation did not provide enough light to thoroughly examine the organs. The issue of light was addressed in the early 18th century. Philip Bozzini developed a light conductor to improve illumination of the internal organs by redirecting light from candles to the observer’s eyes and then into the internal organs. Edison’s discovery of the incandescent light in 1897 further opened the way for the development of modern endoscopes by providing a steady brighter illumination.

German surgeon, George Kelling MD, experimented using a cystoscope to examine the abdominal cavity of a dog while insufflating its abdomen with air in 1901. He coined the term celioscopy for the procedure and became an advocate for minimally invasive investigation as a potential way to decrease hospital stays in patients without invasive procedures. Jacobeus performed the first human laparoscopy in Sweden in 1910 as a way to investigate ascites. In 1911, Bertram M. Bernheim, a surgeon at Johns Hopkins Hospital, Baltimore, Maryland, used a proctoscope to perform laparoscopy coining the term organoscopy.

Although there was some interest in laparoscopy, these procedures were diagnostic in nature and the majority of surgeons remained skeptical. In 1929, Heinz Kalk developed a more advanced lens system for the endoscope and used a second puncture site to create a pneumoperitoneum while describing several diagnostic and therapeutic laparoscopic procedures.

In 1934, John C. Ruddock identified laparoscopy as a superior diagnostic modality and modified a grasper delivering bipolar current to coagulate bleeding vessels. In 1937, Ruddock published in the prestigious and widely read "Blue Journal" for surgeons his series of over 500 cases describing his results and supporting his findings.

In 1938, Janos Veress developed the spring-loaded needle that is currently used for the insertion of CO₂ into the peritoneum. It was originally designed as a mechanism for draining fluid from the abdomen and air from the chest. In its modified state, it is used to deliver the CO₂ necessary to establish a pneumoperitoneum.
The 1950s saw the evolution of fiberoptic technology and closed-circuit video. These technologies allowed the delivery of more light with less heat. Gynecologists became the primary users of this technology.

Kurt Semm became a strong advocate for this technology. His inventions of the aspiration/irrigation system, electocoagulator, multiple laparoscopic instruments, and the automatic insufflator capable of monitoring intra-abdominal pressure contributed to making laparoscopy safer and easier to perform. He is also credited with describing the techniques for tubal ligation using electrocoagulation and oophrectomy and lysis of adhesions as well as performing the first laparoscopic appendectomy in 1983.

In 1982, the first solid-state video camera was introduced, followed in 1984 by the introduction of the charged-coupled device (CCD) image sensors ushering in the era of modern video laparoscopy. These advances, although they would be considered unacceptable by today’s standards, allowed the assistant surgeon a view of the operative field and led to more complicated procedures being attempted.

Although gynecologists embraced laparoscopy, the majority of general surgeons remained unconvinced and skeptical. French gynecologist, Phillipe Mouret MD, has often been credited with performing the first laparoscopic cholecystectomy in 1987. However, Professor Erich Mühe of Böblingen, Germany, performed the first laparoscopic cholecystectomy on September 12, 1985. Although he published his technique, the concept was ignored. In 1988, Barry McKernan and William Saye performed the first laparoscopic cholecystectomies in the United States followed within days by Eddie Joe Reddick, and the United Kingdom quickly followed in 1989.

As the press became aware and publicized these procedures, the lay public soon began asking for the new “Band-Aid®” procedures instead of the traditional open procedure. The introduction of laparoscopic cholecystectomy changed the way general surgery procedures would be performed. Today, with increasingly sophisticated equipment and instrumentation, there are very few surgical procedures that cannot be performed using minimally invasive techniques.

**HISTORICAL PERSPECTIVES: ROBOTIC SURGERY**

The decade of the 1990s brought advances in robotic surgery. By 1994, the first US Food and Drug Administration (FDA) approved surgical robotic device was available as a robotic arm capable of holding the camera and telescope.

The first robotic tele-surgical procedure was performed in Belgium in 1997. This surgical system consisted of three parts.

- The surgeon sat at the surgical console and manipulated the robotic arms in a virtual reality environment.
- The console was connected to the patient side cart with interactive arms that mimicked the precise movements of the surgeon hands in the console. The laparoscopic instruments were attached to the cart and the instruments were introduced into the patient via trocars.
- The instruments were controlled by a vision system that gave the surgeon the benefit of true three-dimensional images. The computer system that interfaced with the console and cart provided real time movement of the instruments, scaled motion, reduced and filtered tremor while providing the operator with six degrees of freedom in the instrumentation.

The first robotic surgical (i.e., tele-operation) procedure performed on a patient, was a robotic-assisted laparoscopic cholecystectomy in Brussels, Belgium in 1997 by Jacques Himpens, MD and Guy Cardiere MD.
OTHER RELATED ADVANCES

In 2001, Professor Jacques Marescaux and Michele Gagner performed the first trans-Atlantic cholecystectomy from New York City on a patient in Strasbourg, France, using fiberoptic cables to transmit the signals. This was accomplished using the Zeus™ system.

In 2002, Gettman and colleagues described transvaginal removal of a kidney in a porcine model. In 2004, Kalloo et al. described using the gastric approach in Natural Orifice Translumenal Surgery (NOTES™) to gain access to the internal organs via natural orifices in the body. In April 2007, Marescaux et al., reported the first pure NOTES™ cholecystectomy without the use of any additional ports, using only a Veress needle to insufflate the abdomen. Today, additional procedures including appendectomy, gastrojejunostomy, liver biopsy, oophrectomy, splenectomy and tubal ligation have been completed using either the transgastric or transvaginal approach.

The NOTES™ technique represents a new and emerging technology blending endoscopy and minimally invasive laparoscopy. Its potential is being carefully monitored and studied by representatives from both the American Society for Gastrointestinal Endoscopy (ASGE) and the Society for American Gastrointestinal Endoscopic Surgeons (SAGES) under the umbrella of the Natural Orifice Surgery Consortium for Assessment and Research (NOSCAR®).

Single incision laparoscopic surgery (SILS™) is also known by a variety of acronyms (i.e., single-port access [SPA], one-port umbilical surgery [OPUS]). On May 16, 2007, Paul Curcillo MD, performed a laparoscopic cholecystectomy through a single umbilical incision. This is not a new technique; gynecologists have been using one port to perform diagnostic procedures and tubal ligations, but it is now being used to do advanced laparoscopic procedures. Like laparoscopy, SILS™ offers all the benefits with a better cosmetic result. However, although standard laparoscopic instrumentation can be used, modified instruments and trocars are being developed to allow greater freedom of movement and reduce the potential clash of instruments that occurs when the instruments are triangulated through a single port.

DEFINITIONS

Although the video and study guide focus on abdominal laparoscopy, there are a variety of terms and acronyms associated with MIS procedures of which perioperative registered nurses should be familiar. Terminology may vary between health care organizations.

**AEM:** active electrode monitoring. A dynamic process of searching for insulation failures and capacitive coupling during monopolar surgery. If the monitor detects an unsafe level of stray energy, it signals the generator to deactivate.

**Arthroscopy:** Endoscopic examination, diagnosis, and/or repair of tissues inside a joint with an arthroscope.

**Capacitive coupling:** Transfer of electrical current from the active electrode through intact insulation to adjacent conductive items (e.g., tissue, trocars).

**Colonoscopy:** Endoscopic examination, diagnosis, and/or repair of tissues inside the large bowel and the distal part of the small bowel.

**Computer-assisted technologies:** Robotic, interventional radiology, voice-recognition software, or other computer technologies used to enhance minimally invasive surgery.

**Direct coupling:** Contact of an energized active electrode tip with another metal instrument or object within the surgical field.

**Endoscopic surgery:** A surgical technique using endoscopic instrumentation inserted through a natural orifice or through one or more small incisions.

**Hybrid OR:** An operating room designed with numerous imaging technologies (e.g., three-dimensional angiography, computed tomography, MRI, positron-emission tomography, intravascular ultrasound) to support surgical procedures that require multiple care providers with varied expertise to provide patient care in one location.

**Hysteroscopy:** Endoscopic examination, diagnosis, and/or repair of tissues inside the uterine cavity and tubal orifices with a hysteroscope.

**Insufflation:** The act of blowing gas into a body cavity or the state of being distended with gas for the purpose of visual examination.
**Integrated OR:** An operating room equipped with technology that centralizes control of audio/video equipment and information systems and is capable of controlling a variety of equipment and activities within the surgical suite. Synonym: digital OR.

**LESS:** Laparo-endoscopic single-site surgery.

**Mill wheel murmur:** A churning cardiac murmur produced by air embolism to the heart; also heard in pneumohydropericardium.

**Minimal access surgery:** Surgical procedures performed through one or more small incisions using endoscopic instruments, radiographic and magnetic resonance imaging (MRI), computer-assisted devices, robotics, and other emerging technologies.

**NOTES™:** Natural orifice translumenal endoscopic surgery.

**OPUS:** One port umbilical surgery.

**Pneumoperitoneum:** The presence of air or gas within the peritoneal cavity of the abdomen often induced for diagnostic purposes.

**SPA:** Single-port access.

**SILS™:** Single-incision laparoscopic surgery.

**Trocar:** A sharp-pointed surgical instrument, used with a cannula to puncture a body cavity

**Veress needle:** A needle equipped with a spring-loaded obturator that is used for insufflation of the abdomen in laparoscopic surgery.

**White balancing:** A part of the color-balancing process that renders neutral color adjustment to achieve balanced intensities and avoid unrealistic color casts.

**PREOPERATIVE CONSIDERATIONS**

The introduction of laparoscopic cholecystectomy in 1988 changed the way general surgery would be performed. Initially, laparoscopic procedures were limited to uncomplicated cholecystectomy with restrictive patient-selection criteria (i.e., surgically naive, slim, female with children) to minimize the challenges encountered while developing MIS skills. As surgeons improved their techniques and skills and technology advanced, limitations on patient selection decreased. Contraindications for laparoscopic surgery may include patients who:

- are unable to tolerate pneumoperitoneum;
- require intervention for bowel obstruction or perforated viscus;
- have an uncorrectable coagulopathy or uncorrectable hypercapnia >50 Torr;
- are suspected of having an abdominal compartment syndrome;
- have an abdominal wall infection;
- have had extensive abdominal surgery within the last 30 days with multiple scars after a laparotomy.14

Creating a pneumoperitoneum and using extreme positions can cause problems with patients who have:

- increased intracranial pressure,
- ventriculoperitoneal or peritono-jugular shunts,
- hypovolemia,
- glaucoma,
- severe congestive heart failure,
- renal failure,
- respiratory disease (e.g., chronic obstructive pulmonary disease, emphysema, bullae),
- history of deep vein thrombosis (DVT) or coagulation problems,
- diaphragmatic hernia, and
- sickle cell disease (i.e., increased hypercarbia can precipitate a sickle cell crisis).15
A thorough preoperative assessment is critical. The perioperative registered nurse must identify unique patient considerations that may require additional precautions and contraindications related to MIS procedures and fluid management. This assessment includes identification of risk factors related to:

- extreme positioning (i.e., extreme Trendelenburg or reverse Trendelenburg) such as
  - age
  - cardiovascular compromise
  - respiratory compromise
  - pregnancy
  - increased intraocular or intracranial pressure;
- prevention of venous stasis such as
  - type and length of procedure
  - position required;
- patient history that indicates need for increased surveillance (i.e., personal or family history of thrombosis, coagulopathy, blood clots, blood-clotting disorders, DVT, or pulmonary embolism) or intraoperative MRI to include the presence of pacemakers, aneurysm clips, or implants; and
- fluid management such as
  - skin color and turgor
  - weight
  - allergies and sensitivities to medications
  - NPO status
  - conditions, diseases, or medications that predispose or exacerbate the seriousness of hyponatremia or hypervolemia.

The assessment must also include a review of preoperative laboratory tests such as electrolyte and coagulation studies. Any abnormalities should be reported to the surgeon and anesthesia provider.

Consideration should be given to patients who have had previous surgery, especially multiple abdominal surgeries, because these patients may have adhesions that could make laparoscopic surgery more difficult. Adhesions also increase the difficulty of the procedure and the risks. Other risks include the presence of an abnormality in the area of the umbilicus, umbilical hernia, or abdominal hernia repair with mesh, especially if it is in the area of the surgery to be performed.

**ANESTHESIA**

Typically, general anesthesia with intubation is recommended for laparoscopic procedures because of the need:

- for muscle relaxation necessary to allow abdominal insufflation of carbon dioxide (CO₂);
- to control and increase ventilation to compensate for hypercarbia and respiratory acidosis resulting from the absorption of CO₂;
- for exaggerated patient positioning such as the Trendelenburg position, that could be very uncomfortable for the patient and can cause respiratory difficulty in the aware patient because of increased intra-abdominal pressure;
- for decreased patient movement (muscular relaxation or paralysis; coughing, or bucking can increase intra-abdominal pressure and has the potential to cause difficulty for the surgeon; and
- for potential insertion of a nasogastric tube to prevent aspiration caused by increased intra-abdominal pressure; insertion can be difficult in an awake patient.

Although a regional anesthesia can be used under very controlled circumstances, it is not recommended.
PREPARATION OF THE OR PROCEDURE ROOM AND INSTRUMENTATION

To promote efficient and safe patient care during MIS procedures, it is of paramount importance that the perioperative registered nurse be familiar with the functions of the equipment and instruments used for this surgery and be competent in troubleshooting effectively. It is also important that instruments are processed and/or reprocessed according to manufacturer’s instructions and are stored properly. Ancillary supplies (e.g., warming devices, intermittent pneumatic compression devices, suction irrigators, smoke evacuators) should be available along with all necessary supplies. Cables, cords and tubing on the floor should be moved and secured so that they are not in the flow of traffic and do not present a hazard to staff members.

Because there is always a potential for the need to convert to an open procedure, the necessary instruments and supplies required to convert to an open procedure should be readily available. Conversion is often the result of unexpected bleeding. The health care facility should develop a plan or protocol to address this issue. Providing simulation exercises can help ensure staff member competency to respond effectively.

Instrumentation

It is important to remember that although MIS procedures use small incisions, the abdominal cavity is breached. According to the Spaulding classification system, any instrument or item that enters sterile body cavities is classified as “critical equipment” and must be sterilized. Laparoscopes, arthroscopes, and some GI endoscopic accessories, such as biopsy forceps, are categorized as critical equipment. This would also include endoscopes that are used transabdominally in conjunction with a laparoscopic procedure (e.g., a transgastric endoscopic retrograde cholangiopancreatography that is performed on a gastric bypass patient in which the scope is passed into the remnant of the stomach to access the ducts).

Insulated instruments should be routinely examined for insulation failure. Methods to accomplish this include use of:

- AEM: a system that continuously monitors endoscopic instruments to minimize the risk of insulation failure or capacitive-coupling injury
- active electrode indicator shafts: shafts with two layers of insulation each a different color, which allows visualization of a break
- active electrode insulation integrity testers: high direct current (DC) voltage to detect any full thickness insulation breaks.\(^{16}\)

Equipment

Prior to the patient’s arrival in the OR procedure room, a perioperative registered nurse should determine whether the proper equipment and supplies are available and are in good working order. Specific items that should be checked include:

- The OR procedure bed should be properly positioned and all ancillary attachments readily available. Bed weight capacity for lift and articulation should be verified.
- Specific positioning devices (i.e., restraints or other methods to secure the patient in extreme Trendelenburg or reverse Trendelenburg position) should be available to secure the patient who may be put into exaggerated positions to improve visibility for the surgical team.
- Video equipment should be checked to ensure that all devices are connected to power sources.
- Video equipment should be plugged into a dedicated outlet to minimize monitor interference and circuit overload.
- All alarms should be activated to ensure that they are audible.
- Video monitors should be checked using the test pattern to confirm proper operation.\(^{16}\)

Video monitors and documentation devices

Ergonomic considerations for MIS are addressed in AORN’s evidence-based “Recommended practices for Minimally Invasive Surgery.” Research suggests that optimal monitor positions include, but are not limited to, the following:

- Video monitors should be placed in a position that is clearly visible to the surgeon, assistants, and staff members.
- For the horizontal plane, position the monitor straight ahead of the surgical team member, aligned with the fore-arm instrument monitor axis, to prevent the person from having axial rotation of the spine.
- For the sagittal plane, position the monitor lower than eye level, approximately 15 degrees downward, to prevent neck extension.
- For viewing distance, the position of the monitor will depend on the size of the screen. If the monitor is too close, perioperative team members’ eyes may undergo extensive accommodation and conversion by the extraocular musculature. If the monitor is too far away, the person may be required to strain and may not be able to see detail.
To avoid glare, change the orientation of the monitor to help eliminate muscle strain. High quality monitors usually have a surface material that will minimize reflected light.

Many operating rooms have placed green filters on the ambient lighting used when MIS is being performed in order to minimize the reflection of light off the monitors. In addition, the green lighting provides adequate illumination for other perioperative team members to perform duties such as charting and reduces ocular fatigue for the whole perioperative team.

It is important to remember that laparoscopic procedures are image dependent, if there is a poor image or no image then you cannot see to perform the surgery.

The perioperative nurse should ensure that video documentation devices are available and an adequate supply of the appropriate recording medium is present (i.e., CD, DVD, paper and ink cartridges).

**Insufflators**

Insufflators use pressure regulators to establish and maintain the pneumoperitoneum. The regulator should always be positioned above the level of the surgical cavity. Cross contamination or damage to the insufflator can occur if there is insufflator deactivation, increased patient abdominal pressure or an empty CO₂ cylinder or piped in gas line which can result in a reverse flow of CO₂ allowing fluid or gas from the abdomen to enter the insufflator via the insufflation tubing. In addition, entry of blood or bodily fluids into the insufflator can result in subsequent patients being exposed from CO₂ passing through the contaminated flow valve.

The CO₂ cylinders may also be a potential source of contamination. Rust particles, dust, and metal filings can be released in the flow of CO₂. The use of a hydrophobic filter with a pore size of 0.2 to 0.3 micrometer is recommended to protect the patient from fluid backflow, extraneous particulate matter, and the backward transmission of microorganisms. It is important to check with the insufflator manufacturer to ensure that the filter being used is compatible with the insufflator. An improper filter can decrease the flow of CO₂ significantly.

The perioperative registered nurse should always check to verify that:

- both the flow and pressure settings are appropriate for this patient based on the patient’s body size and the procedure being performed prior to the start of the procedure and

- a second full backup cylinder and accessories are available, including the wrench or key required for a manual tank change; the back-up supply of CO₂ cylinders should be checked to ensure that it is adequate for the anticipated length of the procedure.

**Fluid distention media**

In some MIS procedures, fluids are used instead of carbon dioxide to provide the working space required. The perioperative registered nurse should ensure that fluids used for irrigation or distention media are selected appropriately for the procedure and the patient. Fluids used for irrigation and as distention media at a temperature other that room temperature should be warmed or cooled and stored in a safe manner. This includes:

- segregating sterile water from other irrigation solutions;
- obtaining written storage instructions from the fluid manufacturer;
- using only warming cabinets that are designed to warm fluids and have temperature controls; and
- discarding any fluid container that has been opened and not completely used.

Refer to AORN’s “Recommended practice guidelines for minimally invasive surgery,” which includes recommendations regarding fluid management for additional information.

Fluids used for irrigation or distention media are selected according to the procedure and the patient. Only nonelectrolyte distension fluids should be used in the presence of monopolar electrosurgery. The chart below provides a comparison of the properties of the various fluids that can be used for distention media.
<table>
<thead>
<tr>
<th>Solution</th>
<th>Electrolyte Solution</th>
<th>Uses</th>
<th>Potential Contraindications</th>
<th>Adverse Reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9% Sodium Chloride&lt;sup&gt;1&lt;/sup&gt;</td>
<td>YES</td>
<td>General irrigation, hysteroscopy, use with laser and bipolar electrosurgery, and urologic procedures&lt;sup&gt;2,3&lt;/sup&gt;</td>
<td>Monopolar electrosurgery</td>
<td>Hypervolemia, pulmonary edema, abdominal cramping, nausea and vomiting, diarrhea</td>
</tr>
<tr>
<td>Ringer's Lactate&lt;sup&gt;4&lt;/sup&gt;</td>
<td>YES</td>
<td>General irrigation</td>
<td>Monopolar electrosurgery</td>
<td>Fluid shift from intracellular to extracellular compartment, hypervolemia</td>
</tr>
<tr>
<td>Dextran&lt;sup&gt;1&lt;/sup&gt;</td>
<td>NO</td>
<td>Hysteroscopy, volume generally limited to 300 mL and not to exceed 500 mL&lt;sup&gt;5&lt;/sup&gt;</td>
<td>Allergy to beet sugar; hypersensitivity to dextran or any component of the formulation; hemostatic defects (eg, thrombocytopenia, hypofibrinogenemia); cardiac decompensation; renal disease with severe oliguria or anuria; hepatic impairment</td>
<td>Plasma expander leading to fluid or solute overload; disseminated intravascular coagulation (DIC), for every 100 mL absorbed, the plasma volume expands by an additional 860 mL; overdose, marked by pulmonary edema, increased bleeding time, and decreased platelet function</td>
</tr>
<tr>
<td>Glycine 1.5%&lt;sup&gt;6&lt;/sup&gt;</td>
<td>NO</td>
<td>Urologic irrigation, hysteroscopy, and resectoscopy with monopolar electrosurgery&lt;sup&gt;3&lt;/sup&gt;</td>
<td>Severe cardiopulmonary or renal dysfunction, decreased liver function; additives may be incompatible, consult with a pharmacist</td>
<td>Aggravated pre-existing hyponatremia caused by shifts from intracellular to extracellular compartment; fluid and electrolyte disturbances (eg, edema, marked diuresis, pulmonary congestion); impaired liver function leading to accumulation of ammonia in the blood; allergic reactions, which are rare</td>
</tr>
<tr>
<td>Mannitol 5%&lt;sup&gt;7&lt;/sup&gt;</td>
<td>NO</td>
<td>Urologic irrigation; hysteroscopy and resectoscopy with monopolar electrosurgery&lt;sup&gt;3&lt;/sup&gt;</td>
<td>Severe cardiopulmonary or renal dysfunction</td>
<td>Aggravated pre-existing hyponatremia caused by shifts from intracellular to extracellular compartment; fluid and electrolyte disturbances (eg, edema, marked diuresis, pulmonary congestion); hypernatremia caused by loss of water and excess of electrolytes from continuous administration</td>
</tr>
</tbody>
</table>

*Editor’s note:* This table presents irrigation solutions that are in common use; however, it is not all-inclusive. Use of other irrigation solutions may be indicated in certain patient populations and for certain conditions.
### Table 1

<table>
<thead>
<tr>
<th>Solution</th>
<th>Electrolyte Solution</th>
<th>Uses</th>
<th>Potential Contraindications</th>
<th>Adverse Reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorbitol 3%</td>
<td>NO</td>
<td>Urological irrigation</td>
<td>Severe cardiopulmonary or renal dysfunction, fructose intolerance</td>
<td>Aggravated pre-existing hyponatremia caused by shifts from intracellular to extracellular compartment; hypernatremia caused by loss of water and excess of electrolytes from continuous administration hyperglycemia in patients with diabetes mellitus; allergic reactions (eg, urticaria)</td>
</tr>
<tr>
<td>Sorbitol 3% / Mannitol 0.5%</td>
<td>NO</td>
<td>Urologic irrigation</td>
<td>Severe cardiopulmonary or renal dysfunction; fructose intolerance</td>
<td>Aggravated pre-existing hyponatremia caused by shifts from intracellular to extracellular compartment; hypernatremia caused by loss of water and excess of electrolytes from continuous administration; hyperglycemia in patients with diabetes mellitus; hyperlactatemia in patients who are metabolically compromised caused by metabolism of sorbitol</td>
</tr>
<tr>
<td>Sterile Water</td>
<td>NO</td>
<td>General irrigation, washing, rinsing, and dilution purposes; transurethral resection of prostate</td>
<td>Continuous irrigation, as a distention medium; additives may be incompatible, consult with a pharmacist</td>
<td>Hemolysis when absorbed into the bloodstream</td>
</tr>
</tbody>
</table>


### Table References

Energy Sources
Energy sources such as electrosurgical units, ultrasonic units, and other thermal sealing devices should be checked to ensure that they are in proper working order and alarms are functioning and audible. Equipment settings should be adjusted appropriately for MIS procedures. When required, grounding devices should be available.

Electrosurgical safety risks such as direct coupling, current insulation failure, and capacitive coupling, combined with a limited field of view may contribute to undetected patient injury during laparoscopic surgery.

- **Direct coupling** is the contact of an energized active electrode tip with another metal instrument or object within the surgical field.
- **Current insulation failure** is when the insulation on an instrument is damaged (e.g., cracked, stripped, worn thin).
- **Capacitive coupling** is the transfer of electrical current from the active electrode through intact insulation to adjacent conductive items such as tissue or trocars. It occurs whenever a nonconductor is separated by two conductors. The use of hybrid trocar systems (i.e., metal and plastic) should be avoided.

A capacitor is created between the metal cannula and the active electrode. The plastic abdominal anchor will prevent the current from dispersing through the abdominal wall but the current may exit through adjacent tissue on its way to the patient return electrode.

It is important to note that an all-plastic cannula system will reduce the potential for capacitance, but it does not eliminate it. The patient’s connective tissue acts as a conductor and thereby, can set up the potential for capacitance. Active electrode monitoring has minimized these risks by deactivating the monopolar generator when it detects unsafe levels of stray energy. All equipment should be inspected and evaluated at least yearly for maintenance to ensure that the equipment is working properly and all pre-set settings are still accurate.

Argon-enhanced coagulation
Patient injury and death have occurred as a complication of using argon-enhanced technology. There is also a significant risk of gas embolism when argon-enhanced coagulation is used during laparoscopic procedures. This can result from abdominal over-pressurization and displacement of CO₂ by argon gas.¹⁶ Because of the risks involved, argon-enhanced coagulation technology should be used cautiously, and when used, intra-abdominal pressure should be monitored carefully.

INTRAOPERATIVE MONITORING AND TROUBLESHOOTING
The perioperative registered nurse has many responsibilities during MIS surgery related to safe patient care. A complete baseline sponge, instrument, and sharp count should be completed before the procedure begins. The MIS patient should be prepped and draped to allow immediate access to perform an open procedure.

The site marking (if required) is performed by the designated person in the preoperative area and a standard time out is performed just prior to incision. Specific components of the time out for an MIS procedure may include, but are not limited to, verifying the presence of the following:

- a footboard if the patient will be in steep reverse Trendelenburg position;
- sequential compression device leggings and a properly functioning unit;
- all required, properly labeled diagnostic images; and
- all appropriate sizes of implants.

Insufflator
Before establishing the pneumoperitoneum, the CO₂ tubing should be flushed to remove any residual air. This reduces the risk of an air embolism.

After the procedure is completed, the insufflation tubing should be disconnected from the trocar cannula before turning off the insufflator. This prevents any backflow pressure. The filter should be discarded after each procedure to prevent cross contamination.¹⁷

If tanks of CO₂ are used to supply the insufflator, the perioperative registered nurse should be prepared to replace the primary CO₂ cylinder before it is empty to prevent loss of the pneumoperitoneum during a critical time in the procedure.

Instruments
As previously noted, personnel must be proficient in assembly and inspection of instrumentation and equipment and aware of measures to minimize patient safety issues (i.e., insulation failure, inappropriate laparoscopic settings). During the procedure instruments must be carefully handled and then replaced in their respective storage cases at the end of the procedure for reprocessing. Many of the instruments used in MIS are fragile and parts can be easily broken if not handled properly. Inspection of all instruments should include inspecting for damage to insulation, as well as identifying any loose or missing parts. Trocars should be inspected before use and before disposal to ensure that all of the component parts are intact.
When performing instrument counts, the team should confirm that all parts are presented and counted. This count includes the caps that are frequently found on laparoscopic instruments and are used to seal the channel and prevent gas from escaping and trocars that may have multiple parts.

Facilities frequently reprocess expensive single-use laparoscopy instruments. When this is done, it is critical to ensure that the instruments are properly decontaminated before sending them to the reprocessing company. Companies should be selected that are FDA approved. See AORN’s “Guidance statement: reuse of single-use devices”\(^ {18} \) for more details.

### Energy sources

The perioperative team must verify the properties of the distention media to minimize risks related to electrosurgery. This includes selection of an insufflation gas that is non-flammable or a nonelectrolyte fluid distention media.

It is also important to verify the use of a conductive trocar system and examination of all MIS electrodes to determine possible insulation failure. During the operative procedure, care should be taken to ensure that the active electrode is not activated until it is in close proximity to the target tissue and only the team member who is using the active electrode should have the ability to activate the electrode (i.e., using hand or foot controls).

### Gas embolism

Gas embolisms can also occur when large amounts of CO\(_2\) directly enter a blood vessel after blind veress needle insertion. Caution should be used when inserting a veress needle blindly and insufflation should start slowly at a low flow rate (eg., 1L per minute). A gas embolism can be detected by:

- the presence of a mill wheel murmur (i.e., alteration in heart tone) by esophageal or precordial stethoscope;
- aspiration of frothy blood from a central venous pressure line;
- the presence of hypercarbia, hypoxemia, hypotension, or cyanosis; or
- use of a precordial stethoscope, transesophageal Doppler, or transesophageal echocardiography.

Cardiac arrest can also indicate the presence of a gas embolism.

Treatment of a gas embolism includes:

- discontinuing nitrous oxide and reducing FiO\(_2\) (fraction of inspired oxygen) to 1L per minute
- identifying and occluding the air entrance site
- discontinuing insufflations
- increasing the rate, volume, and control ventilations with positive end-expiratory pressure
- placing the patient in left lateral decubitis position with head down
- aspirating air through a central venous pressure line.

### Surgical smoke

Exposure to surgical smoke and bioaerosols poses a hazard to both patients and health care workers. Smoke and bioaerosols are routinely produced by surgical instruments (e.g., lasers, electrosurgical units, radiofrequency devices, power tools). The use of high temperatures to obtain homeostasis causes the cell membrane to rupture, creating smoke and releasing the cell contents in the form of smoke. After analysis, airborne contaminants produced during electrosurgery have been determined to contain toxic gas and vapors (e.g., benzene, hydrogen cyanide, formaldehyde); bioaerosols; and dead and living cell material including blood fragments; and viruses.\(^ {19} \)

All members of the surgical team are exposed to the effects of surgical smoke. Using a surgical mask does not prevent the smoke from being inhaled because 77% of surgical smoke is 1.1 microns or smaller in size and can pass through the surgical mask.\(^ {19} \) For more detailed information consult the “AORN Position statement on surgical smoke and bioaerosols.”\(^ {20} \)

Patients are also affected by the absorption of surgical smoke during laparoscopic procedures. Smoke is absorbed through the peritoneal membrane and increases the levels of methemoglobin and carboxyhemoglobin concentrations in the blood, which in turn decreases the oxygen carrying capacity of red blood cells. There is the potential for falsely elevated oxygen level pulse oximeter readings that could result in unrecognized patient hypoxia.\(^ {20} \)

Smoke evacuation should be accomplished by using a reduced intra-abdominal suction level in order to maintain the pneumoperitoneum. Direct wall suction without an inline filter may not be used for smoke capture purposes because of the potential for air line contamination.

At the end of the procedure, the pneumoperitoneum should be released through a smoke evacuation system to prevent the release of the smoke particles into the OR environment exposing the perioperative team to contaminants.
Irrigation and distention fluids
As part of the preparation for the procedure, the perioperative nurse ensured that fluids that would be used for irrigation or distention were properly selected, warmed, and stored. During the procedure, the perioperative nurse should continue vigilance in ensuring that:

- intrauterine pressure is controlled to maintain a balance between too much pressure, which increases intravasation and too little pressure, which decreases visibility;
- fluid pressure levels remain below the patient’s mean arterial pressure (MAP);
- fluids are warmed according to the manufacturer’s recommendations; and
- only non-electrolyte distention fluids are used when monopolar electrosurgery will be employed.

The intrauterine pressure should remain below the patient’s MAP. The MAP is constantly and automatically calculated by anesthesia monitoring devices and is displayed on its monitor.

Risk levels are reduced by increasing the surgeon’s efficiency, and by decreasing the length of the procedure, the amount of distention fluid infused, and the anesthesia time.21

Intravasation is the absorption of distention media through the uterine vasculature. Modes of entry include intrauterine pressure, the number of vascular openings present during the procedure, and the duration of the procedure. Intrauterine pressure must be monitored to maintain a balance between too much pressure that can increase intravasation, and too little pressure that will decrease visibility.

If fluids are used for the distention media, they must be handled and discarded as biohazardous waste according to federal, state, and local regulations.

Fluid management systems are designed to calculate the amount of fluid dispensed to the patient and the amount of fluid returned to the system. These systems allow the perioperative team to minimize the risk of fluid overload. Regardless of how diligently nurses attempt to monitor fluid volumes, the 3-L bags used for delivery may contain as much as 10% more or less (i.e., 300 mL) than the 3 L, which precludes volumetric estimation as a reliable technique. Weight measurement is a more accurate estimation of retained fluid volume.

Positioning
Care must be taken when positioning the patient for an MIS procedure. Special efforts must be made to prevent shearing or friction injuries caused by the steep Trendelenburg or reverse Trendelenburg positions frequently used. The patient must be properly secured on the OR procedure bed. Use of shoulder braces should be avoided because they exert increased pressure on the shoulders and underlying structures when in steep Trendelenburg position. Products such as vacuum-activated surgical positioning systems are available for this purpose. Whenever possible, vacuum positioners should be padded with gel to reduce pressure. When positioning patients, AORN’s “Recommended practices for positioning the patient in the perioperative practice setting”22 should be followed.

Patients who are pregnant
When a patient who is pregnant is undergoing a laparoscopic procedure and placed in the supine position, the enlarged uterus places pressure on the inferior vena cava decreasing venous return to the heart. This decreased venous return can lead to maternal hypotension, decreased cardiac output (i.e., 10% to 30%), and decreased perfusion of the placenta during surgery. Placing a positioning wedge under the patients’ right side takes the pressure of the uterus off the vena cava and improves the venous return and cardiac output.
Use of robotic equipment

Competency of perioperative robotics team members is essential to ensure provision of safe patient care. Perioperative registered nurses should understand the fundamental knowledge and have the skills necessary to provide the professional role responsibilities of a registered nurse during procedures using robotic equipment in the OR. The robotic knowledge and skills required is in addition to the maintaining the basic competency skills expected of a perioperative registered nurse. Proficiency at using surgical robotic systems is directly related to the education and training of the perioperative team.

Vigilance during a surgical procedure is paramount when the robotic equipment is in use. When the patient is docked to the robot, the robotic surgical cart must be detached from the patient before any repositioning of the patient occurs. Failure to undock the system from the patient could result in injury. Communication between all team members is essential for a safe and smooth transition from one position to another. In addition, the perioperative team must be attentive to the risk for increased pressure on the patient when the robot is being positioned and docked.

If the need to convert from a robotic procedure to either a laparoscopic or open procedure arises, it is essential that all team members understand their roles during the conversion. Additionally, all robotic instruments must be released from any tissue that is in the instrument’s grasp. Failure to do so will result in patient injury.

DOCUMENTATION

Specific documentation (e.g., electronic medical record) of care for MIS procedures should include but not be limited to:

- distention media used;
- equipment used for distention media administration;
- quantity of fluid administered and flow rate;
- quantity of fluid returned, if applicable;
- urinary output;
- medication added to distention fluid; and
- relevant information about equipment used (e.g., insufflation, electrosurgery, positioning).

POSTOPERATIVE CONSIDERATIONS AND COMMUNICATION

The hand-off report to the PACU registered nurse should include items of particular concern for the patient who has undergone a laparoscopic procedure. These items include the potential for injury associated with extreme positioning. In particular, a friction or nerve injury could have occurred. The perioperative registered nurse should report the position used as well as any concerns related to positioning as part of the hand-off communication. The hand-off report should also include information about the evacuation of distention gases and management of fluids used for distention and irrigation.

Patient assessment and monitoring

Patients undergoing MIS are assessed and monitored according to facility policy and procedures for any postoperative patient with particular attention paid to skin assessment due to the potential for a friction or burn injury.

Pain management

Pain associated with laparoscopy often includes a referred pain to the shoulders due to phrenic nerve irritation. This is usually caused by distention of the diaphragm. The hand off report should have included whether any preemptive analgesia (e.g. intraoperative local analgesia combined with opioid-sparing pain medication) was administered. A special pain regimen may be prescribed.

Patient education

The PACU registered nurse should instruct the patient to immediately report any postoperative signs or symptoms of electrosurgical injury. Symptoms of a minimally invasive electrosurgical injury can occur days after discharge from the perioperative setting and may include infection from an injured intestinal tract. Prompt reporting of electrosurgical injury symptoms ensures timely treatment and minimizes adverse outcomes. The PACU registered nurse should also instruct the patient to look for and report the following symptoms:

- signs of positioning injury such as skin changes, bruises and burns;
- fever;
- inability to void;
- gastrointestinal bleeding;
- abdominal pain;
- abdominal distention;
- nausea;
- vomiting; and
- diarrhea.
SUMMARY

Today, laparoscopic cholecystectomy is considered to be the “gold standard” for removing a gall bladder. From 1988 to 1992, the number of cholecystectomies performed electively in the United States increased by 58%. It took about four years for general surgeons to shift from the open cholecystectomy technique to the laparoscopic technique. After this initial shift occurred, significant refinements in technique took place. Currently, few abdominal, pelvic, cardiothoracic, or neck surgical procedures cannot be performed laparoscopically, including bariatric surgery. In addition to general surgeons, laparoscopy is commonly used by gynecologists, urologists, and some cardiothoracic surgeons. Advances in video technology, robotics, instrumentation, equipment and training have enabled surgeons to do complex procedures using laparoscopic and robotic techniques.

The future of MIS is rapidly evolving. Currently, multiple trials are underway using miniaturized variations of robotic self-contained units. The future may include using these miniaturized versions that are dropped into the abdomen and manipulated from the outside to perform surgical procedures. Additionally, advanced endoscopic techniques, magnetic retraction, virtual reality, integration of robotic and endoscopic systems, and simulation will further define the practice of surgery.

Editor’s note
Band aid is a registered trademark of Johnson and Johnson, New Brunswick, NJ.

Zeus is trademark Computer Motion, Goleta, CA.

The Natural Orifice Surgery Consortium for Assessment and Research (NOSCAR) is a registered trademark of the American Society for Gastrointestinal Endoscopy (ASGE) Oakbrook, IL and the Society for American Gastrointestinal Endoscopic Surgeons (SAGES) Los Angeles, CA.

Natural Orifice Translumenal Endoscopic Surgery (NOTES) is registered trademark of NOSCAR, Oakbrook, IL.

Single incision laparoscopic surgery (SILS) is a trademark of Covidien Healthcare, Mansfield, MA.

REFERENCES


POSTTEST

1. A thorough preoperative assessment is critical during which the perioperative nurse must identify unique patient considerations that may require additional precautions or contraindications related to MIS procedures. This assessment must include identification of risk factors related to
   1) extreme positioning.
   2) prevention of venous stasis.
   3) informed consent.
   4) fluid management.

A. 1 and 2
B. 3 and 4
C. 1, 2, and 4
D. 1, 2, 3, and 4

2. Creating a pneumoperitoneum can cause problems with patients who
   1) have respiratory disease.
   2) have sickle cell disease.
   3) have cataracts.
   4) have glaucoma.
   5) are morbidly obese.

A. 1 and 2
B. 1, 2 and 4
C. 2, 3, and 5
D. 1, 2, 3, 4, and 5

3. Side effects of carbon dioxide used to create a pneumoperitoneum can include
   1) hypocarbia.
   2) hypercarbia.
   3) hypothermia.
   4) cardiac output reduction.
   5) metabolic acidosis.

A. 1 and 3
B. 1, 4 and 5
C. 2, 3, 4, and 5
D. 1, 2, 3, 4, and 5

4. The intra-abdominal pressure setting for laparoscopic procedures should be set according to
   1) Standard setting of 20mm Hg
   2) Surgeon preference
   3) Age
   4) Weight
   5) Procedure

A. 1 and 2
B. 3 and 4
C. 2, 3, 4, and 5
D. 1, 2, 3, 4, and 5

5. When the patient who is pregnant is undergoing a laparoscopic procedure in the supine position, the perioperative nurse should

A. place a wedge under the patients’ right side.
B. place a wedge under patients’ knees.
C. place a wedge under patients’ left side.
D. place patient in right lateral position.
E. place patient in left lateral position.

6. General anesthesia with intubation is generally recommended for laparoscopic procedures because of the
   1) need to use muscle relaxant to allow for abdominal insufflation.
   2) need to control and increase ventilation to compensate for hypocarbia and respiratory acidosis resulting from absorption of CO₂.
   3) exaggerated patient positions that can be very uncomfortable for the patient.
   4) potential for patient movement, coughing, or bucking that can increase intra-abdominal pressure.

A. 1 and 2
B. 3 and 4
C. 1, 3, and 4
D. 1, 2, 3, and 4
7. When using fluids for distention instead of CO₂, the perioperative registered nurse should ensure that
   1) all fluids used for distention are at room temperature.
   2) only physiological (i.e., electrolyte) distention fluids are used to decrease the potential for electrolyte imbalance.
   3) fluids are warmed according to manufacturer’s recommendations.
   4) fluid deficit is accurately calculated by measuring the amount of distention fluid instilled minus the amount recovered.
   5) an automated fluid management system is used and outflow fluid is collected and measured by weight not volume.

   A. 2 and 4
   B. 3 and 5
   C. 1, 3, 4, and 5
   D. 1, 2, 3, 4, and 5

8. When using electrosurgery during laparoscopic procedures, the perioperative nurse should be aware of the potential for undetected patient injury that can be caused by
   1) use of hybrid trocar systems.
   2) instrument insulation failure.
   3) capacitive coupling.
   4) improper placement of the return dispersive electrode.
   5) limited laparoscopic view.

   A. 2 and 3
   B. 1, 2, 3, and 5
   C. 2, 3, 4, and 5
   D. 1, 2, 3, 4, and 5
Answer Key

The Role of the Perioperative Registered Nurse in Minimally Invasive Surgery

1950