Minimally Invasive Surgery: Creating a Safe Patient Care Environment

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STUDY GUIDE

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TABLE OF CONTENTS

LEARNING OUTCOME 4
OBJECTIVES 4
INTRODUCTION 5
SAFE ENVIRONMENT OF CARE 5
Room Configuration 5
Equipment 6
GAS INSUFFLATION 6
Precautions for Gas Insufflation 6
Gas Embolism 7
IRRIGATION AND DISTENTION FLUID 7
Precautions for Irrigation and Distention Fluid 8
ENERGY-GENERATING DEVICES 9
COMPUTER-ASSISTED SURGERY 10
HYBRID OR 11
MRI SAFETY 12
INTRAOPERATIVE MRI SAFETY 13
EDUCATION AND COMPETENCY VERIFICATION 13
POLICIES AND PROCEDURES 13
SUMMARY 14
REFERENCES 15
POST-TEST 17
POST-TEST ANSWERS 19

LEARNING OUTCOME

After completing this study guide and viewing the accompanying video, the perioperative RN will have increased his or her knowledge of nursing interventions to create a safe environment of care and improve outcomes and satisfaction for patients undergoing minimally invasive surgery (MIS).

OBJECTIVES

After completing the study guide and viewing the video, perioperative RNs and other team members will have increased their knowledge of

- configuring the minimally invasive surgical OR to minimize the risks to patients and perioperative team members,
- the perioperative RN's role in managing insufflation gases and fluids for distention and irrigation,
- minimizing the risks of adverse events from energy-generating devices during MIS,
- optimizing safety during robotic-assisted surgery, and
- hazards and safety protocols related to intraoperative magnetic resonance imaging (MRI) and hybrid ORs.

INTRODUCTION

Minimally invasive surgery involves performing surgical procedures through small incisions or in small spaces with specialized instruments and imaging systems.[1] Many surgical specialties use MIS for a wide variety of procedures.[1] The minimally invasive surgical approach has many advantages, including reduced trauma,[2] decreased pain,[3,4] lower intraoperative blood loss,[3] decreased formation of adhesions,[3] faster recovery,[2] shorter hospital stays,[3,4] and a more rapid return to normal activities after surgery.[4]

The variety of procedures performed with MIS has significantly increased during the past three decades, and this trend is expected to continue. A minimally invasive procedure may be considered the first-line approach for many conditions requiring surgical treatment.[5]

These specialized techniques also have some special risks. Gases and fluids used to create the surgical working space can cause patient complications. Robotic surgery adds levels of complexity, and intraoperative MRI introduces the challenge of working with powerful magnets.[6]

This study guide and the accompanying video provide guidance to the perioperative RN for creating a safe environment of care for patients undergoing MIS. By implementing appropriate protocols and work practices, the perioperative team can maximize safety, improve outcomes, and increase satisfaction for patients and the health care team.

SAFE ENVIRONMENT OF CARE

Health care organizations should establish a multidisciplinary team to create an efficient, safe environment of care for minimally invasive procedures.[6]

Room Configuration

To optimize the safety and efficiency of MIS, each health care organization should establish a multidisciplinary team composed of perioperative RNs, physicians, surgical technologists, infection preventionists, biomedical engineers, and other members of the health care team to plan the layout of the minimally invasive surgical suite. A properly configured suite should be large enough to hold all the equipment needed for MIS while providing good access to the patient and surgical field.[6]

Installation of overhead, ceiling-mounted arms for placement of monitors facilitates optimal positioning and improves the ability of the perioperative team to view the images. Poorly placed monitors can force team members to bend or twist into awkward positions to see clearly. This can cause physical stress in the head, neck, and shoulders. Properly positioned monitors can improve the ergonomic setup of the room and reduce stress for personnel. It may be beneficial to provide video monitors in all four quadrants of the OR.[6]

Ceiling-mounted equipment booms provide shelving, electrical outlets, and medical gas ports and improve the ergonomic positions and increase the efficiency and safety of personnel. Use of booms reduces clutter and facilitates interconnection of equipment. Equipment booms, video monitors, and overhead lights should be positioned to minimize distractions and ergonomic hazards (eg, slips, trips, falls because of low lighting, collisions) during MIS.[6]

The room should have a sufficient number of dedicated electrical circuits and outlets positioned close to equipment stored on shelves. Having outlets close to the equipment minimizes the need to run power cords across the floor and reduces the chance of trips and falls.[6]

Evacuation of surgical smoke is an important consideration during minimally invasive procedures. Smoke can obscure visualization in the operative site and can expose patients to elevated levels of carbon monoxide. Systems should be put in place to evacuate and filter surgical smoke during the procedure and at the end of the procedure when the pneumoperitoneum is released.[7]

The multidisciplinary team should implement methods to control and minimize traffic in the minimally invasive suite.[6] The multidisciplinary team should also collaborate with industry representatives to ensure that equipment and systems for MIS are compatible and can be used together.[6]

Equipment

The perioperative team should prepare the equipment for MIS according to the manufacturer's instructions for use and the preferences of the surgeon. The team should inspect the equipment before use and remove any defective items from service. The defective items should be repaired or replaced according the policies and procedures of the health care organization.[6]

During inspection, the team should assess the following:

- Clarity of lenses
- Cleanliness
- Corrosion, pitting, burrs, nicks, or cracks
- Function and alignment of instrumentation
- Integrity of cables
- Integrity of insulation on insulated devices
- Integrity of seals and gaskets
- Missing parts
- Sharpness of cutting edges
- Wear and chipping of instruments and plated surfaces
- Other defects[6]

GAS INSUFFLATION

Gas is used during many minimally invasive procedures to create a working space and to facilitate visualization of the surgical field.

During laparoscopy, gas is insufflated into the peritoneal cavity to create a pneumoperitoneum. Several gases are available for this purpose. Gas for a particular procedure is chosen based on the properties of the gas, the procedure, and the patient's history. Carbon dioxide (CO_2) is currently the most commonly used gas. It is colorless, odorless, inexpensive, and nonflammable. It is also easily dissolved in the bloodstream, which is important for clearing the gas after the procedure and for absorbing the gas in the event of an embolism. Other available gases for insufflation include air, nitrogen, nitrous oxide, argon, and helium.[6] Air is not easily absorbed through the peritoneum and creates a higher risk for gas embolism.[8] Absorption of nitrous oxide is unpredictable.[8] Compared with CO_2, helium is less soluble in blood.[8] Argon depresses hemodynamics more than CO_2.[8] For these reasons, CO_2 is often preferred.[8]

Gas insufflation has the potential to cause patient injuries and complications including hypercarbia,[6] acidosis,[1,6,8] peritoneal irritation,[6] gas embolism,[6] cardiac arrhythmias,[6] decreased cardiac output,[2] increased blood pressure,[2] decreased blood flow to the kidneys,[1] and decreased urine output.[1]

Precautions for Gas Insufflation

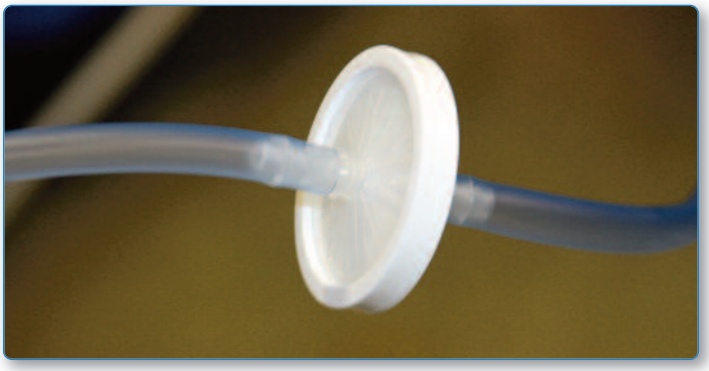
The perioperative team should identify potential complications and injuries to patients associated with gas insufflation and establish practices to reduce the risk of these injuries and complications.[6]

The perioperative RN should set the flow rate for insufflation according to the surgeon's specification and the manufacturer's instructions for use. The flow rate is limited by the smallest diameter in the insufflation system. Decreasing the diameter will increase resistance and decrease flow. Increasing the diameter will increase flow. The manufacturer's instructions for use provide information about flow rates, trocars, filters, and the diameter of tubing that will achieve optimal results for insufflation. These instructions should be readily available to team members using the equipment.[6]

Insufflation pressures should be maintained at the lowest level that achieves necessary surgical conditions.[6,9] Evidence

supports maintaining the pneumoperitoneum at a pressure of less than 15 mmHg.[6] The perioperative team should monitor gas insufflation pressures to ensure the pneumoperitoneum is maintained at the desired level.[6]

The insufflator should be placed above the level of the surgical cavity whenever possible. This decreases the risk of bodily fluids backing up and entering the insufflation system.[6] The insufflator and tubing should be flushed with the insufflation gas before the tubing is connected to the cannula. Flushing removes room air from the system and decreases the risk for an air embolism.[6] This can be especially important for pediatric patients because elements of pediatric circulation, particularly in neonates, predispose young patients to gas embolism.[10]



The perioperative RN should ensure that a hydrophobic filter is placed between the insufflator and the insufflation tubing. This filter helps to prevent contaminants from flowing through the insufflator and into the patient's cavity. It also helps to prevent backflow of bodily fluids and small particles into the insufflator. Particles or fluids entering the insufflator might cause cross contamination. The perioperative RN should verify the filter is compatible with the insufflator and does not interfere with the flow of gas.[10]

When a hysteroscopy is performed, the perioperative team should use an insufflator specifically designed for hysteroscopy. Insufflators for laparoscopic surgery should not be used for hysteroscopy. The uterine cavity is much smaller than the peritoneal cavity and requires an insufflator designed to work at high pressure with low volume. Laparoscopic insufflators are designed to deliver large volumes at low pressure.[6]

Regardless of the type of insufflator used, the perioperative RN should ensure the alarms are turned on and are sufficiently loud to be heard over the noise of the OR.[6]

If a gas cylinder is used with the insufflator, the perioperative RN should verify that it contains the correct gas and that it is not empty. A second full cylinder should be immediately available in case the first cylinder runs out.[6]

Gas Embolism

Gas embolism is a rare but potentially serious complication of laparoscopic surgery. Insufflation of gas increases intraabdominal pressures, and open blood vessels provide an avenue for the gas to enter the circulatory system. The embolus can become life-threatening if a sufficiently large volume of gas enters the vascular system and travels to the right ventricle or pulmonary artery. The perioperative team should be prepared to detect and manage an embolism.[6]

Clinical signs of gas embolism include systemic hypotension, dyspnea, cyanosis, tachycardia or bradycardia, arrhythmia, asystole, elevated pulmonary arterial pressure, elevated central venous pressure, hypoxemia, and increased arterial partial pressure of CO_2. End-tidal CO_2 might either increase or decrease.[11]

If a gas embolism occurs, the perioperative RN should be prepared to assist with immediate treatment. Interventions might include

- administering inotropes, vasopressors, and vasodilators;
- performing cardiopulmonary resuscitation;
- discontinuing the anesthetic gas and delivering 100% oxygen to the patient (intended to wash the insufflation gas out of the lungs, decrease ventilation-perfusion mismatch, and improve hypoxia);
- discontinuing the insufflation gas;
- hyperventilating the patient to assist in removing the gas embolus;
- infusing large amounts of fluid (facilitates movement of the embolism into the lungs where it can be absorbed, and expansion of the intravascular volume can also increase central venous pressure and decrease the risk of additional gas entry); and
- positioning the patient into Trendelenburg or left lateral position to attempt to move the embolism to a more favorable position and improve blood flow.[6]

IRRIGATION AND DISTENTION FLUID

Some minimally invasive surgical procedures use fluid instead of gas for distention to create the surgical working space. Fluid is also used for irrigation to improve visualization of the surgical field in many procedures. These fluids may be instilled by gravity or by an infusion pump. As with insufflation gas, fluids used for distention and irrigation can

cause injuries and complications in some patients. The perioperative RN should identify potential injuries and complications associated with fluid used for irrigation or distention during MIS.[6]

Extravasation involves the escape of fluid from its contained space into surrounding tissue.[12] This can lead to edema, abdominal distention, or intraabdominal compartment syndrome. Intravasation occurs when irrigation or distention fluids are absorbed into the patient's bloodstream. This can lead to hyponatremia, hypervolemia, cardiovascular complications (eg, fluid overload, heart failure), or pulmonary complications (eg, pulmonary edema). This combination of signs is sometimes referred to as transurethral resection (TUR) syndrome. The risk of fluid-related complications increases with the increasing length of the procedure and with increased dissection of the surrounding tissue.[6]

In consultation with the surgeon, the RN circulator should select the fluid used for irrigation or distention based on the type of procedure, assessment of the patient, and the instruments to be used.[6]

Nonelectrolyte fluids with low viscosity (eg, 1.5% glycine, 5% mannitol, 3% sorbitol) are often selected for procedures performed using monopolar instruments, such as gynecological and urological endoscopy procedures. These fluids are hypotonic. If absorbed in large quantities, they can cause TUR syndrome. The patient's age and comorbidities (eg, cardiovascular or renal dysfunction) can increase the risk for developing this syndrome.[6]

Normal saline is often selected for procedures performed using bipolar instruments. This solution is isotonic and contains electrolytes, so it can be safer than nonelectrolyte fluids if large amounts are absorbed.[6]

High-viscosity fluids, such as 32% dextran 70, do not blend with blood. For this reason, they provide good visibility when bleeding occurs during endoscopic procedures. Dextran, however, can draw six times its own volume into the bloodstream. This can cause significant fluid overload, heart failure, and pulmonary edema. Because of the high sugar content of this fluid, instruments must be rinsed immediately after use to minimize damage.[6]

The perioperative RN should preoperatively assess the patient for risks related to fluid management, including the patient's

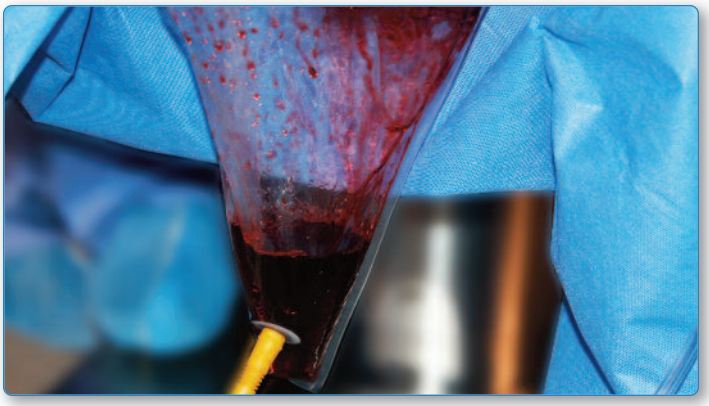
- age,
- allergies and sensitivities to medications,
- conditions or diseases that might predispose the patient to hyponatremia or hypervolemia or exacerbate the seriousness of those complications (eg, congestive heart failure, liver cirrhosis, renal disease),
- medications that might predispose the patient to hyponatremia or hypervolemia or exacerbate these complications,
- skin color and turgor, and
- weight.[6]

Precautions for Irrigation and Distention Fluid

Excessive fluid absorption by the patient is not always readily apparent. Extravasation or intravasation of fluids can occur quickly during MIS, and the warning signs may be subtle. To minimize the risk of complications, it is important for the RN circulator to collaborate with the anesthesia professional to monitor the amount of fluid used and collected during surgery. Fluid deficits should be reported to the anesthesia professional and surgeon at regular intervals throughout the procedure.[6]

It is often difficult to estimate the amount of fluid contained in drapes and buckets or spilled on the floor. To facilitate monitoring, all fluids used for irrigation or distention should be contained as much as possible. Collecting and containing fluid is helpful for making accurate estimates.[6]

To ensure safety, the perioperative team should monitor patients for physiologic changes that might reflect fluid



overload. Monitoring should include core temperature and laboratory values (eg, electrolytes and coagulation studies). The perioperative team should monitor the patient's abdomen, face, and neck for signs of extravasation or intravasation.[6]

Medications are sometimes added to irrigation or distention fluids. Epinephrine is one medication that is commonly added, particularly during orthopedic procedures. The perioperative team should monitor the patient for adverse reactions that might be caused by these medications.[6]

The perioperative RN should verify settings on the fluid pump with the surgeon before administration of the fluid. The RN should continue to monitor the settings throughout the procedure.[6]

The perioperative team should take precautions to prevent thermal injuries related to warmed irrigation and distention fluids. Patients are at increased risk for burns in the perioperative setting because they are usually unconscious or sedated. They are unable to feel an increase in temperature and cannot communicate discomfort. Injuries can occur when fluids are warmed to high temperatures, and even if fluids are not warm to the touch, heat can build up over time and be transferred to the patient.[13]

The perioperative team should always follow the manufacturer's instructions for use when storing irrigation fluids and distention media. These instructions include information about the maximum temperature the fluid should be exposed to and the maximum length of time the fluid can remain in the warming cabinet. These times vary among fluids and among manufacturers.[13]

The perioperative RN should label solutions placed in warming cabinets with the date of placement in the cabinet or the date of removal. Keeping track of dates helps to ensure that the fluid has not exceeded the maximum time for warming. The temperature of solutions on the sterile field should be measured before use.[13]

ENERGY-GENERATING DEVICES

Minimally invasive surgical procedures require operating in small, enclosed spaces with cameras and instruments in close proximity, and these conditions create unique risks for injuries related to energy-generating devices. Electrosurgical units have been reported to cause burns because of direct and capacitive coupling of current as well as insulation failure.[14] Capacitive coupling is the transfer of electrical current from the active electrode through intact insulation to adjacent conductive items (eg, tissue, trocars).[6,14] The use of a monopolar active electrode in conductive fluid, such as sodium chloride 0.9%, has been shown to cause heat transfer and damage to surrounding tissue.[6]

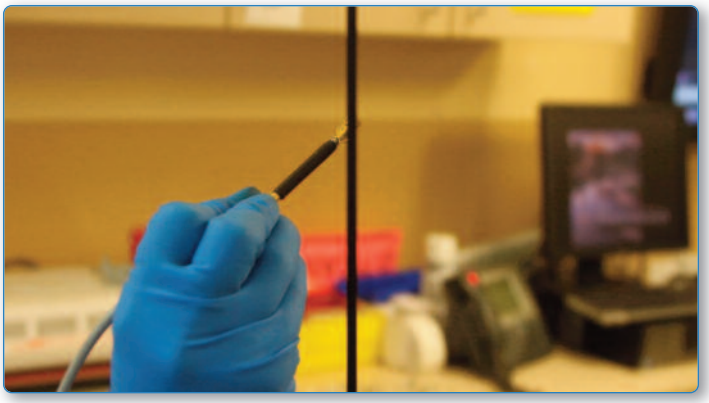
The perioperative team should take precautions to minimize the risk for injury associated with use of energy-generating devices during MIS.[6]

The perioperative team should use the lowest power setting that achieves the desired result. The foot pedal controlling the energy-generating device should be activated only by the person controlling the hand piece and only when the active electrode is in close proximity to the target tissue.[6]

Use of monopolar electrosurgical units during single-port laparoscopic procedures has been demonstrated to cause visceral burns. The perioperative team should use extreme caution when using monopolar electrosurgery during single-port laparoscopy.[14]

Conductive trocar systems should be used to minimize the risk for injury.[6,14] Conductive trocar cannulas provide a safe path for the flow of current between the cannula and the abdominal wall.[14] This reduces the concentration of high-density current and the risk for heat and injury to unintended areas.[14]

Active electrode shielding systems monitor endoscopic instruments continuously to minimize the risk for insulation failure or capacitive coupling injuries. These systems should be employed at the point of electrosurgical instrument use.[14]



Damaged insulation provides an alternate pathway for electrical current to escape the system.[14] This can lead to patient injury.[14] The perioperative RN should examine insulated instruments before use to ensure the insulation is intact.[6,14] These instruments should also be examined after use during the decontamination phase before sterilization.[6,14]

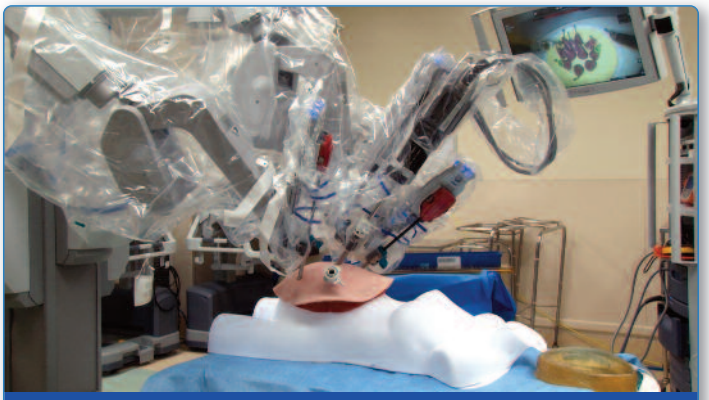
The perioperative team should take precautions when lasers are used for endoscopic procedures. The scrub person should inspect the laser catheter sheaths and laser fibers for damage before and after the procedure. The sheaths or fibers should be removed from service if they are damaged. Before the procedure, the scrub person should confirm that the catheter sheath meets the manufacturer's labeled length and that the laser fiber is sufficiently long to extend beyond the catheter. Finally, the scrub person should confirm that the catheter sheath and laser fiber are intact and complete every time they are removed from the patient. If they are not intact, they should be removed from service, the physician should be notified, and the facility's policy for retained surgical items should be implemented.[14]

Fire is a potential risk in the OR because all the elements necessary to start a fire are present.[13] There are multiple potential fuel sources, including sponges, drapes, gauze, solutions containing alcohol and other volatile compounds, nasal cannulae, dressings, and gowns.[15] Oxidizers in the form of oxygen and sometimes nitrous oxide are present,[15] and there are a number of potential sources of ignition, including energy-generating devices.[15,16] Fiber-optic cables might also provide a source of ignition if they are disconnected from the working element and allowed to remain in contact with drapes, sponges, or other fuel sources.[13] The perioperative team should implement fire safety precautions whenever energy-generating devices are used.[14]

The perioperative team should conduct a fire risk assessment during the time out and discuss a plan of action before beginning any surgical procedure, including MIS.[13] This assessment should identify any potential fuels that are present, potential sources of ignition, and the potential for an oxygen-enriched environment.[13]

COMPUTER-ASSISTED SURGERY

The perioperative team should identify potential risks for injury and complications associated with computer-assisted surgical procedures and should implement safe practices.[6]



This is a simulation of a robotic procedure

Robot-assisted surgery, also known as computer-assisted surgery, has become increasingly popular for many surgical procedures. It provides some significant advantages over standard laparoscopy, including greater range of motion of instruments; elimination of hand tremors; motion scaling; and three-dimensional (3D), high-definition views of the surgical field.[1,6]

Computer-assisted systems are complex and typically consist of several components.[6] The patient cart contains the robotic arms that attach to the instruments.[17] The instruments, in turn, are inserted into the patient's body cavity and allow the surgeon to perform the procedure.[6] The surgeon console contains the controls the surgeon uses to manipulate the robotic arms and the instruments.[17] It also includes a viewing screen for visualization.[17] The vision cart contains a monitor and connection points for additional audiovisual controls and equipment.[17]

Careful coordination among the team members is necessary to minimize the risk for errors that could lead to injury. The perioperative RN circulator should supervise the process of setting up the equipment for computer-assisted surgery. He or she should delegate tasks as needed and should evaluate activities to ensure that everything is set up correctly.[6]

Computer-assisted procedures often require positioning of the patient in the extreme Trendelenburg or reverse Trendelenburg position to improve surgical exposure. The perioperative team should take special care when positioning the patient.[6]

Sufficient support and padding must be provided to minimize both movement and risk for injury.[18]

This is a simulation of a robotic procedure

The term "docking" refers to the process of moving the patient cart over the sterile field and attaching the robotic arms to the instruments. Two team members are needed to accomplish this task. A nonsterile person moves the cart and a sterile person guides the equipment into place and prevents collisions.[6] After the patient cart is docked, it is critically important that the patient not move.[19] If the patient moves or shifts during the procedure, the surgeon should be notified.[6]

The perioperative team should follow the manufacturer's instructions for use for all equipment used in computer-assisted robotic minimally invasive procedures.[6]

Computer-assisted navigation procedures allow the surgical team to navigate with 3D images using a minimally invasive technique. Systems based on computed tomography, fluoroscopy, or imageless systems can be used for computer-assisted navigation. Computer-assisted surgical navigation equipment can include infrared cameras, advanced digital images of the patient for use with the navigation software, and interactive display monitors.[6]

The perioperative RN should assist the surgeon with the registration process. This process includes

- ensuring the preoperative radiologic studies are available,
- positioning the patient,
- positioning the navigation system so that the surgical field is in view of the tracking system,
- attaching the patient antenna,
- collecting data points from anatomical landmarks or fiducial markers,
- registering additional instruments if needed, and
- verifying the accuracy of the information.[6]

Patient registration is the most important step for ensuring the accuracy of the navigation system. The perioperative RN should notify the surgeon if the patient is moved on the OR bed after registration.[6]

HYBRID OR

The Facility Guidelines Institute defines a hybrid OR as "a room that meets the definition of an operating room and is also equipped to enable diagnostic imaging before, during, and after surgical procedures."[6,20] The design of the room combines the requirements for surgery and imaging equipment to facilitate surgical and diagnostic procedures in one location.[6] Bringing portable imaging equipment into a standard OR does not make the room a hybrid OR.[6,20] The hybrid OR may improve efficiency by decreasing the need for patient transportation and minimizing the number of hand offs.[6]

Challenges to the design and construction of a hybrid OR include high cost, complex planning among multiple specialties, space requirements, coordination of schedules, location, training of personnel, team development, and criteria for credentialing.[6]

The health care organization should determine the requirements for the design and operation of the hybrid OR for surgical or invasive procedures. A multidisciplinary team including perioperative and radiology RNs, interventional radiologists, surgeons, first assistants, surgical technologists, anesthesia professionals, infection preventionists, and other involved personnel should be established to develop the design for renovation or new construction to create a hybrid OR in compliance with federal, state, and local building regulations.[6]

In addition to design and construction of the hybrid OR, responsibilities of the multidisciplinary team include the following:

- Establishing safe processes and practices for working in the hybrid OR
- Identifying and defining the roles and responsibilities of team members
- Selecting the imaging system and adjunct technologies that meet the requirements for the planned scope of services[6]

Robot and Equipment. Courtesy of Swedish Medical Center. Seattle, Washington. 2018. Used with permission.

The perioperative team should establish standardized room configurations for each procedure. Benefits of standardized configurations include minimizing the risk of collisions between the imaging system and other equipment; facilitating positioning of monitors, overhead lights, lead shields, and booms in the appropriate location for each procedure; and eliminating potential delays caused by disagreements among personnel about optimal placement of equipment.[6]

The perioperative team should establish a "no-fly" zone according to the recommendations of the imaging system manufacturer, the position of the patient, the configuration of the room, and the part of the body undergoing imaging. Establishing the no-fly zone is important to reduce the risk of equipment collisions. A member of the perioperative team should be assigned responsibility for moving or securing equipment before use of the imaging system. During combination procedures with open surgical incisions, equipment booms or OR lights might be moved into the no-fly zone. The assigned person should ensure that all equipment is moved out of the zone before the imaging system is engaged.[6]

An RN circulator should be assigned to every patient undergoing an operative or other invasive procedure in a hybrid OR. Additional personnel should be assigned according to the type of procedure and the skill set required.[6]

The perioperative team should determine what emergency supplies and equipment (eg, crash cart, fire extinguisher, supplies for converting to an open procedure, gas shutoff valves) should be available before the procedure begins. Factors to consider include the location of the hybrid OR and the planned procedure.[6]

The perioperative team should comply with policies and procedures for radiation safety. These policies and procedures should be reviewed periodically.[6]

MRI SAFETY

All health care personnel, patients, and visitors must follow MRI safety precautions. Locations of the MRI equipment vary in health care facilities. The area around the MRI machine is usually divided into four zones. Zone I is uncontrolled space and can be accessed by anyone. This area is outside the room where the magnet is stored. Zone II is the interface area between zones I and III. Zone III is a strictly controlled area containing the control room and vestibule for screened patients and personnel. Zone IV is the scanner room itself. Zone IV is restricted to screened personnel and patients.[6]

All patients and personnel entering zone III should pass an MRI safety screening process. Patients or staff members with cardiac devices, stents, filters, grafts, cochlear implants, pumps, nerve stimulators, or metal foreign bodies (eg, bullets, pellets, shrapnel) should be screened for MRI safety. A screening checklist should be documented for each person.[6]

Equipment that has been specially designed for safe use with MRI should be used for all procedures. This includes monitors, instruments, oxygen tanks, gurneys, equipment for positioning, and IV poles.[6]

The 5-gauss line represents the area of danger around the MRI machine. All non-MRI safe equipment should be kept outside of this line.

Zones and signs denoting the presence of the MRI scanner should be prominently posted outside the MRI suite and on the door leading to the scanner room.[6]

Every procedure requiring MRI should have an MRI technician assigned to the case. This individual also acts as safety officer during the procedure.[6]

When a patient who is in a traditional type of MRI suite (eg, not in the OR) experiences a cardiac arrest, resuscitation equipment should not be brought into the MRI room because this equipment may not be compatible with the MRI scanner and may create a safety hazard. The team should begin cardiopulmonary resuscitation and the patient should be moved out of zone IV.[6] Moving the patient away from the MRI scanner is a patient safety measure.

INTRAOPERATIVE MRI SAFETY

Some minimally invasive surgical procedures include the use of intraoperative MRI (eg, neurosurgery). The MRI equipment may be housed in a storage garage between two OR suites. Equipment that has been specially designed for safe use with MRI should be used for all procedures. A hybrid OR becomes zone IV when the MRI scanner is removed from the storage cage and into the OR. Warning signs must be prominently

Hybrid OR with Intraoperative MRI Equipment. Courtesy of University of Utah Health, Salt Lake City, Utah. 2018. Used with permission.

placed outside of any OR where MRI is to be used.

There are a number of risks associated with intraoperative MRI. The powerful magnetic fields generated by MRI machines can induce currents in metal implants or cause them to heat up. This can cause burns to the patient, twist wires in the implant, or cause the implant to malfunction. Objects con-taining iron can become projectiles as they are rapidly pulled toward the machine. The health care organization should identify risks for injury and complications associated with intra-operative MRI and establish safe practices.[6]

Challenges to address include the following:

- Equipment compatible with MRI
- Safety training before any team member is assigned to work with intraoperative MRI
- A safety checklist and time out procedures to ensure proper preparation of the environment
- Screening tools for MRI personnel and patients to help prevent adverse events[6]

In the event a patient experiences a cardiac arrest in a hybrid OR equipped with an MRI, the team should begin cardiopulmonary resuscitation, retract the MRI scanner back into the storage area, and then bring the resuscitation equipment and supplies into the OR to care for the patient. Moving the patient out of zone IV and moving the MRI equipment away from the patient is a safety measure.

EDUCATION AND COMPETENCY VERIFICATION

Perioperative RNs should receive initial and ongoing education and complete competency verification related to minimally invasive surgical procedures. Education facilitates the development of knowledge and skill that can improve safe patient care.[6]

Education and competency verification for minimally invasive surgical procedures should include the following:

- Selection criteria, contraindications, and risks related to distention media
- Knowledge of the use and location of instrumentation and specialized equipment
- Preparation for and response to emergency events (eg, air embolism, conversion to an open procedure)
- Reporting of adverse events[6]

Education and competency verification for computer-assisted procedures should include the following:

- Care, handling, and proper use of the robot and accompanying consoles and video equipment
- Troubleshooting equipment problems (eg, emergency shut off, equipment failure)
- Docking and undocking the robot[6]

Perioperative team members assigned to the hybrid OR should receive education about radiation safety and operating the imaging table, controls, and accessories in the hybrid OR. Team members working with intraoperative MRI should receive education about MRI safety procedures, emergency procedures, and screening protocols.[6]

POLICIES AND PROCEDURES

The health care facility should develop policies and procedures related to minimally invasive and computer-assisted procedures. These policies and procedures should be reviewed periodically and revised as needed. They should be readily available in each practice setting where they are used. Policies and procedures assist in the development of patient safety and quality assessment activities.[6]

Policies and procedures related to MIS and computer-assisted equipment should include the following:

- Management of loaned equipment and instruments

- Required qualifications and credentials for operating specific equipment or devices
- Scheduling of procedures related to availability of equipment and qualified personnel[6]

SUMMARY

Minimally invasive surgery presents some unique challenges, but the health care organization and perioperative team can meet them. A multidisciplinary team established by the health care organization should create a room configuration plan for MIS. Potential injuries associated with gas and fluid insufflation media should be identified, and practices to reduce the risk of injuries should be established. The perioperative RN, in collaboration with the anesthesia professional, should monitor the amount of fluid dispensed and collected during the procedure. The RN circulator should supervise setting up equipment for computer-assisted surgery and delegate tasks as needed. An RN circulator should be assigned to every patient undergoing an operative or other invasive procedure in a hybrid OR. The health care organization should establish safe practices for intraoperative MRI. By conscientiously following these guidelines, perioperative RNs can play a key role in creating a safe environment of care and improving outcomes and satisfaction for patients undergoing MIS.[6]

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POST-TEST

MINIMALLY INVASIVE SURGERY: CREATING A SAFE PATIENT CARE ENVIRONMENT

Multiple choice. Please choose the word or phrase that best completes the following statements.

1. Who should be included in planning the design of the minimally invasive surgical suite?
   a. Chief of surgery
   b. Chief of anesthesia
   c. Committee composed of biomedical engineers
   d. Hospital chief of staff
   e. Multidisciplinary committee
2. Which of the following gases is most commonly used for insufflation during laparoscopy?
   a. Air
   b. Carbon dioxide
   c. Helium
   d. Nitrogen
   e. Nitrous oxide
3. Which of the following is a potential complication of gas insufflation during MIS?
   a. Cardiac arrhythmias
   b. Decreased urine output
   c. Hypercarbia
   d. Gas embolism
   e. All of the above
4. All the following are precautions that should be taken with the gas insufflation system during MIS EXCEPT:
   a. Insufflation pressures should be maintained at the lowest level that achieves necessary surgical conditions.
   b. The insufflator should be placed below the level of the surgical cavity whenever possible.
   c. The insufflator and tubing should be flushed with the insufflation gas before the tubing is connected to the cannula.
   d. A hydrophobic filter should be placed between the insufflator and insufflation tubing.
   e. Alarms should be turned on.
5. Which of the following maneuvers should be implemented to treat gas embolism?
   a. Administration of inotropes
   b. Decreasing ventilation
   c. Increasing the anesthetic gas
   d. Positioning the patient in reverse Trendelenburg position
   e. Restricting fluids
6. Which of the following is a complication of fluid extravasation?
   a. Hypervolemia
   b. Hyponatremia
   c. Intraabdominal compartment syndrome
   d. Intravascular fluid overload
   e. Pulmonary edema
7. Which of the following fluids is isotonic?
   a. Glycine 1.5%
   b. Mannitol 5%
   c. Normal saline 0.9%
   d. Sorbitol 3%
8. The perioperative RN should report fluid deficits to the anesthesia professional and surgeon
   a. at regular intervals throughout the procedure.
   b. at the end of the procedure.
   c. when the patient is repositioned.
   d. every 30 minutes.
9. Which of the following precautions should be taken when lasers are used for endoscopic procedures?
   a. The laser catheter sheath and laser fibers should be inspected for damage before use.
   b. The lengths of the catheter sheath and laser fiber should be confirmed before the procedure.
   c. The laser catheter sheath and laser fibers should be inspected for damage after use.
   d. The laser catheter sheath and laser fibers should be inspected every time they are removed from the patient.
   e. All of the above

10. How many perioperative team members are needed to properly dock the patient cart during computer-assisted surgery?
    a. 1
    b. 2
    c. 3
    d. 4

11. Which of the following meet the criteria for a hybrid OR?
    a. An OR equipped with dedicated imaging equipment
    b. An OR with portable imaging equipment
    c. A radiology suite with an anesthesia machine
    d. All of the above

12. Which of the following categories of patients should be assigned an RN circulator for procedures in a hybrid OR?
    a. Patients with American Society of Anesthesiologists physical status 3 or higher
    b. Patients receiving sedation or anesthesia
    c. Patients undergoing procedures lasting more than 1 hour
    d. Every patient undergoing an operative or other invasive procedure

13. Which of the following zones around an MRI machine contains the scanner room itself?
    a. Zone 1
    b. Zone 2
    c. Zone 3
    d. Zone 4

14. In what order should these actions by the perioperative team occur if a patient experiences a cardiac arrest during a procedure in a hybrid OR with an intraoperative MRI in use?
    1. Resuscitation equipment should be brought into the room.
    2. The MRI scanner should be moved back into the garage storage area.
    3. The team should begin cardiopulmonary resuscitation.
    a. 1, 2, 3,
    b. 3, 2, 1
    c. 1, 3, 2
    d. 2, 3, 1

POST-TEST ANSWERS

MINIMALLY INVASIVE SURGERY: CREATING A SAFE PATIENT CARE ENVIRONMENT

1. e
2. b
3. e
4. b
5. a
6. c
7. c
8. a
9. e
10. b
11. a
12. d
13. d
14. b