Introduction

Congenital anomalies of the abdomen are fairly common in neonates, infants, and children and often occur, along with other congenital anomalies, as part of a syndrome. Consequently, when an abdominal lesion is detected, the anesthetist must search for other anomalies, especially those related to the heart, as these anomalies are likely to complicate the anesthetic and the patient’s perioperative course. This chapter discusses common abdominal lesions that require surgery and anesthesia.

Gastroschisis

Gastroschisis occurs in about 1:3,000 live births and is characterized by a defect in the abdominal wall that is usually located to the right of the umbilicus. It is characterized by a hole in the abdominal wall and exposed loops of bowel. Figure 13-1.

**Figure 13-1: A Large Gastroschisis, Exposed Bowel, and Absent Abdominal Wall Covering.**
Etiology

The exact etiology of gastroschisis is unclear, but it is believed to be due to disruption of the omphalomesenteric artery or the right umbilical vein. It has also been suggested that it might be the result of failed development of the abdominal covering after the intestines return to the abdominal cavity at about 10 weeks of fetal life.

Presentation

Gastroschisis usually occurs in isolation. Other congenital anomalies are seldom present. Affected babies are often born prematurely or have a low birth weight. Because there are no covering membranes, multiple loops of bowel are exposed to the environment and are prone to injury. Chronic exposure to amniotic fluid in utero causes fibrin strands that result in scarring, fibrosis, and multiple bowel adhesions. Attempts to take down these adhesions after birth result in marked bleeding from the bowel surface. With time the adhesions will spontaneously disappear and the bowel will float free in the peritoneum. Sometimes the bowel is strangulated and ischemic, which gives it a very edematous, blue, or dusky appearance.

Pathophysiology

Depending when the baby presents for care after her/his symptoms begin, the baby may be dehydrated, i.e., may have sunken fontanels, sunken orbits, dry mucous membranes, and loss of skin turgor on physical examination (See Chapter 1). Infection may be present when the child is first seen. Depending on severity of the infection, the infant may be both septic and hypovolemic. Hypovolemia is usually the result of loosing large amounts of fluids from the exposed surface of the bowel and failure to take in sufficient fluids to compensate for these losses. Signs of hypovolemia include a very fast and thready pulse, cold extremities, and a mottled skin appearance.

Surgical Management

Before surgery occurs, it is important to prevent kinking of the bowel’s blood supply. Supporting the bowel with sterile towels to keep it in the midline and prevent it from falling to one side or the other does this. At times it may be necessary to place the child on her/his side to protect the bowel. The bowel’s blood supply must also be protected during transport of the patient to the hospital. To reduce the massive heat and water loss that occurs form the exposed bowel, it should be covered with a sterile plastic drape. Placing the entire child in a sterile plastic bag that covers her/his body from the feet to the mid chest will easily accomplish this. The plastic bag also allows collection of fluid lost from the bowel surface, which helps the anesthetist and surgeon determine fluid losses and requirements for fluid replacement.
Figure 13-2: Baby in a Plastic Bag for Warmth

The baby shown here was transported for two hours by ambulance in the plastic bag in which she is lying. The bag was tied loosely around the baby’s upper chest to enclose the entire lower body of the baby within the bag. Her temperature on arrival hospital was 36.8°C. There was 80ml of fluid in the bag that was lost from the exposed bowel. Courtesy of Joseph A. Kitterman, MD

If the infant presents to the treating hospital shortly after birth and the amount of extruded bowel is small, the abdomen can be closed immediately. However, if a large amount of bowel is exposed, and/or there is a delay in presentation to the hospital, it may not be possible to immediately close the abdomen. Because a significant amount of the baby’s bowel was outside the abdomen during fetal life, babies with gastroschisis may have an abdominal cavity that is small and will not accommodate the entire bowel. In this case, the exposed bowel is enclosed in a silo (Figure 13-2). A silo is a plastic bag that is sewn to the abdominal wall and contains the entire extruded bowel. Each day the silo is squeezed gently and tied to make the bag smaller, thereby gently “forcing” the bowel into the abdomen. The bowel is slowly manipulated back into the abdomen by this technique over a few days, which allows the abdomen to stretch and accommodate the intestines. This process also allows the bowel edema to regress, making the bowel smaller and more likely to fit within the abdominal cavity. Once the extruded bowel has been reduced into the abdomen, the abdominal wall can be closed surgically. This gentle reduction of bowel is performed at the bedside. The amount of bowel reduced each day is
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tailored to the infant’s clinical response (effects on breathing and perfusion of the lower extremities) thereby reducing the infant’s need for mechanical ventilation.

**Figure 13-2: Baby With a Gastroschisis Who’s Bowel Is Suspended in a Silo**

*The sterile plastic bag is sewn to the abdominal wall and tied superiorly just above the bowel. Each day the tie is moved a little more towards the abdomen to slightly increase pressure on the bowel. The bag is tied to the top of the incubator to protect the blood supply and to aid in removal of edema fluid.*

**Anesthetic Management**

General tracheal anesthesia with routine monitoring of arterial blood pressure, oxygen saturation, electrocardiogram, end-tidal carbon dioxide, and body temperature is required during surgical closure of the abdomen. Fluid resuscitation is very important in the peri-operative management of these patients, as a lot of fluid is lost from the exposed bowel. If the baby presents to hospital many hours after birth, he/she may be severely hypovolemic. Since this is a surgical emergency, efforts to resuscitate the baby with intravenous fluids should occur simultaneously with
preparation for surgery. It is often necessary to continue fluid resuscitation during surgery because the exposed bowel is a continuous source of fluid loss (Figure 13-3).

**Figure 13-3: Flow Chart Depicting Assessment of Volume Status and Management of Hypovolemia During Abdominal Surgery**
Intraoperative hypothermia can easily occur with exposure of the bowel to the cool environment and with irrigating the exposed bowel with fluids (especially cool fluids), during surgery. The operating room should be kept very warm to decrease the incidence of hypothermia. A warm operating room is the most efficient method of preventing hypothermia during surgery. Warming and humidification the inspired anesthesia gases also reduces heat loss (approximately 25% of heat loss occurs via the lungs during mechanical ventilation). In addition, the baby’s exposed extremities can be wrapped with the same cotton material (sheet wadding) that is normally placed on extremities before applying a cast. The baby’s head should be covered with a cap or with plastic, and intravenous fluids should be administered via a fluid warmer if possible. In situations where inflatable warming blankets are available, placing one of these blankets under the baby during surgery is a very effective way to maintain the body temperature.

**Figure 13-4: Cotton Wrapped Around The Extremities of a Baby to Maintain Body Temperature**

This figure shows several methods of maintaining a baby’s body temperature in the operating room. The solid arrows show an overhead heat lamp, which must be maintained at least three feet away from the baby’s skin to prevent skin burns. The asterix show the forced-air warming blanket, and the dashed arrows show the baby’s extremities wrapped in insulating material (sheet wadding).
Overhead radiant heat lamps may also be utilized to keep the baby warm during preparation for surgery, but the lamps should be placed no closer than three feet from the baby’s skin to prevent skin burns. The lamp should be turned off if the skin is prepared with iodine containing solutions, because the combination of heat and iodine increases the chance of burns. Figure 13-4 depicts several methods used to keep infants warm in the operating room. A humidifier, if available, should be inserted in the breathing circuit, as this is a very effective way of reducing heat loss and maintaining body temperature.

The use of a muscle relaxant during surgery facilitates abdominal closure. However, this sometimes makes it easier to replace the bowel in the abdomen and allows too much pressure to be applied to the abdominal contents. One good way to determine if the intra-abdominal pressure increases excessively when the surgeons attempt to place the bowel into the abdomen is to monitor the oxygen saturation and waveform of a pulse oximeter previously placed on a lower extremity. If the pulse waveform and the oxygen saturation (SaO₂) are normal, perfusion to the lower extremity is adequate and the intra-abdominal pressure is not excessive. However, if the oxygen saturation decreases and/or the pulse oximeter displays an abnormal waveform, this is a sign that placing the abdominal contents into the abdominal cavity is producing excessive intra-abdominal pressure. The surgeon should be immediately notified of this so he/she can consider placing the bowel in a silo and closing the abdomen later. The intra-abdominal pressure typically will continue to increase when the abdomen is closed because fluid will leak into the abdominal cavity from the surface of the injured bowel. Therefore, consideration should be given to placing the bowel in a silo if there is any sign that primary closure of the abdomen will be difficult.

Returning the bowel to the abdominal cavity may decrease or prevent movement of the diaphragm, decrease tidal volume, and increase the end-tidal carbon dioxide concentration (EtCO₂). Therefore, monitoring of the end-tidal EtCO₂ is another way to determine if the intra-abdominal pressure is too high during surgical repair of a gastroschisis. If the EtCO₂ increases by more than 10mmHg during abdominal closure, the abdominal pressure is significantly elevated and consideration should be given to placing the bowel in a silo. If during mechanical ventilation the peak inspiratory pressure (PIP) increases to greater than 25cmH₂O when the surgeon attempts to place the bowel in the abdomen, consideration should be given to delaying surgical closure of the gastroschisis and placing the bowel in a silo.

Due to the fairly significant increase in intra-abdominal pressure that occurs once the bowel is placed into the abdomen, there may be impaired movement of the diaphragm and impaired breathing. As a consequence, the majority of babies require mechanical ventilation after closures of a large gastroschisis. Tracheal extubation usually occurs a few days after surgery, when the intra-abdominal pressure has decreased. For environments that do not have the ability to maintain babies on mechanical ventilation with tracheal intubation, placement of a silo and
gradual reduction of the gastroschisis into the abdominal cavity is recommended before attempting to close the abdomen.

**Omphalocele**

Omphaloceles are characterized by herniation of the abdominal contents through the umbilical ring. In contrast to gastroschisis, the bowel of patients with an omphalocele is covered and protected by amnion. The size of an omphalocele varies. It can be very small (almost the size of an umbilical hernia) or very large (one that contains not only bowel but also other organs, e.g., the liver and spleen) **Figure 13-5.**

**Figure 13-5: A Baby With an Omphalocele**

*This figure shows a large omphalocele with bowel and liver in the sac. Note the small size of the abdomen, which cannot accommodate the sac contents.*
Presentation

Omphalocele is a midline lesion, and as such is associated with several other midline anomalies. Approximately 60% of affected infants have associated cardiac lesions; therefore the anesthetist must evaluate babies who have an omphalocele for cyanosis, low oxygen saturation, a cardiac murmur, or for abnormal pulses. A detailed history and physical examination plus an echocardiogram, when available, must be obtained to determine the severity of any accompanying cardiac disease (See Chapter 12).

Pathophysiology

Since omphaloceles are covered and not totally exposed, the threat of dehydration or sepsis is less, although still present.

Surgical management

Surgical management of an omphalocele is similar to that for gastroschisis. Large omphaloceles are often painted with an escharotic (scar producing) agent, such as silver sulfadiazine (silvadine) or betadine, wrapped, and gradually reduced in size. The contents are gradually eased into the abdomen over a period of time. Delayed abdominal closure is performed when the sac contents can be easily placed into the abdomen without compromising ventilation or bowel blood flow.

Anesthetic management

Intraoperative anesthetic management of omphalocele and gastroschisis is similar. However, the intra-operative fluid requirements for omphalocele surgery are fewer than those for gastroschisis, as the covering membrane prevents the bowel from being completely exposed, which minimizes fluid loss. Other anesthetic considerations include keeping the baby warm and monitoring oxygenation levels and the oxygenation saturation waveform patterns during closure of the abdomen to assure that the intra-abdominal pressures are not excessive.

Bowel Obstruction

Bowel obstruction is a common problem in infants and children. Many times it is due to a congenital anomaly; at other times it is acquired. The following section of this chapter provides an overview of this problem.

Pyloric stenosis

Pyloric stenosis is a common cause of gastrointestinal obstruction and occurs in 2-4:1,000 live births. Patients usually present with this malady between 2-8 weeks of age. Pyloric stenosis is the result of hypertrophy (thickening) of the stomach outlet (pylorus); it is more common in males.
than in females. The cause of pyloric stenosis is unknown, but it occurs with higher incidence in bottle-feed infants and in twins.

**Presentation**

Projectile vomiting of non-bilious gastric contents is the usual first sign of pyloric stenosis. The vomiting increases with time and gradually becomes more forceful (projectile) in nature. Vomiting classically occurs after feeding but may occur at any time. The patient usually appears to be hungry and sucks vigorously, despite the vomiting. The repeated vomiting may lead to moderate to severe dehydration with loss of skin turgor and a depressed anterior fontanel. *(See Chapter 1)*

**Diagnosis**

A history of frequent vomiting in a child between 2-8 weeks of age is very suggestive of pyloric stenosis. Physical examination of the abdomen usually reveals hyper-peristalsis as well as an olive-sized mass in the right upper epigastric region, which is best palpated when the child is not crying or just after the child has eaten. The diagnosis can be confirmed by a barium swallow study, which reveals accumulation of barium just proximal to the gastric outlet and very little, if any, barium passing through the point of obstruction. Diagnosis of pyloric stenosis can also be made by ultrasound.

**Pathophysiology**

Gastric fluid is comprised of hydrogen, chloride, and potassium ions. Repeated vomiting of large amounts of gastric fluid depletes these ions and results in metabolic alkalosis and low serum concentrations of chloride and potassium. The kidneys compensate for the loss of hydrogen ion by exchanging potassium for hydrogen and sodium. This further decreases the serum potassium concentration and leads to an alkaline urine with a pH of >5. As vomiting progresses, the sodium and potassium stores become depleted, and the urine becomes acidotic (paradoxical aciduria). If this scenario persists, severe dehydration occurs, and the child has prerenal azotemia and metabolic acidosis.

**Anesthetic Management**

Surgical repair of pyloric stenosis is not an emergency. Repair should only be undertaken after the volume depletion and electrolyte abnormalities have been corrected. Pyloric stenosis is a medical emergency not a surgical emergency. Ideal fluid replacement should include either normal saline (NS) or 5% Dextrose in ½ NS with dextrose at a rate of 1.5 times maintenance fluid requirement. Four milli-equivalents (mEq) of potassium should be added to each 100ml of IV fluid and administered until the potassium concentrations have been repleted. Chloride, potassium, and bicarbonate concentrations should all be within normal limits before the child is taken for surgery.
Giving large volumes of 5% Dextrose in ½ NS may lead to hyponatremia (See Chapter 3).

Before anesthesia, the patient’s stomach should be suctioned with a 10 or 14 French suction catheter to remove fluid and barium from the stomach. A suction catheter of this size is preferable because it is easier to remove residual gastric contents and/or barium from the stomach through them. Tilting the operating table into the head up and head down position and then turning the patients to their right and left sides allows more gastric contents to be removed. A vagal response may occur while suctioning the awake baby’s stomach. Administering 20mcg/kg of atropine just prior to suctioning the stomach helps stop the suction catheter from causing bradycardia. The suction catheter should be inserted through the mouth into the stomach and suctioning continued until minimal aspirate is obtained. If there is blood tinged aspirate, stop the suctioning. If the child has a small nasogastric tube in place preoperatively, it should be removed and replaced with a larger sized catheter. While suctioning removes most of the gastric fluid, it does not remove all of it because suction catheters fail to reach all parts of the stomach. Consequently, a rapid sequence induction is still appropriate, even if gastric suctioning has already taken place. After gastric suctioning, the baby should be pre-oxygenated for 2-3 minutes before a rapid sequence induction is undertaken; cricoid pressure should be applied during induction of anesthesia to reduce the likelihood of regurgitation and aspiration of gastric contents. Cricoid pressure should not be excessive, or it may actually collapse and obstruct the soft tracheas of young children. If this occurs, release the pressure slightly. Oxygen desaturation may occur during induction of anesthesia if tracheal intubation is not accomplished on the first attempt. A styletted tracheal tube improves the likelihood of accomplishing tracheal intubation on the first attempt and is therefore a common practice with rapid sequence intubation.

During surgical repair of pyloric stenosis, large amounts of fluid are not required, especially if the surgery is done by a laparoscopic approach. Ventilation is usually controlled during surgery, but it is important not to over ventilate the patient’s lungs, as this will worsen existing alkalosis of patients who also have metabolic alkalosis. If the preoperative level of carbon dioxide (CO₂) is elevated and the pH is normal, the patient has compensated for the metabolic alkalosis. The anesthetist must only provide sufficient ventilation to maintain the preoperative CO₂ level, otherwise severe alkalosis and decreased cerebral blood flow will occur. The patient should be awake and responding to her/his surroundings at the end of surgery before removing the tracheal tube. This reduces the likelihood of aspirating gastric contents.

**Pain Management**

While correction of serum metabolic derangements often occurs before surgery, correction of electrolyte abnormalities in the cerebral spinal fluid takes longer. These abnormalities (especially an elevated bicarbonate level) can delay emergence from anesthesia. Thus, pain medication, particularly opioids, should be administered judiciously, if at all, during surgery. Acetaminophen
suppositories (40-45mg/kg) may be administered either during surgery, or the anesthetist can wait until after tracheal extubation. Alternatively the surgeon can infiltrate the operative site with local anesthetic towards the end of surgery. The combination of infiltrated local anesthetic plus rectal or postoperative oral acetaminophen elixir usually provides adequate pain control.

Other causes of bowel obstruction include malrotation of the bowel, volvulus of the bowel (twisting of the bowel around a focal point), intussusception (characterized by involution of a segment of bowel into another, the presence of Ladd’s bands across part of the bowel, or atretic segments of bowel). Atresia of the bowel (abrupt ending of the bowel lumen) can be found in the duodenum, jejunum, or colon. Duodenal atresia often occurs in association with other congenital anomalies. It is often part of the syndrome whose acronym is VACTERL, which stand vertebral, ano-rectal, cardiac, tracheal-esophageal defects, radial bone (or renal) and limb anomalies. Duodenal atresia is a common finding in children with Down syndrome.

**Bowel Obstruction Due to Atresia, Malrotation or Volvulus**

**Presentation**

Continuous vomiting by patients with bowel obstructions causes moderate to severe dehydration, depending on the amount of time between the onset of the patient’s symptoms and when the patient’s presents to hospital. Signs of dehydration are discussed earlier in this chapter and also in Chapter 1. Severely distended bowel, increased abdominal girth, and visible loops of bowel below the abdominal wall are commonly detected on physical examination. An abdominal X-ray confirms the diagnosis when it reveals dilated loops of bowel and/or air fluid levels. The presence of free air in the abdominal cavity (bowel perforation) is a surgical emergency; The mortality rate with perforation is high. Bowel sounds may be hyperactive or decreased, depending on whether the child is in an early or late stage of the disease.

**Pre-Operative Preparation**

Laboratory values, including hemoglobin level and serum electrolytes, should be obtained, as these data help guide the patient’s perioperative fluid and electrolyte management. Depending on the hemoglobin concentration, intra-operative blood transfusion may be required. An elevated serum sodium concentration (hypernatremia) is an indication of the severity of the dehydration and is helpful in directing perioperative fluid resuscitation.

**Surgical Management**

In children, exploration of the abdomen and relief of a bowel obstruction is done under general anesthesia. Because these children have a full stomach, they are prone to aspirate their gastric contents during the induction of anesthesia. Appropriate precautions (rapid sequence induction of anesthesia with cricoid pressure) should be taken to prevent this from occurring.
Anesthetic Management

Bowel obstruction due to malrotation, volvulus, or bowel atresia requires urgent surgery to prevent the bowel from becoming ischemic and/or perforating, especially if the bowel’s blood supply is compromised. Sometimes the bowel has perforated by the time the patient presents for care, further increasing the urgency of surgical repair. Use of routine anesthesia monitors, including electrocardiogram (ECG), arterial blood pressure, end-tidal carbon dioxide (when available), and core temperature are imperative. Fluid resuscitation is very important, both before and after induction of anesthesia. Therefore, adequate intravenous access is required for surgery. This usually means inserting at least two intravenous catheters. While 24 gauge intravenous catheters are easier to place, 22 or 20-gauge catheters permit more rapid infusion of fluids, blood, or albumin during surgery. A large bore catheter is especially important for resuscitation.

Adequate pre-oxygenation is mandatory because oxygen desaturation occurs commonly once anesthetic drugs are given. This occurs because the distended bowel compresses the diaphragm, causing atelectasis and inadequate lung expansion with inspiration. The stomach should be adequately suctioned before anesthesia is induced, not only to reduce the likelihood of aspirating gastric contents but also to reduce the size of the stomach and decrease compression of the diaphragm. If a nasogastric catheter is not present, one should be inserted and connected to suction to remove as much of the stomach contents and gas as possible before inducing anesthesia. Despite adequate preoperative gastric suctioning, regurgitation may still occur during induction of anesthesia. Therefore, the rapid sequence induction technique should be used when intubating the trachea. The intravascular volume must be corrected prior to inducing anesthesia to avoid causing severe hypotension. Rapid sequence induction typically involves administering of sedative-hypnotic drug, such as intravenous thiopental (4-6mg/kg), propofol (2mg/kg), ketamine (2mg/kg), or etomidate (2mg/kg), and a rapid acting muscle relaxant, such as succinylcholine (2mg/kg) or rocuronium (1mg/kg) while applying cricoid pressure to prevent regurgitation of gastric contents. On occasion it may not be possible to intubate the trachea on the first attempt. In such situations, gentle mask ventilation (enough to see the chest move with each manual ventilation) may be performed while continuing to apply cricoid pressure. This helps prevent or treat the rapid decrease in oxygen saturation, which is made worse by atelectasis that is induced by the distended abdomen. Ketamine and etomidate are particularly helpful in patients who have bowel obstruction and accompanying sepsis or moderate dehydration, as these drugs decrease arterial blood pressure less than thiopental or propofol, especially propofol, which causes significant decreases in systemic vascular resistance. It is important to note that neither ketamine nor etomidate prevents hypotension if the patient is severely hypovolemic. Thus, the importance of normalizing the intravascular volume as much as possible before the induction of anesthesia cannot be overemphasized. In the presence of perforated bowel, however, surgery may have to proceed while fluid resuscitation is ongoing. During this time vasopressors [adrenaline (epinephrine), dopamine] may be needed to support blood pressure and cardiac output.
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Maintenance anesthesia is usually accomplished with halothane, sevoflurane or isoflurane and with the administration of intermittent doses of muscle relaxants. If possible, the muscle relaxant used should increase the patient’s heart rate, as this helps sustain cardiac output and arterial blood pressure in young children. Muscle relaxation, which is very helpful during abdominal surgery, may be achieved by giving intermittent boluses of rocuronium or other short/intermediate acting muscle relaxants. Succinylcholine is usually avoided (except in a dire emergency) because it predisposes patients who have the genetic predisposition this disease to develop malignant hyperthermia (MH). This drug should be used very cautiously, especially in patients with undiagnosed muscle weakness or in those with a family history of members who developed malignant hyperthermia or febrile episodes that eventually led to death or the need for intensive care after surgery. The administration of succinylcholine to 3-8 year old males should be avoided as much as possible, as male children of this age can have undiagnosed muscle disease and develop severe hyperkalemia, cardiac arrest, and die after normal doses of succinylcholine.

After inducing anesthesia, catheterizing the urinary bladder allows the anesthetist to monitor urine output during surgery. This is a helpful guide for evaluating fluid status. If the urine output is at least 0.5-1ml/kg/hr during surgery, kidney perfusion is adequate. Lesser amounts of urine production suggest that resuscitation of intravascular volume is incomplete. Additional fluid boluses of 10ml/kg or more of Ringer’s lactate or normal saline are indicated. These boluses of fluid should be dextrose free, as large volumes of dextrose containing solutions can cause hyperglycemia, particularly in septic patients. Maintenance fluids (not volume replacement fluids) should, however, contain 5% dextrose to provide sufficient glucose to meet the patient’s needs, particularly during the anesthetic management of children less than one month of age or children with inadequate nutrition. If possible, the serum glucose concentration should be measured during surgery to be certain the serum glucose concentrations are not too high or low. During anesthesia serum glucose concentrations usually increase for at least three reasons: 1) decreased utilization of glucose; 2) catecholamine induced glucose production from glycogen; 3) interference by catecholamines with the uptake of glucose at the cellular level. All of these tend to cause hyperglycemia in both sick and in anesthetized patients. The only way to know the patient’s glucose concentration is to measure it. If a cardiac arrest occurs when the glucose level is >200mg/dl, 50% fewer patients can be resuscitated and of those resuscitated, 50% will have central nervous system (CNS) injury. Similar injury can occur with hypoglycemia.

Patients with bowel obstruction vomit, which results in the loss of large amounts of gastrointestinal fluid. Their intravascular volume also decreases because fluid is sequestered into the injured bowel. Fluid resuscitation should start with 10cc/kg. of dextrose free balanced salt solution, such as lactated Ringer’s solution and normal saline. A sufficient volume of crystalloid solution must also be infused continuously during surgery (10cc/kg/hr. or more) to replace the fluid losses caused by handling the bowel and exposing it to the environment during surgery. At times, much more fluid is required. The amount of fluid needed must be based on frequent
evaluation of the patient’s arterial blood pressure, heart rate, tissue perfusion, and urine output (See Chapter 3). Colloid solutions, such as 5% albumin, can also be utilized for volume expansion, but they are more expensive than crystalloid solutions and have not been shown to be any more effective at restoring intravascular volume than normal saline. Maintenance fluids must also be given in addition to the replacement fluid. Maintenance fluids should contain 5% Dextrose. The usual administration rate is 4ml/kg/hr. for the first 10kg of body weight; 2ml/kg/hr. for the 2nd 10kg of body weight; and 1 ml/kg/hr. for the every kilogram of weight over 20kg (See Chapter 3). A balanced salt solution with 5% dextrose should be used for this purpose, not D5 ½ NS or ¼ NS. These latter two solutions can lead to severe hyponatremia. Maintenance fluids are usually administered continuously through one IV and replacement fluids for ongoing losses through a separate IV whenever possible.

**Pain Management**

Pain relief is usually accomplished by giving intermittent intravenous doses of pain medication, such as ketamine (1-2mg/kg), pethidine, (0.5-2mg/kg) fentanyl (0.5-1.0mcg/kg) or morphine (0.5-1.0mg/kg). Pethidine must be administered cautiously to young children because one of its metabolites causes significant respiratory depression and lasts a long time. In addition, excretion and metabolism of pethidine is reduced in neonates compared to adults, so its effects may last longer. Many children with bowel obstruction are premature and are at risk for post-operative apnea. Administration of opioids to these infants should be done with caution. Close postoperative monitoring for apnea and hypoxemia is therefore mandatory in these patients. The use of neuraxial blockade, such as epidural anesthesia, with infusion of local anesthetics, can also be employed for pain management (See Chapter 21). However, the sympathetic blockade that occurs when local anesthetics are given for these blocks may further accentuate intraoperative hypotension, especially if the child is hypovolemic. Neuraxial blockade is not an option for septic children, as it may further aggravate the infection and predispose the child to getting a central nervous system infection. For very sick patients, infusions of vasoactive medications, such as epinephrine (adrenaline) or dopamine, may be necessary during surgery to maintain adequate hemodynamics (blood pressure and heart rate).
Conclusion

Anesthesia for patients needing abdominal surgery requires knowledge of the lesions and of how they affect the patient’s physiology. This knowledge must include evaluation of these patients for volume status and for the presence of other congenital anomalies. Cardiac anomalies are the most common accompanying lesions and may complicate both the anesthesia and the postoperative course. Despite all of the real and potential complications, survival of these patients is good if they receive appropriate preoperative, intraoperative, and postoperative care.

References: