Assessment Points

System	Effect	Assessment By Hx	PE	Test
CV	Congenital heart disease leads to desaturation PDA may cause CHF	CHD, PGE_1 treatment	Murmur; cyanosis	ECHO
RESP	Children with bronchopulmonary dysplasia may be prone to apnea	Hx of hyaline membrane disease or other parenchymal lung disorder	Abnormal pulm compliance or O_2 requirement	CXR, ABGs, O_2 sat
GI	GE reflux may cause vagal overload	Hx of reflux	None obvious	pH study, barium swallow
CNS	Seizures may cause apnea; structural abnormalities may create ineffective respiratory drive	Hx of seizures or change in neurologic development	Exam for seizures or neurologic change	EEG, head US, CT, MRI

Key References: Henderson-Smart DJ, Steer P: Postoperative caffeine for presenting apnea in preterm infants, *Cochrane Database Syst Rev* (2):CD000048, 2000; Balain M, Oddie S: Management of apnoea and bradycardia in the newborn, *Paediatr Child Health* 24(1):17–22, 2014.

Perioperative Implications

Monitoring
- Routine

Airway
- Not usually a problem; obstructive apnea may occur but is rare.
- Bronchospasm may occur in infants with bronchopulmonary dysplasia.

Maintenance
- Usually no problem during procedure; vigilance required postop

Extubation
- Watch for intermittent inadequate respiratory effort for hours.

Adjuvants
- No special concerns

Anticipated Problems/Concerns

- Consider scheduling elective procedures after 60 wk post conceptual age.
- Periop not complex; vigilance regarding care and assessment in postop period.

Appendicitis, Acute

Gaurav Malhotra

Risk

- One of most common abdominal emergencies
- Possible at any age but most common during an individual's teens and 20s
- 11 in 10,000 individuals will experience appendicitis
- M:F ratio 1.4:1
- Most common reason for nonobstetric surgery during pregnancy; Occurs in 1 out of every 800 to 1500 pregnancies; slightly more common during second trimester; incidence of perforation highest during third trimester (70%)

Perioperative Risks

- Risk of intraabdominal perforation or abscess; risk increases with delay in diagnosis and treatment.
- Ileus.
- Sepsis.
- Fecal fistula.
- Mortality is 2-3% for perforated versus 0.1% for nonperforated appendicitis.
- Mortality for perforated appendicitis higher in elderly and pregnant pts.
- In pregnant pts, fetal mortality of approximately 35% for perforated appendicitis compared with 1.5-3% for uncomplicated appendicitis.

Worry About

- Airway and aspiration risk because pt may have full stomach with symptomatic nausea and vomiting
- Tachycardia due to pain, dehydration, or sepsis
- Hypotension due to dehydration or sepsis (poor PO intake, vomiting, diarrhea, or intra-abdominal abscess)
- Preop IV antibiotics
- Appendicitis in pregnancy
  - Possible delay in diagnosis due to atypical symptoms, as well as hesitation in performing imaging and diagnostic studies out of concern for the fetus
  - Awareness of anatomic and physiologic changes of the parturient
  - Avoidance of teratogenic agents and risk factors for intrauterine fetal asphyxia

Overview

- One of the most common abdominal emergencies in children, adults, and pregnant women.
- Increased risk of perforation if diagnosis delayed over 24 h.
- Increased morbidity/mortality with perforation.
- Pts may present with right-lower-quadrant or diffuse abdominal pain, nausea and vomiting, diarrhea, anorexia, malaise, fever, or mild leukocytosis.

Etiology

- Primarily due to appendiceal obstruction (80%); obstruction most commonly due to fecaliths, hyperplasia of lymphoid follicles (commonly in pediatric pts), stones, or tumors.
- Obstruction of the appendix causes increased intraluminal pressure, which leads to thrombosis and occlusion of blood vessels and lymphatics supplying it: this causes organ inflammation and ischemia, which can further progress to perforation, intraabdominal abscess, and peritonitis.
- Appendiceal inflammation leads to bacterial proliferation, most commonly anaerobic and gram-negative organisms.

Usual Treatment

- Appendectomy is standard of care. Pt should be taken to OR as soon as possible to avoid perforation or disease progression.
- Periop antibiotics may need to be continued postop, especially in cases of perforation.
- Laparoscopic or open appendectomy performed.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
CV	Tachycardia; hypotension	Vomiting; signs of dehydration	Vital signs; orthostatic signs	BP and HR ECG as indicated by H&P
RESP	V/Q mismatch	Dyspnea; tachypnea	Splinting due to abdominal pain, diminished breath sounds	Pulse oximetry and RR, increased A-a gradient
GI	Ileus, perforation, abscess	Abdominal pain, vomiting, diarrhea	McBurney point tenderness, abdominal guarding Peritoneal irritation: rebound tenderness; Rovsing and psoas signs	Abdominal x-ray, CT, US, barium enema WBC count
RENAL	Dehydration, electrolyte disturbances	Oliguria	Vitals signs; orthostatic signs	UA, BUN, creatinine

Key References: Backius M, McGrath B, Monk J, et al.: Changing epidemiology of acute appendicitis in the United States: study period 1993–2008, *J Surg Res* 175(2):185–190, 2012; Gadalla F: Appendectomy for a pregnant patient. In Yao F, Malhotra V, Fontes MI: *Yao and Artusio's anesthesiology: Problem-oriented patient management,* ed 7, Philadelphia, 2012, Lippincott Williams & Wilkins, pp 778–792.

Perioperative Implications

Preoperative Preparation

- Isotonic fluid replacement to correct fluid deficits and electrolyte abnormalities
- Aspiration prophylaxis: H_2 antagonist, nonparticulate antacid, and nasogastric tube placement
- Antibiotics with adequate gram-negative and anaerobic coverage
- Opiate premedication for abdominal pain
- Baseline fetal heart rate tracing in parturient

Monitoring

- Standard.
- Urinary catheter.
- Consider invasive monitors if septic.
- Consider fetal heart rate monitor if fetus is viable and obstetrics team is immediately available.

Airway

- Full stomach precautions

Induction

- Rapid sequence induction with cuffed ETT.
- Anticipate hemodynamic instability with induction in septic or dehydrated pts.
- In parturient, avoid supine hypotension syndrome by positioning in left uterine displacement.
- Can consider regional anesthesia if pt is cooperative, hydration is adequate, systemic sepsis is absent, and high abdominal exploration is unlikely.

Maintenance

- Standard maintenance with adequate muscle relaxation.
- Evacuate stomach with oral-gastric or nasogastric tube.
- If using laparoscopic approach, anticipate hypotension with abdominal insufflation causing decreased venous return and cardiac output.
- In parturient, ensure fetal well-being by maintaining adequate maternal oxygenation, hemoglobin content, and hemodynamics.

Extubation

- Extubate when pt is fully awake and regains laryngeal reflexes.

Postoperative Period

- Pain control with PCA, oral opioids, and NSAIDs.
- PONV; Treat with ondansetron, metoclopramide, or promethazine.
- Continue antibiotics for 3-5 d for perforated appendicitis.
- Monitor for sepsis.
- In parturient:
  - Fetal heart rate monitor to ensure fetal well-being.
  - Consider tocolytic medication to prevent premature labor (22% of women in third trimester go into labor within 1 wk of surgery).

Adjuvants

- Laparoscopic versus open appendectomy: Laparoscopic approach tends to have shorter hospital stay, decreased postop pain, and decreased wound infection rate; however, it also tends to have a higher rate of intraabdominal abscess and hospital costs.

Anticipated Problems/Concerns

- Aspiration risk
- Hemodynamic instability due to dehydration and possible sepsis

Arnold-Chiari Malformation (Chiari Malformation Type II)

Jason D. Walls | R. Alexander Schlichter

Risk

- Arnold-Chiari malformation (Chiari Malformation type II or CMII) is found exclusively in pts with myelomeningocele.
- Myelomeningocele occurs in 0.6 of 1000 live births.

Perioperative Risks

- Vocal cord paralysis
- Respiratory distress
- Apnea
- Neurogenic dysphagia and pulmonary aspiration
- Hydrocephalus and increased ICP
- Congenital heart defects (37% of pts with myelomeningocele) including atrial septal defect, ventricular septal defect, anomalous pulmonary return, tetralogy of Fallot, bicuspid aortic valve, coarctation of the aorta, and hypoplastic left heart syndrome

Worry About

- Any symptoms of possible brainstem compression (stridor, hoarse voice, or difficulty swallowing) in a child less than 2 y with CMII must be urgently evaluated as a neurosurgical emergency.
- Nearly 21% of children with myelomeningocele will development hindbrain, cranial nerve, or spinal cord compression by 3 mo of age, increasing to 33% by age 5 y.
- Of pts with symptomatic CMII, 15% die by 3 y of age.
- Mortality rate has improved with emergent surgical treatment in symptomatic pts.

Overview

- CMII is characterized by herniation of the cerebellar vermis, brainstem, and fourth ventricle through the foramen magnum in the setting of myelomeningocele.
- Commonly associated with hydrocephalus (90%) and syringomyelia (20-95%).
- Other variable abnormalities associated with CMII include dysplasia of the corpus callosum, enlargement of mass intermedia, abnormalities of the white and gray matter, hippocampal dysplasia, elongation of the pons, beaking of the midbrain tectum, and defects of the falx and tentorium.
- Symptomatic CMII is the leading cause of death in pts less than 2 y old with myelomeningocele.
- Symptoms differ relative to age of onset, with neonates presenting as a neurologic emergency and older children presenting with more subtle findings of hyporeflexia weakness, or headache.

Etiology

- Pathophysiology not completely understood
- Multiple theories of embryologic origin, including primary malformation or secondary abnormalities related to altered cerebral spinal fluid dynamics

Usual Treatment

- Early closure of myelomeningocele, usually within 72 h after birth, proven to cause upward movement of hindbrain herniation but does not appear to prevent lifetime occurrence of symptomatic CMII.
- Treatment of hydrocephalus more important than surgical decompression to prevent CMII symptoms, and, in any symptomatic CMII pt, physician must first rule out and treat hydrocephalus.
- Of pts, 20% will need surgical treatment including brainstem decompression via posterior cervical laminectomies at all involved segments and possible duraplasty.
- Unlike Chiari Malformation type I, suboccipital craniotomy often not necessary due to already enlarged foramen magnum.
- Intrauterine myelomeningocele repair shows evolving benefits of possibly preventing CMII and decreasing overall severity.
- Intrinsic brainstem dysfunction cannot be treated surgically.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
CNS	Hindbrain herniation Hydrocephalus Increased ICP	Occipital headache, weak cry, irritability	Opisthotonus posturing, quadriparesis, hypotonia, ataxia, and down-beat nystagmus Increased head circumference; bulging anterior fontanelle	MRI Shunt evaluation
SPINAL CORD	Cervical myelopathy Syringomyelia	Altered dexterity, handwriting change, unable to provide self-care	Upper extremity weakness, spasticity, ataxia, hand muscle atrophy, scoliosis, back pain, and loss of sensorimotor function	MRI, SEP/ MEP
HEENT	Cranial nerve X dysfunction	Stridor (must evaluate to rule out neurologic cause; do not assume viral upper-respiratory infection)	Vocal cord paralysis; altered gag reflex	Laryngoscopy (direct; fiberoptic)
RESP	PEAC Central and obstructive breathing disorders	Snoring, apnea, daytime sleepiness, daytime attention deficit	Cyanosis, bradycardia, death during painful experience	PSG, ENT evaluation
GI	Neurogenic dysphagia, aspiration, nutritional deficiency	Choking, regurgitation, prolonged feeding time, weight loss	Muscle wasting; aspiration pneumonia	Swallow study; direct laryngoscopy

Key References: Messing-Jünger M, Röhrig A: Primary and secondary management of the Chiari II malformation in children with myelomeningocele, *Childs Nerv Syst* 29(9):1553–1562, 2013; McClain CD, Soriano SG, Rockoff MA: Pediatric neurosurgical anesthesia. In Cote CJ, Lerman J, Anderson B, editors: *A practice of anesthesia for infants and children,* ed 5, Philadelphia, 2013, Elsevier, pp 510–532.