Pediatric Laparoscopy

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Minimally invasive surgery (MIS) is one of the most rapidly developing surgical technologies to date. State-of-the art ORs are being built or redesigned solely for the purpose of performing minimally invasive procedures. As a result of advances in surgical techniques, new laparoscopic equipment is being created and introduced almost daily. In the past 10 years, MIS has replaced many traditional surgical procedures in the general adult population. This phenomenon also has started to change the way pediatric surgery is being performed.

Although in its infancy when compared to the advances in adult MIS, the field of pediatric laparoscopic surgery is on the rise, fueled by an upsurge in pediatric surgical techniques. Pediatric surgeons are undertaking new methods to perform traditional open procedures. Many pediatric MIS surgery programs are new, so they have the unique opportunity to combine virtual reality surgery and robotics with the latest technology and instrumentation.

The demand is high for perioperative nurses who are skilled specifically in laparoscopic procedures. Acting in the role of preceptors, these highly skilled nurses serve as resources to other perioperative staff members and assist in updating and troubleshooting equipment. Ongoing education and training is crucial to ensure that perioperative nursing staff members are aware of the special needs of pediatric patients undergoing laparoscopic procedures as well as to assist staff members in maintaining competency.

Setting Up a Pediatric MIS Program

Perioperative nurses face many challenges when setting up a pediatric MIS program. Although smaller laparoscopic instruments now are being designed, locating appropriately sized instruments and equipment that will accommodate the pediatric patient can be difficult. Pediatric MIS surgical instruments may not be readily available because of the limited number of companies producing instruments specifically for pediatric patients.

Health care facilities that have many credentialed surgeons receive numerous

ABSTRACT

SIGNIFICANT DEVELOPMENTS in minimally invasive surgery (MIS) for the adult population have led to increased application of MIS techniques for pediatric patients.

LAPAROSCOPY IS THE MOST COMMON MIS procedure used in pediatrics. Traditional surgical procedures that are now being performed laparoscopically include gastrostomy, pyloromyotomy, and repair of congenital diaphragmatic hernia and imperforate anus.

ALL PERIOPERATIVE TEAM MEMBERS must be prepared to provide appropriately sized instruments and equipment to facilitate use of MIS techniques in the pediatric population and must ensure safe patient care to achieve optimal patient outcomes. *AORN J* 88 (August 2008) 211-236. © AORN, Inc, 2008.

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requests for particular laparoscopic instruments. It becomes difficult, time consuming, and expensive to stock all the different types of disposable and nondisposable laparoscopic instruments at a facility.

Instrument consistency and limited OR budgets also are factors that have to be considered when purchasing MIS instruments. Purchasing instruments from only one company can be advantageous because the correct handles and inserts are available for procedures, which helps decrease set-up time as well as reduce the scrub person's anxiety when assembling instruments for use. Furthermore, keeping instrumentation consistent can help in the educational process for both nursing and central services personnel. Consequently, it is preferable to have a core group of individuals making decisions for the surgical team and keeping inventory stocked accordingly.

In the ever-changing world of health care and medical equipment, it is imperative that facilities stay aware of the newest laparoscopic equipment available. These new products should be used for trial periods at the facility to determine whether they are safe for the patient, user-friendly for staff members, and cost-effective for the facility. Purchasing surgical instruments becomes a negotiation between the health care facility and the various vendors. Which instrument should be used, which is best for the specific surgical procedure, and which is more cost-effective for the facility are just a few of the questions that need to be asked. Perioperative nurses play an important role in helping to determine and evaluate the required surgical needs of the facility's surgeons and patient population.

Another challenge that perioperative nurses face when establishing a pediatric MIS program is orientation and continuing education of all MIS team members. This rapidly changing specialty requires that all nursing team members be equally educated. Finding the time and resources to accomplish this is an ongoing challenge.

When surgery is indicated, the next step is to decide which surgical approach would be appropriate for the pediatric patient and which would provide the best surgical outcome.

Indications and Patient Selection

When surgery is indicated, the next step is to is for the surgeon to decide which surgical approach would be appropriate for that specific pediatric patient and whether the traditional open procedure or the laparoscopic approach would provide the best surgical outcome. Specific parameters for the pediatric patient need to be met and monitored during surgery to ensure the delivery of safe, high quality patient care. A positive patient outcome is the ultimate goal, whether the surgery is diagnostic, curative, or palliative.[1]

Benefits of the laparoscopic approach include

- better visual access and exposure for the surgeon,
- reduced adhesion formation,
- decreased postoperative pain,
- decreased length of hospitalization, and
- improved cosmetic effect.

Disadvantages of MIS in the pediatric patient may include

- risk of intra-abdominal injuries,
- risk of gas embolism,
- risk of hemorrhage,
- increased cost of specialized pediatric MIS instrumentation, and
- increased intraoperative time.[2]

Furthermore, the surgeon may not be able to perform the procedure effectively using the MIS technique, and ultimately, may have to perform the traditional open procedure.

Laparoscopy is contraindicated in patients who are hemodynamically unstable or in patients with known pelvic disease.[2] Some pediatric patients (eg, premature infants) may not be good candidates for laparoscopic surgery. These tiny and fragile patients may not tolerate the increased intra-abdominal pressure or required Trendelenburg position because of their compromised cardiovascular, respiratory, and thermoregulatory systems.

ANESTHESIA CONSIDERATIONS

One of the most important aspects to understand about pediatric laparoscopic surgery is the physiologic responses that can occur while the patient is under anesthesia. Anesthesia risks are minor for healthy children undergoing routine laparoscopic procedures.[3,4] The challenge for anesthesia care providers arises when surgeons perform laparoscopic procedures on neonates, infants, children, or adolescents who have complex coexisting diseases. Matters of concern for anesthesia care providers are related to the wide variations of ages and body sizes of pediatric patients and the physiologic compromise that may occur during laparoscopic procedures as a result of positioning and intra-abdominal insufflation.

Carbon dioxide (CO_2), a colorless gas that is absorbed into the blood, is injected into the abdomen to expand the abdominal cavity during laparoscopy thus improving visibility. Randomized clinical trials, the cornerstone of evidence-based practice, have been conducted in adults to evaluate cardiovascular and respiratory impairment resulting from CO_2-induced pneumoperitoneum insufflation and the need to place the patient in a head-down position. The physiologic consequences of achieving pneumoperitoneum in pediatric patients have not been rigorously studied and cannot be extrapolated from adult trials. Attempting to replicate the same clinical trials in pediatric patients remains a challenge, especially in neonates and infants. As laparoscopic procedures in the pediatric population continue to evolve, randomized clinical trials will need to be conducted to improve outcomes.

ANESTHETIC PREOPERATIVE EVALUATION. A thorough preoperative patient evaluation is required for predicting anesthesia and surgical risks. The American Society of Anesthesiologists (ASA) created the Physical Status Classification system to assess the patient's overall health before surgery (Table 1). Assigning a particular physical status classification number helps the anesthesia care provider determine the potential risks associated with laparoscopic surgery for a particular pediatric patient.

PREOPERATIVE SEDATION. The stress of hospitalization and the impending surgical procedure affects a pediatric patient and his or her parents. Addressing preoperative anxiety is the first step to ensuring successful induction of anesthesia. During the preoperative visit, the anesthesia care provider evaluates the pediatric patient's medical condition. It also is important for the anesthesia care provider to assess the psychological status of both the child and the parents. If the concerns of the child and parents are addressed, then the child will be less anxious, less likely to require preoperative sedation, and more cooperative during induction of anesthesia.[5]

The decision to administer a preoperative sedative depends on many factors, including

- the child's age and emotional state,
- the child's and parent's preoperative preparation, and
- the parent's state of mind and education.

Educating the pediatric patient and his or her parents about what to expect can make the OR environment less threatening and stressful. Taking all of these factors into consideration, the anesthesia care provider determines whether it is appropriate for a patient to receive a preoperative sedative.

TABLE 1
American Society of Anesthesiologists (ASA) Physical Status Classification[1]

ASA 1	A normal, healthy patient
ASA 2	A patient with mild systemic disease
ASA 3	A patient with severe systemic disease
ASA 4	A patient with severe systemic disease that is a constant threat to life
ASA 5	A moribund patient who is not expected to survive without the surgery
ASA 6	A patient declared brain-dead whose organs are being removed for donor purposes

1. ASA physical classification system. American Society of Anesthesiologists. http://www.asahq.org/clinical/physicalstatus.htm. Accessed June 23, 2008.

Peripheral venous access must be established before the start of the procedure because increased abdominal pressure may decrease blood return to the heart and cause compression of the vena cava.

Peripheral venous access. Compression of the vena cava may result because of increased intra-abdominal pressure caused by a decrease in blood return to the heart. Therefore, peripheral venous access must be established before the start of the procedure.

Anesthetic technique. Currently, there is no ideal anesthetic technique that can be used in laparoscopic surgery for all patients. Local, regional, and general anesthetic techniques have all been used for adults undergoing laparoscopic procedures. In the pediatric population, however, general anesthesia is the technique of choice. General anesthesia is preferred because typically a child lacks the ability to cooperate during regional anesthesia and also because general anesthesia allows the patient's airway to be secured and controlled and allows monitoring of end-tidal CO_2 during the critical stages of pneumoperitoneal insufflation.

By controlling ventilation, the anesthesia care provider is able to assess the adequacy of ventilation and maintain normocarbia. Another advantage of general anesthesia is minimizing the risk of injury from the child moving around. Generally, nitrous oxide is avoided because of the potential for flammability and bowel distension.[4]

Physiological changes affecting anesthesia. Anesthetic management of the pediatric patient undergoing laparoscopic surgery requires an understanding of the effects of CO_2 insufflation and increased intra-abdominal pressure on the preexisting pathophysiological status of the patient's respiratory, cardiovascular, renal, and gastrointestinal (GI) systems. Important factors such as patient positioning, length of surgery, and insufflation pressures also can adversely influence respiratory, cardiovascular, renal, and GI physiology.

Respiratory system. Pneumoperitoneum, increased serum CO_2 partial pressure, and placing the patient in the Trendelenburg position produce significant physiologic consequences in the pediatric patient during laparoscopic procedures. The chest wall of neonates and infants is pliant, and chest muscles are immature. The ribs are positioned horizontally and are more pliable than those of adults. Because neonates and infants are diaphragmatic breathers, their ventilation can be significantly impaired by anything that hinders movement of the diaphragm, which usually occurs during pneumoperitoneal insufflation. Patients with decreased pulmonary function tend to have a low tolerance for CO_2 pneumoperitoneal insufflation. Preoperative evaluation and vigilant intraoperative monitoring, however, help ensure that the majority of patients with impaired pulmonary function undergoing laparoscopic procedures will do well.[2]

Neonates and infants also are more prone to gastric distention. Any deviation from normal diaphragmatic function can result in compromised respirations because the chest wall cannot adjust accordingly. The anesthesia care provider may need to use higher inspiratory pressure to distend the lungs, and therefore, it is suggested that cuffed endotracheal tubes be used.[4] During pneumoperitoneal insufflation, rapid absorption and accumulation of CO_2 through the peritoneal cavity into the circulation can cause hypercarbia, respiratory acidosis, tachycardia, and hypertension.[2,6-8] Monitoring end-tidal CO_2, lowering the intra-abdominal pressure, and managing hyperventilation reduces the risk that respiratory acidosis will occur.[8,9]

The Trendelenburg position intentionally displaces the abdominal contents cephalad but restricts diaphragm movement, decreases functional capacity, reduces chest wall compliance, and compromises ventilation, all of which lead to hypercarbia and hypoxemia.[10] Elevation of the diaphragm may change the position of the endotracheal tube, which can result in endobronchial intubation. The lower lobes of the lung may not be able to expand completely, which can result in aggravation of hypoventilation and hypoxia.[10]

In the immediate postoperative period, shoulder pain can occur because of phrenic nerve irritation that results from retained intra-abdominal CO_2 under the diaphragm. Thus, it is important for the surgeon to allow as much of the intra-abdominal CO_2 as possible to escape before removal of the final trocar. Postoperative nausea and vomiting also are considered side effects of retained intra-abdominal CO_2.[4,11-13] Excessive CO_2 may remain in the body for as long as three hours after the procedure. It is important for postanesthesia care unit (PACU) nurses to be aware of this when assessing postoperative pain, nausea, and vomiting and before administering any narcotics because narcotics and sedatives depress the patient's respirations, which may worsen any hypercarbia and hypoxemia that are present.

CARDIOVASCULAR SYSTEM. The hemodynamic changes that occur during laparoscopic procedures usually are tolerated well and without consequences in healthy patients; however, adverse effects can occur in patients who have a compromised cardiovascular system. Increased intraperitoneal pressure can compress the inferior vena cava, decrease venous return to the heart, and decrease cardiac output. The Trendelenburg position usually worsens this condition. Pediatric patients with preexisting compromised ventricular function or intracardiac shunting may not tolerate laparoscopic surgery well and may require additional monitoring and anesthetic consideration, such as using lower pneumoperitoneal pressure and avoiding use of the Trendelenburg position if possible. Young children have a higher level of sensitivity to vagal tone during insufflation of CO_2, and peritoneal stretching can cause vagal nerve stimulation, bradycardia, hypotension, and asystole if not treated promptly.[6,13,14]

RENAL AND GI SYSTEMS. The kidneys of the neonate are not fully developed and the renal structures are immature. The kidneys in an infant are completely developed; however, glomerular filtration tubular capacity is below adult values and does not reach maturity until a child reaches approximately one to two years of age. Increased intra-abdominal pressures decrease renal blood flow, which can lead to a decrease in urine output, particularly in a neonate. Decompressing the stomach allows for maximum visual access. It also prevents insertion of a trocar into a stomach inflated with CO_2. The anesthesia care provider decompresses the patient's stomach by inserting a wide-bore, orogastric or nasogastric (NG) tube.

To minimize shoulder pain that can occur because of phrenic nerve irritation from carbon dioxide retained under the diaphragm, the surgeon allows much of the intra-abdominal carbon dioxide to escape before removing the final trocar.

PERIOPERATIVE NURSING CARE OF THE PEDIATRIC PATIENT

The expression "the pediatric patient is not a small adult" is noteworthy because many issues and concerns that are not normally associated with adolescent and adult surgical patients must be dealt with before a pediatric patient enters the OR. Nursing care of the pediatric patient includes a wide range of responsibilities that are based on the nursing process and on AORN standards of practice. A team approach is vital for ensuring positive patient outcomes. Perioperative nursing care focuses on a comprehensive preoperative patient assessment so that an age- and size-specific plan of care can be developed for the pediatric patient (Table 2).

Throughout the perioperative period, perioperative nurses act as patient advocates. This role encompasses providing patient comfort

TABLE 2
Nursing Care Plan for Pediatric Patients Undergoing Laparoscopic Surgery

Diagnosis	Nursing interventions	Measurement criteria	Outcome statement
Risk for difficulties with airway management/ineffective breathing patterns related to creating a pneumoperitoneum	• Reviews and reports deviations in preoperative pulmonary function studies and arterial blood gas studies. • Identifies factors associated with an increased risk for compromised respiratory status (eg, appropriate carbon dioxide insufflation settings). • Monitors respiratory status changes and uses monitoring equipment to assess pulmonary function. • Evaluates postoperative respiratory status and provides supplemental oxygen if needed.	The patient exhibits signs of effective breathing patterns as evidenced by oxygen saturation values within the expected range and breath sounds free of adventitious sounds.	The patient's pulmonary function is consistent with or improved from baseline and respiratory rate and arterial oxygen saturation are within expected ranges.

Risk for hypothermia related to exposure to the perioperative environment, patient age, and exposed body surface	• Ensures that the patient's body temperature is monitored throughout the perioperative period.
	• Implements thermoregulation measures, including
	  ◦ increasing the ambient room temperature, as appropriate,
	  ◦ prewarming the patient for a minimum of 15 minutes before anesthesia induction,
	  ◦ placing a pediatric temperature-regulating blanket on the patient,
	  ◦ circulating temperature-controlled water through energy transfer pads adhered to the patient's skin,
	  ◦ using IV and irrigation solution warmers according to manufacturer instructions, and
	  ◦ placing a stockinette cap on the infant's head and wrapping the infant's extremities with cotton cast padding to help minimize skin exposure as much as possible.
	• Evaluates response to thermoregulation measures.
		The patient's core body temperature remains in the expected range throughout the perioperative experience.	The patient is at or returning to normothermia at the conclusion of the immediate postoperative period.

Anxiety and compromised family coping related to the stress of surgery	• Determines patient and family member knowledge levels, identifies barriers to communication, and assesses readiness to learn. • Ensures that family members are involved in care and receive age-appropriate teaching about the sequence of events, treatment options, and discharge expectations. • Provides oral and written instructions for anesthesia, the surgical procedure, and discharge based on age and identified need. • Ensures that a parent is present during induction, if desired and permitted by policy. • Elicits family members' perception of anesthesia and surgery.	The patient, if old enough, and family members verbalize understanding of anesthesia, the sequence of events, and expected outcomes and demonstrate decreased anxiety throughout the perioperative period.	The patient, if old enough, and family members demonstrate knowledge of the physiological and psychological responses to the perioperative experience and knowledge of discharge care.

and ensuring patient safety. Nursing activities are focused on assessing, planning, implementing, evaluating, and reassessing care provided. Monitoring the patient's physiologic response to surgical and anesthetic interventions, preventing thermal injury, and providing emotional support and comfort to the patient's family during surgery are just a few of a perioperative nurse's responsibilities.

Planning for and gathering necessary equipment, instrumentation, and medications are key factors in ensuring a positive patient outcome. It is important to consider the size and age of the patient, the procedure to be performed, and the surgeon's preferences. To avoid unnecessary delays, preparation of the surgical suite is essential for reducing both anesthesia and surgical times. The circulating nurse must be constantly alert for technological difficulties involving the video monitors and equipment because one small glitch at the wrong time could be devastating for a pediatric patient. The circulating nurse has the added responsibility of maintaining safety for the entire surgical team. There are a greater number of safety hazards in the room because of the movement of booms or towers and monitors and an increased number of power cords associated with the same.

The circulating nurse confirms the surgical site with the parents or legal guardian and the patient, if the patient is old enough to understand the site-verification process.

Preoperative Nursing Care

Patient assessment begins with a review of the patient's medical record to determine whether the patient has a current history and physical examination; medications have been reconciled and signed off; the appropriate laboratory results have been documented (eg, the hospital policy regarding pregnancy test for minors before a surgical procedure has been followed); and radiology reports are available. The preoperative nurse then gives a hand-off report to the circulating nurse. The circulating nurse can obtain additional information from the patient's family members and from other specialty health care providers, especially for patients arriving in perioperative services from an intensive care unit (ICU).

When interviewing the patient and his or her family members, the circulating nurse confirms the patient's medical history, the anticipated procedure, and any additional health questions that may need clarification. Verifying the patient's identity with the parents, the patient's identification bracelet, and the medical record is very important. The circulating nurse also confirms the surgical site with the parents or legal guardian and the patient, if the patient is old enough to understand the site-verification process. The circulating nurse verifies that the anesthesia and surgical consents have been properly administered and are in the patient's medical record. The surgeon or a designated surgical resident marks the surgical site in cooperation with the patient's parents or legal guardian.

Appropriate and thorough preoperative education for the patient and family members is vital. If the patient is old enough, it is important to include the patient in this process whenever possible. Discussing expectations and providing emotional support helps develop a trusting relationship and alleviate unnecessary anxieties.

Room preparation. Before the start of the procedure, the circulating nurse and scrub person gather all necessary supplies, equipment, and instruments of appropriate size for the patient's procedure. The circulating nurse reviews the surgical procedure preference checklist to ensure that the following items are present and functioning correctly:

- video camera equipment,
- flat-screen video monitors,
- fiberoptic light source with functioning light bulb, and
- full CO_2 insufflation tank with pressure settings set as low as possible.

To ensure patient safety, the circulating nurse

Monitoring a pediatric patient's temperature and maintaining normothermia throughout the perioperative period is critical for all pediatric patients, especially neonates and infants who have immature heat-regulating systems.

checks the insufflation machine's pressure settings before the start of the procedure. The circulating nurse also positions the flat-screen video monitors to allow optimal visual access by the surgeon and his or her assistant.

The circulating nurse and scrub person complete sponge, needle, and instrument counts before the patient enters the OR. Maintaining electrosurgical safety during laparoscopic procedures is of the utmost importance in preventing electrosurgical burns. One method for assessing insulation failure when using the monopolar electrosurgical unit (ESU) is to check for defects by using an insulation scanning device before the start of the procedure. The scrub person uses the sterile probe to scan each laparoscopic instrument that will be used for electrosurgery. Scanning instruments helps detect microscopic insulation cracks that could cause an electrical current to stray from the instrument to nearby tissue or organs, thereby causing an electrical burn. The scrub person passes all scanned instruments with flaws in the insulation off the field and the circulating nurse obtains replacements before the procedure starts. The circulating nurse and scrub person also ensure that all supplies, equipment, and instruments necessary to emergently convert an MIS procedure to an open approach are immediately available.

Maintenance of thermoregulation. Unintended hypothermia or hyperthermia can result in severe consequences, especially in the younger pediatric population. Monitoring a pediatric patient's temperature and maintaining normothermia throughout the perioperative period is important for all pediatric patients but especially for neonates and infants who have immature heat-regulating systems. Neonates and infants cannot regulate their temperatures, nor sustain their body temperature in a cold external environment. They are vulnerable to heat loss through evaporation, conduction, convection, and radiation. Infants and children experience excessive heat loss due to their body surface area that is large in proportion to their body weight.

The circulating nurse may increase the room temperature to warm the ambient air in the OR. A number of pediatric surgical suites have built-in heating panels that can raise the room temperature around the OR bed quickly and keep it constant. Prewarming the patient for a minimum of 15 minutes before anesthesia induction is an option to help prevent hypothermia.[15] The circulating nurse may place temperature-regulating blankets over the patient while the patient is on the OR bed. Circulating temperature-controlled water through energy transfer pads adhered to the patient's skin is a method to cool or warm patients.[15] To prevent heat loss, the circulating nurse may wrap the patient's arms and legs with cotton cast padding and cover an infant's head with a stockinet cap.

The circulating nurse should provide the scrub person with irrigation fluids warmed to body temperature and give the anesthesia care provider warmed IV solutions. The anesthesia care provider may use an IV solution warmer to continuously warm IV solutions as they are infused and may warm and humidify the airway. A majority of mechanical insufflators currently in use dispense cold CO_2 into the peritoneal cavity, which contributes to the risk of hypothermia. Another method to minimize intraoperative hypothermia, therefore, is to warm the insufflation gas.[4,15]

Hyperthermia also is a risk for pediatric patients, especially neonates and infants. Heat released from the light transmitted via the telescope can cause progressive hyperthermia when working in a small area, such as the chest cavity.[4]

Intraoperative Nursing Care

After the patient has been anesthetized, the anesthesia care provider administers preoperative antibiotics, if indicated and requested by the surgeon. If directed by the anesthesia care provider or surgeon, the circulating nurse inserts an acetaminophen suppository for postoperative analgesia before the initial incision is made. The circulating nurse also provides the surgeon with a local anesthetic to infiltrate the surgical sites before insertion of the trocars.

Prevention of intra-abdominal injury. In infants and children, the bladder is considered to be an intra-abdominal organ because infants and children have shallow pelvises. It is important to empty the bladder in pediatric patients before insertion of a trocar to avoid bladder injuries. Before the procedure is started, the circulating nurse performs the Credé maneuver, which entails pressing down on the abdomen to empty the bladder manually.[4,12,14] The circulating nurse should discuss with the surgeon and anesthesia care provider the need to insert an indwelling urinary catheter before laparoscopic procedures. Usually, the circulating nurse removes the catheter at the end of the procedure and then records the amount and color of urine on the anesthesia record and on the intraoperative nursing record.

Prevention of venous stasis and deep vein thrombosis. Because of immobility, venous stasis and deep vein thrombosis (DVT) are associated risks for any patient undergoing a lengthy surgical procedure. The type of prophylaxis that can be used (ie, mechanical, pharmacological, both) is determined by preoperatively identified risk factors. Collaboration between the anesthesia care provider, surgeon, and circulating nurse is important to establish the appropriate method of prophylaxis for each patient.

Problems with coagulation ordinarily are treated using a pharmacological approach (eg, low molecular weight heparin).[16-18] Guidelines for the use of anticoagulation therapy vary from patient to patient. To help prevent DVT, the surgeon may instruct the anesthesia care provider to administer a one-time dose of subcutaneous heparin.

Thromboembolic disease (TED) hose and pneumatic sequential compression devices (SCDs) help decrease venous stasis by applying external compression to the legs.[16-18] The application of SCDs in pediatric patients is determined on an individual basis; TED hose and SCDs may not be available for pediatric patients of all ages and sizes. In prolonged laparoscopic procedures, TED hose and SCDs are recommended for adolescents and young adults. If used, it is recommended that the SCD sleeves be applied and the device be turned on before induction of anesthesia.[16,18,19]

Positioning pediatric patients for any surgical procedure begins with an assessment of the patient's age, weight, and height and the type and length of the procedure.

Positioning for Laparoscopic Procedures

Positioning pediatric patients for any surgical procedure begins with an assessment of the patient's age, weight, and height and the type and length of the procedure. The perioperative nurse should inspect the patient's skin and document any abnormalities, assess for physical limitations or impaired immobility, and document findings on the intraoperative nursing record. Intraoperatively, it is important for the circulating nurse to pad the patient's bony prominences to avoid skin, muscle, and nerve damage. It also is important to avoid the hyperextension and hyperflexion of extremities to prevent nerve damage. Securing the patient's position is vital to prevent the patient from moving, slipping, or sliding off the OR bed. Changing the patient's position before, during, and after surgery should be carried out slowly to prevent unexpected hemodynamic changes. Depending on the procedure, the patient may be placed at the end of the OR bed or turned 90 degrees from the head of the bed, which allows the surgeon to stand on the side of the OR bed for the procedure.

It is important to ensure that the anesthesia care provider has access to the endotracheal tube and IVs. Care should be taken when moving the patient to ensure that the endotracheal tube is secure to prevent it from becoming dislodged. The length of the airway circuit should be long enough to reach the patient to prevent tension on the circuit. Removing the head of the OR bed can shorten the distance between the anesthesia care provider and the child's head. Whenever possible, the patient's face and endotracheal tube should be turned toward the anesthesia care provider. In this position, the anesthesia care provider has access to the endotracheal tube and can suction the patient as needed.

Whenever possible, the patient's face and endotracheal tube should be turned toward the anesthesia care provider to provide access to the endotracheal tube and allow endotracheal suctioning.

Positioning a pediatric patient for laparoscopic procedures is specific for age, size, and procedure. Typically, children and adolescents are placed in the supine, lateral, or lithotomy positions for laparoscopic procedures. In addition to the traditional positions, Trendelenburg, reverse Trendelenburg, and Fowler's modified sitting position also may be used. Modification of conventional positions may be necessary for neonates, infants, and young children.

Supine position. The supine position can be used in surgical procedures of the abdomen. When a pediatric patient is placed in the supine position on the OR bed, his or her arms can be positioned either along the side of the torso with the palms facing inward or on padded arm boards with palms facing up. When positioning the patient's arms outward on arm boards, it is important not to extend the arms to more than a 90-degree angle. Hyperextension of the arms can result in brachial plexus injury.[19-22]

Lateral decubitus position. The lateral position can be used in surgical procedures of the thoracic or flank areas. Positioning neonates, infants, and young children in the lateral position requires modification. In various procedures, the surgeon may position the child's nondependent arm over the patient's head and suspend it from an anesthesia screen or support the arm on padding materials. In some situations, the patient's arm may need to be included in the surgical field prep. An age- and size-appropriate axillary roll is used to prevent brachial plexus injury to the dependent arm and to enhance respiratory excursion. In this position, chest and diaphragmatic movement are restricted, which may impair ventilation and compromise venous return.

Lithotomy position. The lithotomy position can be used in surgical procedures of the genitourinary system. Children and adolescents can be placed in the lithotomy position by employing the use of stirrups. Infants and very young children, however, are too small to be placed in stirrups. An alternative position would be to place them in a supine, frog-leg position. Dropping the foot of the OR bed and bringing the patient to the end of the mattress allows the surgeon to stand at the end of the OR bed for the procedure.

Potential complications of placing the patient in the lithotomy position for a long period of time include venous stasis, DVT, common perineal nerve injury, and compartment syndrome of the lower extremities.[13,20,23,24] Careful padding of the legs and bony prominences is essential to avoid common perineal nerve damage and pressure sores. An additional risk for injury may include hand injuries as a consequence of fingers being caught between the hinges of the OR bed and the bed break. Placing the patient into the lithotomy position and then insufflating the abdomen with CO_2 can increase intra-abdominal pressure, which applies pressure against the diaphragm; impairs diaphragmatic motion; and decreases functional residual capacity, pulmonary compliance, and tidal volume.

Peritoneal insufflation can restrict movement of the diaphragm, reduce lung compliance, decrease functional residual capacity, and compromise blood flow to the lower extremities.

Maximizing Exposure of the Surgical Site

In addition to creating a pneumoperitoneum, other methods to maximize exposure of the surgical site include placing the patient in the Trendelenburg or reverse Trendelenburg position and using single-lung ventilation. Changing the patient's position from supine to Trendelenburg or reverse Trendelenburg allows the surgeon to attain better surgical access during laparoscopic surgery. The physiologic changes that occur during laparoscopic procedures can be exacerbated when patients are placed in these positions.[20] The Trendelenburg position displaces the abdominal contents toward the patient's head and away from the surgical field. This position increases venous return and cardiac output and can result in an increase in intracranial pressure. Peritoneal insufflation, however, can restrict movement of the diaphragm, reduce lung compliance, decrease functional residual capacity, and compromise blood flow to the lower extremities. The reverse Trendelenburg position shifts the abdominal contents toward the patient's feet. In doing so, diaphragmatic function improves but venous return and cardiac output are decreased. Compression of the inferior vena cava also may occur. Placing the patient in a steep head-up position can increase the risk of DVT.[20]

Single-lung ventilation for thoracoscopy procedures often is used to help maximize thoracic access; however, this is not always possible in neonates, infants, and small children because of their size and medical condition and the limited working space.[12] Alternative methods of maximizing thoracic access include retracting the lung with an instrument, allowing gravitational force to pull the lung away, and using "low pressure CO_2 insufflation during the procedure to aid in keeping the lung collapsed."[25(p304)]

Single-lung ventilation is not well tolerated by neonates weighing less than 4 kg. A combination of a modified lateral position, ventilation of one lung, and use of general anesthesia all contribute to ineffective lung compliance, particularly in small pediatric patients.

Surgical Skin Preparation and the Surgical Time Out

After the patient has been positioned, the circulating nurse performs the surgical skin prep using either betadine or chlorhexidine gluconate solution depending on institution policy and patient allergies. The nurse must note that chlorhexidine gluconate is not recommended for use on children younger than two months of age.

When prepping the patient, it is critical to avoid applying excessive amounts of prep solution, which can run off the patient onto the OR bed and pool underneath the body. Unsterile plastic drapes may be placed around the surgical incision to prevent fluid from pooling under the patient during surgery. Upon completion of the surgical skin prep, the circulating nurse inspects the area around the patient to ensure that no pooling of the prep solution has occurred. If not immediately removed, pooled prep solution can lead to skin irritation or burns. When using surgical skin preps containing alcohol, the scrub person ensures that sufficient drying time has been allowed before applying drapes to prevent fires from occurring.

Before the surgical procedures commences, the entire surgical team participates in the surgical time out. This includes final verification of the patient, surgical site, and procedure and acknowledgement that x-rays and implants, if needed, are available.

Basic Laparoscopic Equipment

Many hospitals have created size-specific laparoscopic instrument kits for laparoscopic procedures. These sets vary in both the diameter and length of the instruments, and they are used according to the age and weight of the patient (Table 3). Specialty kits such as a laparoscopic pyloromyotomy kit can be created for more specialized procedures to eliminate the need to open multiple instrument kits.

Advances in digital imagery and the quality of laparoscopes have improved screen images. This provides a good quality video image while still allowing the surgeon to use the smallest laparoscope available. Laparoscopes used in pediatric surgery vary in diameter (eg, 3 mm, 5 mm) and are available with either a straight or angled lens. Table 4 lists other laparoscopes available and the types of procedures in which they might be used.

For pediatric laparoscopic procedures, it is difficult to use a 10-mm laparoscope in a 3-kg infant. Constant research and development needs to be conducted in the field of laparoscopic instrumentation with particular attention paid to the design and production of smaller instruments specific for pediatric use. Basic laparoscopic equipment includes

- insufflation tubing,
- a light cord,
- a sterile video camera,
- a suction irrigator, and
- sterile antifog solution.

Creating the Pneumoperitoneum and Achieving Safe Peritoneal Access

Pneumoperitoneal insufflation in conjunction with placing the patient in the Trendelenburg or reverse Trendelenburg position are used to gain access to organs in the upper or lower portions of the abdomen. The benefits of using CO_2 include that it

- is readily available,
- is economical,
- is soluble in blood,
- is eliminated rapidly from the body, and
- inhibits combustion in the presence of electrosurgery.[6]

Drawbacks associated with CO_2 insufflation include that it increases CO_2 absorption, which can lead to hypercapnia, thereby causing acidosis; cardiovascular comprise; hypothermia when cold CO_2 is insufflated; and, on rare occasions, gas embolism.[4,6]

Achieving safe peritoneal access and avoiding trocar-associated injuries are major concerns in pediatric laparoscopic procedures. The thinness and pliability of the abdominal wall

Table 3

Laparoscopy Kits

Infant laparoscopy kit
3 mm x 20 cm instruments

Pediatric laparoscopy kit
3 mm x 30 cm instruments

Adolescent laparoscopy kit
5 mm x 30 cm instruments

Adult laparoscopy kit
5 mm x 36 cm instruments

Table 4

Laparoscopes and Procedures

1.0 mm laparoscope
Fetoscopy and some inguinal hernia contralateral explorations

2.9 mm laparoscope
Pyloromyotomies, ventricular-peritoneal shunt insertion, inguinal hernias

4 mm and 5 mm laparoscopes
Standard laparoscopic procedures

10 mm laparoscope
Procedures for adolescents and adults

in infants and children make injury to organs or vessels more likely than with adults. Entering the abdominal cavity can be achieved by using a closed or open technique. The closed technique involves penetrating the abdomen with a conical or sharp trocar. Potential complications that can occur with this method include injury to blood vessels, abdominal organs, or the intestinal tract.

Many pediatric surgeons prefer the open technique or a modification of the open technique to penetrate the abdominal wall safely. Before inserting a sharp trocar, the surgeon makes a small incision and inserts a Veress blunt-tip needle and cannula. When the surgeon has verified needle placement, he or she insufflates the abdomen with CO_2.

Selecting insufflation pressure. Studies have been performed in adults to determine safe intra-abdominal CO_2 pressures.[13,14,26,27] Replicating these same studies in pediatrics has been unsuccessful thus far. In spite of the creation of small pediatric laparoscopes and instruments that allow laparoscopic surgery in pediatric patients, manufacturers have not addressed the incongruency of using the same type of mechanical insufflators for pediatric patients that are used for adults. Safe intra-abdominal pressures in pediatric patients have not been well defined, nor have any standards been set for insufflation of the peritoneal cavity of pediatric patients. Insufflation pressures vary in neonates, infants, and children.

According to Beebe et al,

> *The surgeon selects the pressure desired in the abdomen for the surgical exposure as well as the maximal flow rate for insufflation. During the beginning of insufflation, CO_2 is initially injected at the maximal flow rate. The machine periodically stops insufflation and measures the intraperitoneal pressure. The machine automatically reduces the flow rate as it senses pressure building up in the abdomen, and then it halts it at the set pressure. Pediatric surgeons select a slow maximal flow rate (0.6 L/m) because the volume needed to be insufflated is small. A slow flow rate also reduces the severity of a CO_2 embolism if inadvertent intravascular injection occurs.*[26(p1186)]

Veyckemans states

> *[Insufflation pressures] should be kept as low as possible and monitored by the anesthesiologist. The advantages of low insufflation pressures are reduced respiratory and hemodynamic consequences of the pneumoperitoneum, easier control of CO_2 absorption by increasing alveolar ventilation, and a reduced risk of mortality in case of accidental CO_2 embolism. Insufflation is started slowly, and the flow is progressively increased up to when the desired intra-abdominal pressure (IAP) or good working conditions are obtained.*[27(p429)]

The recommendation, therefore, is initially to set insufflation pressures as low as possible while creating the pneumoperitoneum and increase the gas infusion volume slowly until visual access is maximized and normal physiology is maintained.[26,27]

Placing the trocars and cannulas. After insufflation, the surgeon removes the Veress needle and inserts the trocar and cannula into the abdominal cavity. He or she removes the trocar and inserts the laparoscope through the cannula. The surgeon performs a general inspection of the abdomen. Under direct visual access, the surgeon repeats the process when placing additional trocars. The specific location of other trocars is dependent on the procedure being performed.

Basic Laparoscopic Procedures

Numerous laparoscopic procedures now can be performed successfully in pediatric patients. These include

- laparoscopic gastrostomy,
- congenital diaphragmatic hernia (CDH) repair,
- laparoscopic-assisted repair of Hirschsprung's disease,
- laparoscopic-assisted repair of imperforate anus,
- laparoscopic Nissen fundoplication,
- laparoscopic pyloromyotomy,
- laparoscopic-assisted ventricular-peritoneal shunt insertion, and
- congenital cystic adenomatoid malformation (CCAM) resection.

Table 5 provides a list of the instruments and equipment needed for each procedure.

TABLE 5
Instruments and Equipment for Pediatric Laparoscopic Procedures

Laparoscopic gastrostomy
Basic laparoscopic kit
Basic laparoscopic equipment
Grasper x 2
4-mm or 5-mm by 20-cm, 0-degree laparoscope
3-mm or 5-mm trocars
#11 knife blade
Appropriate sizes of low-profile gastrostomy (G) tubes
G-tube dilator set
Appropriately sized U-stitch

Congenital diaphragmatic hernia repair
Basic laparoscopic kit
Basic laparoscopic equipment
5-mm mini trocar
3-mm trocars
40-mm by 20-cm, 30-degree laparoscope
3-mm by 20-mm laparoscopic grasper
#11 knife blade
Insufflation warming cable

Laparoscopic-assisted repair of Hirschsprung's disease

For an infant
Infant laparoscopic kit (disposable laparoscopic instruments are not needed when using the infant laparoscopic kit)
Basic laparoscopic equipment
4-mm by 20-cm, 30-degree laparoscope
Dissecting kit
Hegar dilators
Cystoscopy tubing (used in the place of a suction irrigator)
Self-retaining retractor ring and small hooks

For a toddler or older child
Basic laparoscopic kit
Basic laparoscopic equipment
5-mm by 30-cm, 30-degree laparoscope
5-mm short trocars x 3
Laparoscopic peanut dissector
5-mm endoscopic clip applier
5-mm endoscopic sheers
Endoscopic needle driver
5-mm vessel sealing system
Rectal nerve stimulator
Hegar dilators
Self-retaining retractor ring and small hooks
Dissecting kit

Laparoscopic-assisted repair of imperforate anus
Laparoscopic kit
Basic laparoscopic equipment
5-mm by 20-cm, 30-degree laparoscope
5-mm short trocars x 4
Laparoscopic peanut dissector x 2
5-mm vessel sealing system
Laparoscopic loop suture x 2
Endoscopic needle driver
5-mm endoscopic clip applier
5-mm endoscopic sheers
Pena rectal nerve stimulator
Weitlaner and Gelpi self-retaining retractors
Hegar dilators
Dissecting kit
Self-retaining retractor ring and small hooks
Pediatric bowel kit (have available)

Laparoscopic Nissen fundoplication
Laparoscopic kit
Basic laparoscopic equipment
4-mm by 20-cm or 5 mm by 30-cm, 0-degree and 30-degree laparoscopes
Graspers x 3
3-mm and 5-mm trocars
Veress needle
Endoscopic needle holders x 2
Endoscopic shears
Liver retractor
11 knife blade

Laparoscopic pyloromyotomy
Laparoscopic pyloromyotomy kit
Basic laparoscopic equipment
3-mm orthopedic sheathed knife
4-mm by 20-cm, 30-degree laparoscope
#11 knife blade
#20 red rubber catheter
Minor kit

Laparoscopic assisted ventricular peritoneal shunt insertion
Basic laparoscopic kit
Basic laparoscopic equipment
4 mm by 20 cm or 5 mm by 30 cm, 0-degree and 30-degree laparoscopes
#11 knife blade
7-mm introducer
5-mm grasper
5-mm trocar

Laparoscopic gastrostomy. A pediatric patient may require a gastrostomy if he or she has swallowing difficulties, is failing to thrive, has neurological impairment, or has esophageal disorders. This procedure is contraindicated if the patient has excessive peritoneal adhesions from previous surgeries or requires a planned laparotomy for other procedures.

The circulating nurse and anesthesia care provider place the patient in the supine position on the OR bed. The circulating nurse positions the flat-screen monitors at the head of the OR bed. After induction of anesthesia, the circulating nurse preps the patient's abdomen from the xiphoid process to the lower abdomen. The anesthesia care provider passes an NG tube into the patient's stomach before the start of the procedure.

A pediatric patient may require a gastrostomy if he or she has swallowing difficulties, is failing to thrive, has neurological impairment, or has esophageal disorders.

The surgeon stands on the patient's right side and after achieving the pneumoperitoneum, places the initial trocar and cannula in the umbilicus. The surgeon removes the trocar and inserts a laparoscope and then visually inspects the intra-abdominal cavity. After determining the site for the next port, the surgeon views the area through the laparoscope and places the next trocar left of the umbilicus. This is the site where the gastrostomy tube later will be placed. The surgeon then grasps the anterior wall of the stomach, pulls it up to the upper abdominal wall, and temporarily secures it there with stay sutures. The surgeon uses a 7-Fr introducer to puncture the stomach. The pneumoperitoneum may be decreased to allow easier access to the stomach, if needed. The surgeon then uses additional dilators to dilate the opening.

The surgeon may choose to use a Malecot catheter or a low-profile gastrostomy tube (ie, gastric button) for the gastrostomy. The surgeon increases CO_2 flow to regain the pneumoperitoneum, and laparoscopically verifies that the gastric button is in the correct position. The surgeon removes the cannulas and desufflates the abdomen. He or she closes the trocar sites with suture or topical skin adhesive. The scrub person dresses the gastrostomy site with gauze and places the decompression tube in the gastric button. This allows for gastric decompression until the gastrostomy site heals.

Congenital diaphragmatic hernias. Congenital diaphragmatic hernias occur in approximately one in every 2,500 births.[28] A diaphragmatic hernia is a life-threatening disorder. The lung on the affected side is not fully developed at birth because all or some of the abdominal contents are in the thoracic cavity. In addition to affecting lung development, these organs also may be compromised by their presence in the thoracic cavity. The infant may have difficulty breathing after birth. If the patient has severe breathing problems, he or she may need to be placed on extracorporeal membrane oxygenation emergently for preoperative stabilization before undergoing surgical repair.

There are two types of CDH: Bochadalek and Morgagni hernias. Bochadalek hernias are more common (ie, approximately 90% of all CDHs)[28] and involve an opening on the back of the diaphragm. This type of CDH usually occurs on the left. The abdominal contents are pushed into the thoracic cavity through the diaphragmatic defect.[29,30]

Morgagni hernias are much more rare and involve an opening in the front of the diaphragm. These hernias usually occur on the right. The liver or intestines may move up into the thoracic cavity through the diaphragmatic defect. Survival of the neonate with a Morgagni CDH depends on many factors, including the degree of fetal liver herniation into the chest and the presence or absence of other anomalies.[29] There is a slightly higher incidence of Bochadalek hernias in boys; Morgagni hernias are more common in girls.[28] Whether the CDH defect is located on the left or right, these hernias can cause poor lung development on the affected side, which in turn can lead to respiratory distress and pulmonary hypertension.

The minimally invasive surgical repair for CDH can be achieved by one of two methods: laparoscopically through the abdomen or thoracoscopically through the chest. Although the literature is sparse regarding laparoscopic repair of CDH using the abdominal approach in infants, the few articles that discuss the abdominal approach indicate that it is both effective and safe for infants.[30]

For the laparoscopic abdominal approach, the circulating nurse and anesthesia care provider move the patient to the foot of the OR bed in a supine, frog-leg position after induction of anesthesia. The surgeon stands at the foot of the bed facing the patient, while the assistant and scrub person stand to the left and right of the surgeon, respectively. The circulating nurse positions the first flat-screen monitor directly over the infant and in front of the surgeon and the second flat-screen monitor just to the left of the patient's head for the assistant.

For the thoracoscopic approach, the infant is placed in the lateral decubitus position with the affected side up after induction of anesthesia. The surgeon and the assistant stand in front of the infant, and the scrub person stands behind the infant. The first flat-screen monitor is positioned adjacent to the infant and in front of the surgeon. A second flat-screen monitor is positioned for the assistant.

The infant is secured to the OR bed to prevent him or her from shifting when the OR bed is repositioned during the procedure. To protect the infant from pressure sores, the circulating nurse ensures that all bony prominences are well padded. The circulating nurse places an appropriately sized ESU grounding pad on the infant's back. The circulating nurse then preps the infant's skin and the assistant and scrub person place the surgical drapes according to the position of the patient.

Intra-abdominal insufflation must be monitored carefully because the opening from the abdomen into the chest can cause rapid cardiovascular compromise to ensue. Preferred instrumentation for this procedure includes short instruments and laparoscopes. Port placement involves the use of two 5-mm and two 3-mm trocars. A 4-mm or 5-mm by 20 cm, 30-degree laparoscope is used in the 5-mm umbilical trocar. Instruments that are 3 mm in diameter and 20 cm in length are preferred and used in the 3-mm trocars. Making use of a reducer cap allows the second 5-mm trocar to be used as a working port for 3-mm instruments. After placement of the cannulas, the surgeon inspects the defect. If a hernia sac is discovered, the surgeon excises and removes the sac through one of the 5-mm cannulas.

Intra-abdominal insufflation diaphragmatic hernia repair must be monitored carefully because the opening from the abdomen into the chest cause rapid cardiovascular compromise to ensue.

Laparoscopic abdominal or thoracoscopic repair of a CDH instead of the traditional "open" CDH repair offers many advantages to infants who are candidates for this type of procedure. In the open procedure, the surgeon makes a large subcostal incision to expose the defect in the diaphragm. In the laparoscopic procedure, the surgeon makes several small incisions to accommodate the laparoscope and other laparoscopic instruments; consequently, the cosmetic results are more aesthetically pleasing. The benefits of using the laparoscopic approach include decreased need for postoperative pain medications, which in turn can decrease the intubation phase and the incidence of postoperative ileus.[29]

When possible, the surgeon brings together the anterior and posterior rims of the diaphragm for a primary closure using nonabsorbable, interrupted sutures. If the defect is too large for a primary closure, the surgeon may use a synthetic patch. There are many different types of mesh patches available, and usually the decision about which type to use is based on surgeon or facility preference. In some situations, a gastrostomy may be performed after the diaphragmatic hernia is repaired. Chest tubes and abdominal drains usually are not used postoperatively. If the patient should need a second procedure (eg, gastric fundoplication), laparoscopic surgery is the preferred method because it reduces the number of adhesions normally associated with an open surgical procedure.

Laparoscopic-assisted repair of Hirschsprung's disease. Hirschsprung's disease can be defined as a "congenital disorder characterized by the absence of ganglion cells in the distal bowel, which results in functional obstruction, most commonly in the newborn period."[31(p569)] The length of bowel involved can vary but usually is confined to the upper rectum or the sigmoid colon. The segment of colon where the normally present ganglion cells cease to be found is called the "transition zone."[32] This transition zone defines how much of the colon will need to be removed. The length of the colon that is affected will vary from patient to patient.

The long-established surgical treatment for Hirschsprung's disease has been to create a colostomy to decompress the dilated bowel. Several months later, in either a two-staged or three-staged procedure, the surgeon performs a pull-through procedure, whereby the colon without ganglion cells is resected and the colon with ganglion cells is mobilized and brought down and sewn to the anus.

During the last two decades, major advances have occurred in MIS and in surgical techniques for Hirschsprung's disease. The Swenson, Duhamel, and Soave pull-through procedures have all been modified to incorporate laparoscopic-assisted techniques.[33,34] Pediatric surgeons are transitioning away from traditional, open surgical repair of Hirschsprung's disease to the one-stage laparoscopic-assisted pull-through or transanal approach.[2,35]

Hirschsprung's disease is a "congenital disorder characterized by the absence of ganglion cells in the distal bowel, which results in functional obstruction, most commonly in the newborn period."

Transanal endorectal pull-through without laparoscopy permits surgical repair to be accomplished, or almost completely accomplished, through the anus. This procedure is most likely to be successful in children with a transition zone in the rectum or sigmoid colon. Although the transanal endorectal pull-through may appear ideal, the laparoscopic-assisted endorectal pull-through is, to a greater degree, a more versatile technique because it allows the surgeon to obtain biopsies from the transition zone. These biopsies help the surgeon determine the level of aganglonic cells before removal of the diseased portion of the rectum or mesocolon.

The circulating nurse turns the mattress so that the cutout portion of the mattress is at the head of the bed and then places a temperature-regulating blanket on the OR bed. After induction of anesthesia, the anesthesia care provider directs the individual placing the IV not to place it in the feet of infants and young children because the patient's feet will be included in the surgical field. The anesthesia care provider drops the foot of the OR bed and the circulating nurse and anesthesia care provider place the patient transversely at the end of OR bed in a supine position so that the surgeon can stand at the end of the OR bed during the procedure. The circulating nurse places the flat-screen monitor or video tower near the end of the bed.

The surgeon performs a circumferential prep encompassing the area from the nipples

If the rectum cannot be identified via the posterior approach in the traditional method of high imperforate anus repair, the surgeon repositions the patient supine so that a laparotomy can be performed.

to the feet. This is accomplished by placing sterile sheets and towels under the patient as he or she is rolled from side to side.

The circulating nurse and possibly another assistant may need to hold the infant as the surgeon preps. The assistant lifts the patient by the feet while the circulating nurse places an ESU grounding pad on the patient's upper back. The assistant lowers the patient's feet one at a time and the scrub person places them in sterile stockinet or wraps them with sterile nonelastic rolled gauze. The scrub person places a sterile towel near or at the nipple line. Using an extremity sheet, the surgeon and scrub person place the infant's body and legs through the hole in the drape. The surgeon now is able to turn the infant supine and prone as needed. The surgeon inserts an indwelling urinary catheter aseptically and places the catheter and bag on the sterile field.

In the laparoscopic-assisted pull-through procedure, the surgeon performs seromucosal biopsies by intraperitoneal dissection. A pathologist examines the seromucosal biopsies to determine whether ganglion cells are present. If ganglion cells are not present, this section of the colon should be removed. As the pull-through procedure progresses, the surgeon sends confirmatory biopsies from the colon being removed to verify that ganglion cells are present in the segment of colon to be sewn to the anus.

The advantages of performing a laparoscopic-assisted Hirschsprung's disease repair include a smaller incision, avoiding a colostomy, less postoperative pain, and excellent results. The application of MIS techniques to this surgical procedure has remarkably transformed the timing and consequences of surgical intervention in children with Hirschsprung's disease.[2,35]

Laparoscopic-assisted repair of imperforate anus. Several types of anorectal congenital malformations exist. The degree of complexity of anorectal malformations vary from minor to multifaceted malformations that can be associated with anomalies of the distal anus and rectum as well as urinary and reproductive structures. The latter are difficult to manage. Imperforate anus, an abnormal termination of the anorectum, is one type of anorectal malformation. The patient may exhibit a wide spectrum of clinical presentations, ranging from a fistula in the perineum to a blind-ending rectum without a fistula.[32] Common anomalies associated with imperforate anus include

- vertebral,
- anal,
- cardiac,
- tracheoesophageal,
- renal, and
- limb defects

known as VACTERL syndrome.

Imperforate anus defects range from minor, in which the defect is located near its normal anatomical position and can be treated easily, to the more complex, in which the rectum is located high in the pelvis thereby requiring major surgical intervention. The overall goals of this procedure are to separate any abnormal communications of the GI tract with the genitourinary system and to preserve bowel continence.

The traditional method of repair for a high imperforate anus, in which the rectum is higher up in the pelvis, has been the posterior sagittal anorectoplasty. In this approach, the surgeon places the patient in the prone position and makes an incision from the "coccyx to the perineal body with exposure of the external sphincter, levators, rectum, and fistula."[36(p9)] If the rectum cannot be identified via the posterior approach, the surgeon repositions the patient supine so that a laparotomy can be performed. The surgeon makes a laparotomy incision and mobilizes the colon so that it can be repositioned and brought down to create a new anus.

Over the years, the laparoscopic approach has gained recognition as a surgical option to repair the defect without performing a laparotomy or colostomy. As this surgical technique continues to evolve, however, some pediatric general surgeons may prefer to perform a colostomy along with the laparoscopic-assisted repair in certain circumstances.[2,37]

The pediatric general surgeon begins by reviewing and evaluating all clinical data available to determine whether the infant needs an initial diverting colostomy or whether a primary repair is possible. Depending on the defect, a cystoscopy may be performed before the surgical procedure to rule out associated anomalies in the urogenital system or perineum.

Intraoperative nursing care is the same as for the patient with Hirschsprung's disease. The circulating nurse prepares a separate setup if the surgeon intends to insert a central venous catheter. The circulating nurse and scrub person also prepare a separate setup if the surgeon intends to perform a cystoscopy to determine the existence of a fistula. If a fistula is present, the anesthesia care provider and circulating nurse lower the foot of the bed and move the patient to the end of the mattress, which allows the surgeon to stand at the end of the OR bed for the procedure. The circulating nurse then positions the patient in a supine, frog-leg position.

When the surgeon has completed the cystoscopy, the circulating nurse places the patient transversely at the end of the OR bed in a supine position for repair of the imperforate anus. The nurse places the flat-screen monitor or video tower with insufflator near the end of the bed. The surgeon may stand on the opposite side or at the end of the OR bed. Prepping and draping for laparoscopic-assisted imperforate anus is the same as for the laparoscopic-assisted repair of Hirschsprung's disease.

In the laparoscopic-assisted approach, the surgeon makes three small abdominal incisions and inserts appropriately sized trocars. The surgeon then insufflates the patient's abdomen and, under direct laparoscopic vision, observes the pelvic floor musculature to dissect out the rectourethral fistula. After the fistula has been divided and closed and the underlying muscles have been identified, "the rectum is pulled down and anastomosed to the center of the sphincter complex to form a neoanus. The sphincter complex is then reconstructed."[32(p9)]

One of the advantages of performing laparoscopic Nissen fundoplication is that the vagus nerve is better protected because of improved visualization with laparoscopic magnification.

Laparoscopic Nissen fundoplication. A pediatric patient may require a laparoscopic Nissen fundoplication if he or she has

- gastroesophageal reflux,
- failed medical management to prevent the symptoms of reflux,
- neurological impairment,
- failed to thrive,
- esophagitis,
- an esophageal stricture, or
- respiratory compromise.

Contraindications to laparoscopic Nissen fundoplication include the presence of excessive peritoneal adhesions or extreme hepatosplenomegaly. Patients who weigh less than 1,500 g are not good candidates for this procedure, and neither are patients in whom the surgeon anticipates the need for a planned open laparotomy for other procedures. One of the advantages of performing a Nissen fundoplication laparoscopically is that the vagus nerve is better protected because of improved ability to see the nerve with laparoscopic magnification. One of the disadvantages of performing the procedure laparoscopically is the increased incidence of dysphagia and gas bloating postoperatively.[37]

Before the procedure is started, the circulating nurse prepares a separate setup for the anesthesia care provider with a complete set of esophageal Bougie dilators. The circulating nurse and anesthesia care provider place the patient in a supine position at the end of the OR bed on a warming blanket and then secure the patient to the bed to prevent inadvertent shifting during the procedure. The circulating nurse ensures that proper body alignment is maintained and supported. The anesthesia care provider then places the bed in reverse Trendelenburg.

The circulating nurse positions the flat-screen monitors at the head of the OR bed and the surgeon stands at the foot of the OR bed. The assistant stands on the surgeon's right side and the person holding the camera stands at the surgeon's left side. The circulating nurse performs the surgical scrub from the patient's nipple line to mid-thigh.

The anesthesia care provider inserts an NG tube to decompress the stomach and dilates the esophagus with the appropriately sized dilators according to the surgeon's instructions. After achieving the pneumoperitoneum via a Veress needle, the surgeon inserts five 3-mm or 5-mm trocars into the abdomen. Reusable trocars and cannulas, which are smooth and do not have expandable sleeves, may need to be stabilized, especially in a neonate. This is accomplished by placing a 1-cm piece of red rubber catheter on each cannula sleeve and stitching them to the abdomen. This helps prevent the cannulas from migrating in or out of the patient.

The surgeon inserts the laparoscope into the cannula below the umbilicus and then inspects the intra-abdominal cavity. He or she places a liver retractor through the cannula on the patient's right side and the assistant holds it in that position during the procedure. The surgeon uses the other cannula sleeves for dissecting, suturing, and cutting instruments. He or she completely wraps the fundus around the esophagus and secures it with interrupted sutures for 2 cm. The surgeon passes the suture line through the anterior side of the fundus and then through the esophagus to the other side of the fundus before tying it. He or she secures the fundoplication to the undersurface of the diaphragm. The surgeon removes the cannulas while viewing them laparoscopically before removal of the final cannula. He or she desufflates the patient's abdomen, allowing the CO_2 used for the procedure to escape and then closes the trocar sites with suture or skin adhesive. The scrub person applies dry sterile dressings before the patient is transferred to the PACU.

LAPAROSCOPIC PYLOROMYOTOMY. Hypertrophic pyloric stenosis occurs in one in 400 live births.[36] This condition is characterized by hypertrophy of the pyloric smooth muscle, which results in gastric outlet obstruction. Typically, the condition presents as projectile, nonbilious emesis at approximately one month after birth.[36] At first, the infant may regurgitate occasionally after a feeding. As the mechanical obstruction increases, however, the vomiting begins to occur after every feeding, resulting in significant dehydration and electrolyte and acid-base disturbances. Infants who have been symptomatic for many days may develop a slight jaundice and experience weight loss.

Pyloric stenosis is a medical emergency, not a surgical emergency. The initial treatment for pyloric stenosis is to rehydrate the patient with IV fluids for 24 to 48 hours and correct the metabolic alkalosis. Metabolic alkalosis occurs from depletion of chloride, sodium, and potassium, which are all found in gastric secretions.

The surgeon and anesthesia care provider review the results of the patient's serum electrolytes before surgery because electrolyte imbalances, particularly of sodium and potassium, increase the patient's risk of complications during surgical correction of stenosis when the patient is under general anesthesia. Electrolyte imbalances should be corrected before the patient undergoes surgical repair. Vomiting can be minimized by inserting an NG tube, which in turn decreases the risk of aspiration.

Surgical treatment of pyloric stenosis is pyloromyotomy that can be performed via an open or laparoscopic approach. Steven Rothenberg, MD, developed the laparoscopic pyloromyotomy procedure in 1997. According to Zitzman,

> *A meta-analysis of laparoscopic versus open pyloromyotomy found laparoscopic pyloromyotomy to be associated with a higher*

complication rate (eg, mucosal perforation, incomplete pyloromyotomy) and similar operating times but shorter recovery times.[38(p306)]

Infants with pyloric stenosis usually are not premedicated before induction of anesthesia. Although the infant may have had an NG tube inserted preoperatively, inadequate drainage of gastric fluid is always suspected. Therefore, before induction of anesthesia, the anesthesia care provider removes the NG tube and suctions the infant's stomach several times with a large caliber, soft suction catheter to remove any remaining gastric fluid. Even though the infant has been suctioned, lingering amounts of gastric fluid may remain. To prevent aspiration, the anesthesia care provider may elect to perform an awake intubation. Another method that the anesthesia care provider may employ is a rapid-sequence IV induction. It is crucial for the circulating nurse to assist the anesthesia care provider during induction by applying cricoid pressure to prevent aspiration.

The circulating nurse and anesthesia care provider place the patient transversely on the OR bed in a supine position. After induction of anesthesia and placement of an IV catheter, the circulating nurse performs the Credé maneuver by pressing down on the patient's abdomen to manually empty the bladder. If requested by the surgeon, the anesthesia care provider administers prophylactic antibiotics before the initial incision. To reduce the need for postoperative analgesia, the anesthesia care provider may ask the circulating nurse to administer a loading dose of acetaminophen (ie, acetaminophen suppository) before the surgeon makes the incision. The nurse positions the video tower with insufflator near the head of the bed and the surgeon stands on the opposite side of the OR bed during the procedure.

The surgeon may infiltrate the trocar sites with a local anesthetic before inserting the trocars to help minimize postoperative discomfort. The surgeon makes an umbilical incision and insufflates the abdomen, after which he or she inserts a laparoscope through the umbilical incision. The surgeon then makes two small skin incisions in the upper right quadrant to accommodate a laparoscopic atraumatic grasper and a retractable blade. "A retractable blade is used to perform a longitudinal seromuscular incision and its blunt end is used in combination with a grasper to complete the myotomy."[32(p5)]

To reduce the need for postoperative analgesia, the anesthesia care provider may ask the circulating nurse to administer a loading dose of acetaminophen via a suppository before the surgeon makes the incision.

LAPAROSCOPIC-ASSISTED VENTRICULAR-PERITONEAL SHUNT INSERTION. If the patient requires management of hydrocephalus or if a premature infant experiences an intraventricular hemorrhage, a laparoscopic-assisted ventricular-peritoneal shunt insertion may be required. The presence of an infection in the patient's peritoneal cavity is a contraindication to ventricular-peritoneal shunt insertion.

The laparoscopic approach is less traumatic to the abdominal wall and peritoneum than the traditional open approach. Laparoscopy also allows the surgeon to directly view placement of the peritoneal catheter. More often than not, a ventricular-peritoneal shunt is implanted in the right parietal-occipital region. This area is preferred because it presents the most direct path to the third ventricle and because the speech center is situated on the left side of the brain.

The circulating nurse and anesthesia care provider place the patient in a supine position with the surgical side of the head turned laterally. The circulating nurse helps the anesthesia care provider place a small shoulder roll under the patient's right shoulder to slightly hyperextend the neck and shoulder. Before prepping, the circulating nurse removes the patient's hair with electric clippers. The nurse places the patient's hair in a small plastic bag and labels and tapes it to the patient's chart if this is the patient's first haircut.

The circulating nurse preps the patient's skin from scalp to mid-thigh. The neurosurgeon may inject the incisional area with a local anesthetic to help achieve hemostasis in this highly vascular area.

Working simultaneously, the neurosurgeon creates a cranial burr hole while the pediatric general surgeon inserts a laparoscope into the abdominal cavity and visually inspects the abdomen. After inserting an additional 5-mm trocar at a selected entry site, the general surgeon removes the trocar and inserts the laparoscope through the cannula. The general surgeon laparoscopically confirms the desired size by external palpitation of the abdominal wall. In the meantime, the neurosurgeon irrigates the peritoneal catheter with either normal saline or an antibiotic solution. As with all silastic or implanted materials, the scrub person ensures that the ventricular catheter, valve, and peritoneal catheter are handled as minimally as possible.

After removing the patient's hair with electric clippers, the nurse places the patient's hair in a small, labeled plastic bag and tapes it to the chart if this is the patient's first haircut.

The neurosurgeon inserts the ventricular catheter into the ventricle and collects cerebrospinal fluid for laboratory studies. The neurosurgeon then connects the distal ventricular catheter to the selected valve. The neurosurgeon advances the peritoneal catheter through a small tunnel made in the subcutaneous tissue down the right side of the neck and anterior chest and then pulls the catheter toward the abdomen. Viewing the area laparoscopically, the general surgeon uses a 7-Fr catheter introducer to channel the distal peritoneal catheter into the peritoneal cavity. This approach confirms intra-abdominal cavity placement via the laparoscope.

After removing the laparoscope and desufflating the patient's peritoneal cavity, the general surgeon closes the trocar sites. At the same time, the neurosurgeon attaches the proximal peritoneal catheter to the distal valve and then closes the scalp incision.

Congenital cystic adenomatoid malformation resection. The diagnosis of CCAM can be made prenatally by ultrasound. The findings may reveal either a cystic mass or a solid lung tumor. A CCAM is classified into one of three categories: type I and type II CCAMs appear as cystic, fluid-filled masses, while a type III CCAM appears as a solid mass.[28] Most CCAMs are manageable after the overall assessment and diagnosis are made. If the lesions are small and the infant is stable with no signs of respiratory distress, surgical intervention may not be needed immediately after birth. Surgical intervention may be warranted, however, if the mass is large and causing airway obstruction or mediastinal shift.

Pediatric surgeons strive to perform these resections early to minimize the risk of infection and bleeding and to lessen the possibility of various types of cancers later in life if the CCAM is left unresected. Performing this procedure before the infant reaches six months of age decreases the chances of the CCAM growing, and thereby allows normal lung tissue to develop.

Initially, these procedures were performed through a small thoracotomy incision, which required muscle layers to be divided and the intercostal space to be entered. Currently, pediatric surgeons perform this procedure thoracoscopically as opposed to performing an open thoracotomy.

The surgeon marks the surgical site before the patient is brought into the OR. After the IV and endotracheal tubes are placed, the circulating nurse and anesthesia care provider place the patient in the lateral decubitus position onto the patient's nonsurgical side. They secure the patient in the lateral position to prevent the patient from slipping off the OR bed as it is rotated from side to side. Rotating the OR bed as needed throughout the procedure allows gravity to act as a natural retractor. In order to safeguard bony prominences, the circulating nurse places protective padding at all pressure points.

Single-lung ventilation is preferred; therefore, the anesthesia care provider performs contralateral lung intubation. The circulating nurse preps the patient after which the scrub person places the surgical drapes. After the team performs a surgical time out, the surgeon infiltrates each trocar site with a local anesthetic before making the incision. After placing a 5-mm trocar for use with a 4-mm by 18-cm, 30-degree thoracoscope, the surgeon uses very low CO_2 insufflation to help deflate the affected lung. The surgeon places two trocars (ie, one 5-mm, one 3-mm) for working ports for 3-mm by 20-cm laparoscopic graspers. He or she seals smaller vessels with a 5-mm electrosurgical vessel sealing system and ties off larger vessels with 3-0 silk ties using intracorporeal knot tying and a 5-mm laparoscopic multi-clip applier. The surgeon brings the specimen out through one of the larger trocar sites and the circulating nurse sends the specimen to pathology.

When the procedure is completed and before the cannulas are removed, the surgeon makes a final inspection of the abdominal cavity. The surgeon desufflates the abdomen, allowing the CO_2 escape to minimize postoperative referred pain from retained CO_2.[6,13] The surgeon inserts an appropriately sized chest tube and then removes all cannulas laparoscopically before removing the final cannula. He or she closes the trocar sites, asks the anesthesia care provider to reinflate the lung, and closes the incisions with suture or topical skin adhesive. As the patient is returned to the supine position, the surgeon, anesthesia care provider, and circulating nurse assess the patient for any visible signs of injury or pressure. At the end of the procedure, the surgeon may ask the circulating nurse to remove the urinary catheter. The circulating nurse documents the urine output on the intraoperative nurse's record and informs the anesthesia care provider and the PACU nurse of the amount of urine discarded. The anesthesia care provider stabilizes and extubates the patient and, along with the circulating nurse, transfers the patient to the PACU.

> ***Securing the patient safely on the OR bed is imperative because the surgeon may have the anesthesia care provider rotate the OR bed during the procedure to allow gravity to act as a natural retractor.***

Postoperative Nursing Care

The circulating nurse calls the receiving unit (eg, PACU, ICU) with preparatory information before transporting the patient. Planning ahead ensures a smooth transition, particularly if a ventilator, central line monitors, or any other nonstandard monitoring devices are required.

At the completion of the surgical procedure, the circulating nurse stands by the patient's side to assist the anesthesia care provider with extubation. Pediatric patients are susceptible to airway complications such as laryngospasm, aspiration, and apnea. The circulating nurse assists the anesthesia care provider in maintaining the patient's airway as needed by assisting with suctioning the patient, administering supplemental oxygen, and positioning the patient on his or her side as warranted.

Before transferring the patient to the PACU, the circulating nurse makes sure that a supplemental oxygen tank and an appropriately sized face mask are on the transfer bed (eg, stretcher, gurney, crib, bed). The circulating nurse also ensures that a portable transport monitor capable of measuring oxygen saturation is available for transport. The circulating nurse also ensures that a laryngoscope and appropriately sized blades and endotracheal tubes are brought along if the patient is being transferred directly to the ICU from the OR. The anesthesia care provider ensures that the patient's postoperative pain is controlled while in the OR and before transfer to the PACU. Providing relief of pain and discomfort helps decrease postoperative anxiety and agitation.

The circulating nurse and anesthesia care provider transport the patient to the PACU or to the ICU depending on the patient's status. On arrival in the PACU or ICU, the circulating nurse helps the receiving nurse connect the patient's oxygenation saturation probe, electrocardiogram leads, and blood pressure cuff to the appropriate monitors. When the patient is stable, the circulating nurse verifies the patient's name and hospital identification number with the receiving nurse, and then the circulating nurse and anesthesia care provider give a hand-off report to ensure that all preoperative and intraoperative information is relayed to the receiving nurse.

Robotic-assisted surgical systems are ideal for small spaces, so robotic-assisted surgery is extending into the pediatric surgical arena, specifically in pediatric urology.

Robotic-Assisted Surgery

Surgical technology continues to advance rapidly. Robotic-assisted surgical systems are ideal for small spaces so robotic-assisted surgery is extending into the pediatric surgical arena, specifically pediatric urology. Pyeloplasty and ureteral reimplantation are two common pediatric procedures being performed with a surgical robotic system. Advantages of robotic-assisted surgical systems are that patients experience less pain, recover faster, have decreased hospital stays, and have smaller surgical scars.[39,40]

The advantages of robotic-assisted surgery outweigh the disadvantages. Using three-dimensional viewing and a 10-fold magnification of the surgical field gives the surgeon the impression of virtually operating inside the patient's body while he or she is actually sitting at a control console several feet away from the surgical field. This is a great improvement over the standard 2.5-fold or 5-fold magnifications available with loops worn by the surgeon during the standard open surgical procedure. Sophisticated instruments and hand grips allow the surgeon to maintain manual dexterity and precision. Advanced software is able to filter out hand tremors and scale down hand movements, thus allowing the surgeon to be more precise and accurate. Another benefit of robotic-assisted surgery is that it allows the surgeon to sit comfortably instead of standing for long periods of time. By assuming a sitting position, the surgeon's arm stress is decreased markedly.

The disadvantages of robotic surgery are its high cost, a steep learning curve, and limited medical reimbursement.[41] The initial cost of the surgical robotic system coupled with yearly maintenance fees is a substantial expenditure for many health care facilities. The start-up cost of a robotic surgical system is approximately $1.2 million with at least $100,000 in annual maintenance costs. If a decision is made to purchase a surgical robotic system, facility administrators may need to reallocate funding to compensate for these costs.

Specialized instruments used in robotic surgery are another costly concern. At this time, instruments can be used for only 10 procedures and then must be replaced.[39] Instrument prices can range from $1,000 to $3,000 per instrument.

All members of the surgical team have a steep learning curve. Furthermore, initially, there is an increase in actual OR time, which also can adversely affect the OR budget. Medical reimbursement is limited and dependent on the manufacturer of the robotic system. For example, there is only one robotic surgical system that is approved by the US Food and Drug Administration for use in the United States.[40] Medical reimbursement is obtainable for specific robotic procedures when that particular system is used.

Indications for robotic-assisted surgery are expanding and are not limited to centers in the United States. The era of telerobotic surgery is on the horizon. A surgeon in New York assisted in the first transatlantic laparoscopic cholecystectomy of a patient who was located in France.[39] Robotic technology has advanced to the point that patients need not travel great distances for surgical intervention.

Keeping Up With Evolving Technology

It is imperative for perioperative nurses to embrace cutting-edge technology such as using the laparoscopic approach with new procedures and using robotic-assisted surgical systems. Doing so allows perioperative nurses to further define their roles and expand their knowledge and expertise. The nursing process and the AORN standards of clinical nursing practice provide the framework for the pediatric patient to remain the focus in the surgical arena. Holding fast to these principles enables perioperative nurses to deliver safe, quality patient care in an otherwise automated and technical environment. Through education and advanced training, perioperative nurses can expand the scope of their practice and grasp opportunities that are yet to come.

As MIS in pediatrics continues to evolve, perioperative nursing care is the constant thread that weaves its way throughout the delivery of patient-centered care. The entire surgical team must be forever watchful to detect any physiological alterations and respond quickly to ensure patient safety and optimal patient outcomes. – AORN –

Acknowledgement: *The authors thank the members of AORN's Pediatric Specialty Assembly who participated in discussions on the Pediatric Specialty Assembly portal that formed the basis for this article. The authors also thank Navil Sethna, MB, ChB, senior associate in perioperative anesthesia and pain medicine, and Christian Seefelder, MD, senior associate in perioperative anesthesia, Children's Hospital, Boston, MA, for their assistance in preparing this article.*

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Examination 6.0

Pediatric Laparoscopy

Purpose/Goal

To educate perioperative nurses about caring for pediatric patients undergoing laparoscopy.

Behavioral Objectives

After reading and studying the article on pediatric laparoscopy, nurses will be able to

1. explain the challenges of performing minimally invasive surgery in pediatric patients,
2. discuss perioperative nursing care of pediatric patients undergoing laparoscopic surgery,
3. describe how to position the patient to maximize exposure of the surgical site, and
4. discuss basic pediatric laparoscopic procedures.

Questions

1. Disadvantages of minimally invasive surgery (MIS) in the pediatric patient may include
   1. increased cost of specialized pediatric MIS instrumentation.
   2. increased intraoperative time.
   3. risk of gas embolism.
   4. risk of hemorrhage.
   5. risk of intra-abdominal injuries.

a. 2 and 3
b. 1, 4 and 5
c. 2, 3, 4 and 5
d. 1, 2, 3, 4, and 5

2. Pediatric patients typically lack the ability to cooperate during regional anesthesia so general anesthesia is the preferred anesthetic technique.

a. true
b. false

3. When developing a plan of care, the nurse should implement thermoregulation measures including
   1. increasing the ambient room temperature, as appropriate.
   2. prewarming the patient for a minimum of 15 minutes before induction of anesthesia.
   3. placing a pediatric temperature-regulating blanket over the patient.
   4. circulating temperature-controlled water through energy transfer pads applied to the patient's skin.
   5. using IV and irrigation solution warmers according to manufacturer instructions.
   6. placing a stockinette cap on the infant's head and wrapping the infant's extremities with cotton cast padding.

a. 1, 3, and 5
b. 2, 4, and 6
c. 2, 3, 4, 5, and 6
d. 1, 2, 3, 4, 5, and 6

4. If used, sequential compression device sleeves should be applied and the device turned on immediately after the induction of anesthesia.

a. true
b. false

5. When the patient is in the lithotomy position, careful padding of the legs and bony prominences is essential to avoid injury to the

a. common perineal nerve.
b. pudendal nerve.
c. femoral nerve.
d. brachial plexus.

6. Methods to maximize exposure of the surgical site include
1. creating a pneumoperitoneum.
2. placing the patient in the Trendelenburg position.
3. placing the patient in the reverse Trendelenburg position.
4. using single-lung ventilation.

a. 1 and 3
b. 2 and 4
c. 1, 2, and 4
d. 1, 2, 3, and 4

7. Chlorhexidine gluconate should not be used on infants younger than two months of age.
a. true
b. false

8. Pediatric insufflation pressures should be
a. calculated based on the patient's weight.
b. the same as for adults.
c. set as low as possible and increased slowly.
d. started at 10 mm Hg and then continued at a flow rate of 2 mm Hg.

9. During laparoscopic Nissen fundoplication, a 1-cm piece of red rubber catheter may be placed on each cannula sleeve and stitched to the abdomen to
a. measure the distance from the esophagus to the fundus of the stomach.
b. prevent the cannulas from migrating in or out of the patient.
c. decompress the stomach and dilate the esophagus.
d. serve as a portal to achieve the pneumoperitoneum.

10. Pediatric surgeons strive to perform congenital cystic adenomatoid malformation (CCAM) resections early to
1. minimize the risk of infection and bleeding.
2. lessen the possibility of various types of cancers later in life.
3. decrease the chances that the CCAM will grow.
4. allow normal lung tissue to develop.
5. collect cerebrospinal fluid to allow for differential diagnosing.

a. 1 and 3
b. 2, 4, and 5
c. 1, 2, 3, and 4
b. 1, 2, 3, 4, and 5

The behavioral objectives and examination for this program were prepared by Rebecca Holm, RN, MSN, CNOR, clinical editor, with consultation from Susan Bakewell, RN, MS, BC, director, Center for Perioperative Education. Ms Holm and Ms Bakewell have no declared affiliations that could be perceived as potential conflicts of interest in publishing this article.

This program meets criteria for CNOR and CRNFA recertification, as well as other continuing education requirements.

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Answer Sheet

6.0

Pediatric Laparoscopy

Event #08043
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PLEASE FILL OUT the application and answer form on this page and the evaluation form on the back of this page. Tear the page out of the *Journal* or make photocopies and mail with appropriate fee to:

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Mark only one answer per question.

1	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	6	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
2	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	7	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
3	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	8	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
4	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	9	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ
5	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ	10	Ⓐ Ⓑ Ⓒ Ⓓ Ⓔ

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A score of 70% correct on the examination is required for credit.

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6.0 Learner Evaluation

Pediatric Laparoscopy

THIS EVALUATION is used to determine the extent to which this continuing education program met your learning needs. Rate these items on a scale of 1 to 5.

Purpose/Goal

To educate perioperative nurses about caring for pediatric patients under laparoscopy.

Objectives

To what extent were the following objectives of this continuing education program achieved?

1. Explain challenges of performing minimally invasive surgery in pediatric patients.
2. Discuss perioperative nursing care of pediatric patients undergoing laparoscopic surgery.
3. Describe how to position the patient to maximize exposure of the surgical site.
4. Discuss basic pediatric laparoscopic procedures.

Content

To what extent

5. did this article increase your knowledge of the subject matter?
6. was the content clear and organized?
7. did this article facilitate learning?
8. were your individual objectives met?
9. did the objectives relate to the overall purpose/goal?

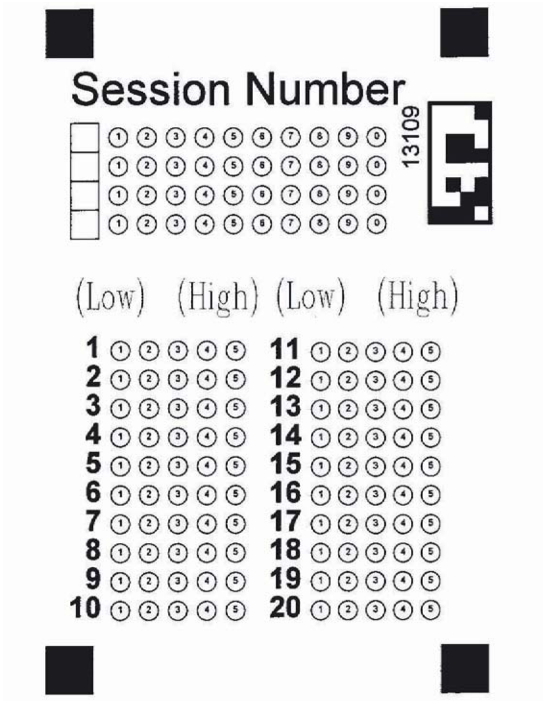
Test Questions/Answers

To what extent

10. were they reflective of the content?
11. were they easy to understand?
12. did they address important points?

Learner Input

13. Will you be able to use the information from this article in your work setting?
    1. yes
    2. no
14. I learned of this article via
    1. the *Journal* I receive as an AORN member.
    2. a *Journal* I obtained elsewhere.
    3. the *AORN Journal* web site.



15. What factor most affects whether you take an *AORN Journal* continuing education examination?
    1. need for continuing education contact hours
    2. price
    3. subject matter relevant to current position
    4. number of continuing education contact hours offered

What other topics would you like to see addressed in a future continuing education article? Would you be interested or do you know someone who would be interested in writing an article on this topic?

Topic(s): ______________________________

____

____

Author names and addresses: ______________________________

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