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GENERAL SURGERY BOARD REVIEW MANUAL

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Frequently Encountered Problems in Pediatric Surgery II: Older Infants and Children

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Preface

Board certification in general surgery or a recognized subspecialty is a requirement for the practice of surgery today. Hospital credentialing committees, managed care organizations, and insurers require physicians to be board certified in order to practice in this field. Most importantly, patients want to be treated by board-certified surgeons. If a board certification candidate does not pass the board examinations, she or he can not expect to practice surgery.

The amount of knowledge needed to pass the written and oral board examinations in general surgery may seem overwhelming at times. This knowledge must be learned in the hospital wards, the operating rooms, and through continued in-depth reading of general and specialty textbooks and journals. The *Hospital Physician General Surgery Board Review Manual* serves as a valuable adjunct to these resources for board certification candidates preparing for the written examinations. The outline format allows the candidate to review a single important topic in general surgery in a systematic and focused fashion.

The first two parts of this volume concern the topic of pediatric surgery. Part I addressed surgical problems encountered in neonates, including esophageal atresia, pyloric stenosis, congenital intestinal obstruction, omphalocele and gastroschisis, hernias, and necrotizing enterocolitis. Part I also discussed special considerations in preparing neonates for surgery. Part II discusses frequently encountered problems occurring in older infants and children, specifically rectal bleeding, appendicitis, aspiration of a foreign body, and the more commonly seen tumors.

This peer-reviewed manual was developed without involvement of or review by the American Board of Surgery. The manual is based on the Series Editors' and Contributing Authors' familiarity with basic science information and surgical data, clinical experience, awareness of new developments and research results, and knowledge of the level of competence expected of a board-certified surgeon. We hope that board certification candidates in general surgery find this review manual useful as they progress through surgical training.

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I. INTRODUCTION

Part I of this topic addressed surgical problems in neonates, including special considerations in preparing neonates for surgery. Specific conditions discussed included esophageal atresia, pyloric stenosis, congenital intestinal obstruction, omphalocele and gastroschisis, hernias, and necrotizing enterocolitis. Part II addresses commonly seen surgical problems that occur in older infants and children, including rectal bleeding, appendicitis, aspiration of a foreign body, and some of the more commonly seen tumors.

II. RECTAL BLEEDING

- A. **Causes.** Causes of rectal bleeding in children are listed in **Table 1**.
- B. **Meckel's diverticulum**
1. **Incidence.** There is a male-to-female predominance of 3:1.
 2. **Etiology.** Ulceration occurs in the ileal mucosa adjacent to the ectopic gastric mucosa that lines in varying amounts the Meckel's diverticulum or duplication. The diverticulum is usually within 100 cm of the

Frequently Encountered Problems in Pediatric Surgery: II

Table 1. Causes of Rectal Bleeding in Children

Age	Causes
Newborn	Necrotizing enterocolitis, infectious enterocolitis, anal fissure, sigmoid mucosal prolapse, hemorrhagic disease of the newborn (vitamin K deficiency), milk allergy*
1–2 years of age	Anal fissure, infectious enterocolitis, intussusception, Meckel's diverticulum, duplication, rectal prolapse, juvenile colonic polyps†
2 years to puberty	Juvenile colonic polyps,‡ Meckel's diverticulum, duplication, proctitis, ulcerative colitis, granulomatous colitis, anal fissure, familial polyposis

*Rare.

†Presentation is usually before 2 years of age.

‡Other polyps (ie, Peutz-Jeghers syndrome) rarely occur.

ileocecal valve and can cause other problems, such as intussusception, volvulus around a persistent fibrous cord to umbilicus, and diverticulitis with or without perforation.

3. **Clinical presentation**

- a. The patient usually presents with a sudden, painless, large amount of dark red or burgundy-colored rectal blood.
 - 1) Bleeding occasionally leads to shock.
 - 2) Cessation is usually spontaneous, but bleeding recurs in a few days to a few weeks.
- b. Usually, there is a substantial drop in hematocrit levels.

4. **Diagnosis.** A radionuclide study is the gold standard for evaluation of Meckel's diverticulum.

5. **Management.** A complete blood cell count, barium enema, proctoscopy, or colonoscopy may be necessary, depending on clinical assessment.

- a. If the results of the workup are negative and the child is not anemic, observation is needed.
- b. Surgery is the definitive treatment for a bleeding Meckel's diverticulum.

C. **Polyps**

1. **Juvenile polyps**

- a. **Definition.** Juvenile polyps are inflammatory, not neoplastic, with very rare malignant potential. Usually, they are a pedunculated mass of granulomatous tissue with edema and "lakes" of mucus.

culated mass of granulomatous tissue with edema and "lakes" of mucus.

b. **Epidemiology and incidence**

- 1) Polyps occur in children 2 to 12 years of age. Occurrence peaks between 4 and 5 years of age.
- 2) The incidence is unknown but may be as high as 3%.

c. **Clinical presentation**

- 1) Symptoms include painless bleeding with bowel movements.
- 2) Solitary polyps occur in 70% of cases; 30% involve multiple polyps.
- 3) Reports of coexistent juvenile and adenomatous polyps are rare.

d. **Management**

- 1) At least one polyp should be removed for diagnosis.
- 2) Serial endoscopy is indicated in the absence of hemorrhage.
- 3) Colectomy is advised only if massive hemorrhage occurs.

2. **Peutz-Jeghers syndrome**

a. **Definition.** This inherited condition is characterized by pigmented mucocutaneous lesions and polyps of the gastrointestinal tract. Polyps are typically hamartomatous, with some adenomatous, especially in the duodenum. Most of the polyps occur in the small bowel, but they can also occur in the colon.

b. **Pattern of inheritance.** This variety of polyps has a mendelian, autosomal dominant gene of high penetrance; 50% of patients have a positive family history.

c. **Symptoms**

- 1) Rectal bleeding or melena
- 2) Recurrent episodes of abdominal pain secondary to intussusception
- 3) Melanin spots (ie, freckles) on lips and buccal mucous membranes also occur.

d. **Treatment.** Treatment is usually expectant, with the use of serial endoscopy.

e. **Prognosis.** The incidence of malignant degeneration is unknown.

3. **Familial adenomatous polyposis**

a. **Definition.** This is a genetically predetermined polyp formation of the mucosa of the gastrointestinal tract.

b. **Pattern of inheritance.** The disease is mendelian, autosomal dominant, with

high penetrance. Either sex can transmit familial polyps but only if the person has the disease. There is no sex predominance.

c. **Clinical presentation**

- 1) Usually, patients experience rectal bleeding or frequent stools.
- 2) Occasionally, patients with familial polyposis are asymptomatic.

d. **Incidence of malignancy**

- 1) Malignancy is rare in patients younger than 10 years.
- 2) Incidence of malignancy is 6% in patients 10 to 13 years old.
- 3) Incidence of malignancy is probably 100% by 25 years of age.

e. **Treatment.** Treatment is removal of the entire colon. The mucosa of the anal rectum is also removed and the ileum is anastomosed to the cuff of the anal rectal muscle (Soave procedure).

D. **Intussusception**

1. The most common intussusception is ileocolic.

2. **Epidemiology.** The common age range is 3 months to 2 years; the highest incidence of the disorder occurs at age 6 months.

3. **Diagnosis**

a. **Clinical presentation**

- 1) If the patient is younger than 3 months or older than 2 years, an intestinal anomaly such as Meckel's diverticulum or a polyp should be suspected as a lead point for the intussusception.
- 2) A triad of colicky abdominal pain (alternating with periods of lethargy), an elongated, sausage-like abdominal mass in the right side of the abdomen, and stools containing bloody mucous ("currant jelly" stools) is typical, but all of these components are not invariably present.

b. **Rectal examination.** Bimanual rectal examination is essential because the leading edge of the intussuscepted bowel is often best palpated by this maneuver.

c. **Barium or air enema.** Barium or air enema is diagnostic and, in most infants, is curative. This procedure must be per-

**Barium or air enema
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formed by an experienced pediatric radiologist.

4. **Treatment.** Hydrostatic reduction under fluoroscopic control (barium enema) is a safe form of treatment with adherence to the following guidelines:

a. **Preoperative management**

- 1) A senior surgical resident should examine the patient, and the usual prerelaxation preparations should be made before any attempt at reduction is made.
- 2) The patient should be started on intravenous fluids and may be sedated with morphine.
- 3) Enema reduction should not be performed if the child has peritoneal signs. This patient should be resuscitated with intravenous fluids, administered intravenous antibiotics, given a nasogastric tube, and taken to the operating room expeditiously for manual reduction.

b. **Operative management**

- 1) The senior surgical resident should be present during the enema.
- 2) Reduction is not considered successful unless there is reflux of air or barium into the ileum.
- 3) Repeat attempts can be made if the patient's condition permits.
 - a) The "rule of 3s" states that barium reduction should be attempted three times, for 3 minutes each attempt, with the barium suspended at a height of 3 feet above the patient.
 - b) Manual reduction should be attempted if enema reduction is unsuccessful.

c. **Postoperative management**

Appendicitis is by far the most common problem requiring abdominal surgery in childhood.

- 1) The patient should always be admitted to the hospital for 24 hours of observation.
 - 2) The patient should be given nothing by mouth for the first 12 hours, after which diet can gradually be advanced.
- d. **Recurrence of symptoms**
- 1) If symptoms recur, enema reduction should be attempted again.
 - 2) Bowel resection is required if either enema reduction or manual reduction cannot be accomplished.
 - 3) Following hydrostatic or manual reduction, 5% of children experience a recurrence of symptoms.

III. APPENDICITIS

- A. **Definition.** Appendicitis is inflammation of the vermiform appendix.
- B. **Incidence.** The most frequently encountered surgical problem in the emergency department is the evaluation of abdominal pain to rule out appendicitis. Appendicitis is by far the most common problem requiring abdominal surgery in childhood. Appendicitis in children younger than 3 years is infrequent, accounting for approximately 2% of all cases.
- C. **Clinical presentation**
1. Abdominal pain
 - a. The pain may begin in the periumbilical area or epigastrium.
 - b. Usually (but not always) the pain then shifts to the right lower quadrant.
 2. Anorexia, nausea, and vomiting may be present but are not discriminating signs. Abdominal pain usually *precedes* vomiting.
 3. Fever and leukocytosis tend to be minimal when the patient presents early in the course of the disease.

D. **Diagnosis**

1. **Physical examination**

- a. Consistent, localized point tenderness is the cardinal reliable sign; other physical findings tend to vary.
 - 1) The peritoneal cavity is six-sided, and localized pain indicates where the appendix or its inflammatory fluid resides (eg, retrocecal or pelvic location).
- b. A rectal examination is necessary in all cases of abdominal pain because it may be the only way to detect tenderness associated with a retrocecal appendix or to feel a pelvic mass, phlegmon, or abscess.
- c. An initial examination should be performed by a surgeon as soon as the surgical service is notified of the patient.

2. **Radiography**

- a. A calcified fecalith seen on an abdominal radiograph may be strong evidence of appendicitis.
- b. If history and physical examination strongly suggest appendicitis, a radiograph is not needed.

3. **Differential diagnosis.** Differential diagnosis of appendicitis in children includes acute mesenteric adenitis, acute gastroenteritis, Meckel's diverticulitis, and intussusception.

E. **Treatment**

1. **Appendicitis without perforation**

- a. **Observation.** Some cases of abdominal pain should be observed, with repeat examinations performed by the same physician over 6 to 12 hours. Based on these examinations, patients whose diagnoses are in question should be admitted.
- b. **Appendectomy.** Surgery should be performed as soon as possible after diagnosis.
 - 1) **Antibiotic therapy.** All patients should be treated preoperatively with antibiotics. Postoperative antibiotic therapy is determined by the operative findings.
 - 2) **Hospital discharge**
 - a) When the appendectomy is performed soon after symptom onset, discharge from the hospital is usually within 2 days after surgery.

- b) When diagnosis and treatment are not accomplished early enough, the incidence of intra-abdominal abscess and wound infection increases.
- 2. **Appendicitis with perforation.** In children younger than 3 years, the appendix is usually perforated by the time the child is brought to the emergency department.
 - a. **Preoperative management**
 - 1) Fluids should be administered in a manner that brings the child to a euvoletic status.
 - 2) Hypothermia should be controlled.
 - 3) Antibiotic therapy should be administered on admission.
 - b. **Surgical management**
 - 1) Appendectomy is always indicated.
 - 2) The peritoneal cavity should be explored via an incision in the right lower quadrant.
 - 3) Limited peritoneal débridement should be performed.
 - c. **Hospital discharge.** The patient can be discharged on the fifth to seventh postoperative day if both of the following conditions apply:
 - 1) The patient is afebrile for 24 hours after antibiotic administration is stopped.
 - 2) Leukocyte count is 10,000/mm³ or less, with a normal differential.

IV. ASPIRATION OF A FOREIGN BODY

- A. **General considerations.** If aspiration of a foreign body may have occurred, the clinician must have a high index of suspicion and a very low threshold for recommending endoscopic examination; otherwise, excessive morbidity and mortality result. Foreign body aspiration occurs most commonly in toddlers but may be seen in older children or infants as well.
- B. **Laryngeal foreign body**
 - 1. **Management**
 - a. A foreign body lodged in the oropharynx or glottis may warrant immediate attention to clear the airway using one or more of the following means:
 - 1) The Heimlich maneuver
 - 2) Dislodgment using a finger

Fewer than 10% of aspirated foreign bodies are located above the carina; most slip into the bronchus.

- 3) Direct laryngoscopy
- 4) Bronchoscopy
- b. If there is time to move the patient to surgery, a mask airway should be maintained and laryngoscopy performed in the controlled conditions of the operating room. If the patient is ventilating adequately when seen, no maneuvers should be performed until the patient is in the operating room, where conditions and equipment are ideal.
- C. **Tracheobronchial foreign body**
 - 1. **Incidence.** Fewer than 10% of aspirated foreign bodies are located above the carina. Most foreign bodies slip into the bronchus; most are located in the right mainstem bronchus.
 - 2. **Morbidity.** The consequences of a neglected foreign body in this region are quite serious and include atelectasis, recurrent pneumonia, and eventual destruction of the segment or lobe.
 - 3. **Diagnosis**
 - a. **Radiography**
 - 1) Plain chest radiograph will reveal the foreign body if the object is radiopaque. Radiopaque objects include bottle caps and some toys.
 - 2) However, most foreign bodies are not radiopaque. Radiolucent foreign bodies most frequently encountered include peanuts, carrots, hot dogs, grapes, aluminum pop-tops, and wood and plastic objects.
 - b. **Fluoroscopy.** Fluoroscopy can detect subtle mediastinal shifts during expiration and inspiration but cannot necessarily pinpoint the side of the patient's body in which the object resides.
 - 1) A foreign body that totally obstructs the bronchus leads to slow lung

If an esophageal foreign body is a miniature battery, immediate removal is indicated because batteries cause rapid tissue necrosis.

collapse and slow mediastinal shift toward the side where the offending object resides.

2) More often, partial occlusion of the lumen causes a “ball-valve effect,” with subsequent trapping of air on the side of the lesion and mediastinal shift away from the side where the foreign body resides.

4. **Removal**

- a. An aggressive approach is warranted. History alone may be sufficient to warrant admission and endoscopy, even in the absence of physical and radiographic findings.
- b. A bronchoscope greatly facilitates foreign body removal from the tracheobronchial tree.
- c. A fine Fogarty arterial embolectomy balloon passed beyond the object can aid in its removal, particularly if the object is fragile (eg, peanuts).

D. **Esophageal foreign body**

1. **Morbidity.** A foreign body that lodges in the esophagus can cause respiratory distress in small children. Objects tend to lodge just above the cricopharyngeal muscle, usually behind the larynx or cervical trachea, thereby impinging on or obstructing the airway.
2. **Diagnosis** is by radiography.
 - a. A chest radiograph will locate the object if it is radiopaque.
 - b. An abdominal radiograph will determine if the object has slipped through to the stomach.
 - c. A barium swallow is occasionally required. This procedure must be performed by a skilled pediatric radiologist to avoid aspiration.
3. **Removal.** An esophageal foreign body should

be removed endoscopically with the patient under general anesthesia.

- a. If the foreign body is a miniature battery, immediate removal is indicated because batteries cause rapid tissue necrosis.
- b. After the object has been removed, the esophagoscope should be reintroduced to assess the status of the esophageal wall at the site of impaction and manipulation.
- c. A postoperative chest radiograph is indicated for all patients.

E. **Gastrointestinal foreign body**

1. Once in the stomach, most foreign bodies safely traverse the gastrointestinal tract, usually within 4 to 5 days of aspiration. Sites where foreign bodies are more likely to lodge are the pylorus, Treitz’s ligament, and the ileocecal valve.
2. If the object is radiopaque, it can be followed through serial radiography. The patient’s stools should be checked for appearance of the object. The child should be followed for abdominal pain, vomiting, or blood in the stool.
3. If it is still in the stomach after 4 to 6 weeks, the object can be retrieved by gastroscopy.
4. A battery should be removed from the stomach immediately.

V. **TUMORS**

A. **Wilms’ tumor**

1. **Pathology**

- a. A Wilms’ tumor, also called a nephroblastoma, is a renal embryoma.
- b. At presentation, the tumor is typically confined within the renal capsule, but it may invade neighboring structures, particularly the renal vein.
- c. Its mechanism of metastasis is hematogenous and lymphatic.

2. **Epidemiology**

- a. Typically presents in children younger than 5 years
- b. No sex predilection
- c. Commonly found in children with genitourinary anomalies, aniridia, or hemihypertrophy

3. **Clinical presentation.** The tumor typically presents as an asymptomatic mass.

Frequently Encountered Problems in Pediatric Surgery: II

Table 2. Characteristics and Treatment of Wilms' Tumor According to Stage

Stage	Characteristics	Treatment
Stage I	One kidney, completely excised	Surgery and chemotherapy (10 weeks to 6 months)
Stage II	Tumor extends locally, completely excised	Surgery and chemotherapy (18 months)
Stage III	Residual tumor, local	Surgery, chemotherapy, and radiation therapy (15 months)
Stage IV	Hematogenous metastasis	Surgery, chemotherapy, and radiation therapy (18 months)
Stage V	Bilateral involvement	Varies

Table 3. Characteristics and Treatment of Neuroblastoma According to Stage

Stage	Characteristics	Treatment
Stage I	Confined to organ of origin, completely excised	Surgery
Stage II	Local invasion	Surgery and/or chemotherapy and/or radiation therapy
Stage III	Tumor crosses midline	Surgery and/or chemotherapy and/or radiation therapy
Stage IV	Distant metastasis	Chemotherapy
Stage IVs	Small primary tumor; metastases limited to liver, skin, or bone marrow	Surgery and chemotherapy and/or radiation therapy

- a. Slightly more common on the left
 - b. Bilateral in fewer than 10% of cases
 4. **Diagnosis**
 - a. Ultrasonography and computed tomography (CT) are the main diagnostic studies used.
 - b. Chest radiography is routinely used to rule out pulmonary metastases.
 5. **Treatment and prognosis.** Treatment is multimodal (**Table 2**); prognosis depends on tumor stage and histology.
- B. Neuroblastoma**
1. **Pathology.** A neuroblastoma is of neural crest origin and may arise in the adrenal medulla or anywhere along the sympathetic ganglia.
 2. **Epidemiology.** Most children are younger than 5 years when the tumor is diagnosed, with a peak incidence of 18 months. Other anomalies are unusual with this tumor.
 3. **Clinical presentation**
 - a. The tumor typically presents as an asymptomatic mass.
 - 1) Seventy-five percent of neuroblastomas occur in the abdomen.
 - 2) Twenty percent of neuroblastomas occur in the chest.
 - 3) Five percent of neuroblastomas occur in the neck and pelvis.
 - b. Fever, weight loss, failure to thrive, anemia, and neurologic deficits may be evident.
 4. **Diagnosis**
 - a. CT and magnetic resonance imaging are used to delineate the tumor.
 - b. Radiographic detection of the presence of calcium in the mass is suggestive of neuroblastoma.
 5. **Management**
 - a. **Preoperative treatment.** Bone marrow biopsy and urinary catecholamines are necessary.
 - b. **Treatment** of neuroblastoma according to disease stage is presented in **Table 3**.
- C. Rhabdomyosarcoma**
1. **Definition.** Rhabdomyosarcoma is a tumor of striated muscle. This tumor may occur in essentially any part of the body.
 2. **Epidemiology**
 - a. Most common soft tissue tumor in children
 - b. Accounts for 8% of tumors in children
 - c. Fifth most common tumor in children

(after leukemia, central nervous system tumors, Wilms' tumor, and neuroblastoma)

3. **Treatment.** Treatment typically combines surgery, chemotherapy, and radiation therapy.
 4. **Prognosis.** Prognosis is guarded.
 - a. Good results are seen in patients with tumors that can be completely excised.
 - b. Patients with advanced stages of the disease have much poorer results.
- D. **Germ cell tumors**
1. **Clinical presentation**
 - a. Germ cell tumors usually present as a mass.
 - b. Hormonally active tumors may present as precocious development of secondary sexual characteristics.
 2. **Management**
 - a. **Preoperative treatment.** Alpha fetoprotein and beta human chorionic gonadotropin levels should be obtained.
 - b. **Treatment.** These tumors are treated with surgery and, for advanced cancers, chemotherapy.

2. **A 3-year-old boy choked and turned blue while playing with a Lite-Brite toy. In the emergency department, he is wheezing but is otherwise in no acute distress. His mother thinks he coughed out the small plastic peg because she retrieved one from his mouth shortly after the choking episode. The most appropriate management is:**
 - A) An inspiratory/expiratory radiograph series followed by bronchoscopy if needed
 - B) Discharge because the patient is essentially asymptomatic
 - C) Admission to the hospital with repeat radiographs the next day
 - D) CT scan of the lung
 - E) Ultrasonography of the lung
3. **In children, the most common type of malignant germ cell tumor of the testicle is:**
 - A) Teratoma
 - B) Seminoma
 - C) Dysgerminoma
 - D) Endodermal sinus tumor
 - E) Sertoli cell tumor
4. **The most appropriate management of a patient with a stage II Wilms' tumor with favorable histology is:**
 - A) Actinomycin D and vincristine
 - B) Vincristine, actinomycin D, and cyclophosphamide
 - C) Adriamycin, vincristine, and cyclophosphamide
 - D) Ifosfamide and etoposide
 - E) Radiation therapy

BOARD REVIEW QUESTIONS

1. **A 4-month-old, otherwise healthy boy has been irritable and has had bloody stools for 24 hours. Physical examination shows a mildly distended but nontender abdomen. On rectal examination, a luminal mass is felt at the tip of the examining finger. Following intravenous resuscitation and insertion of a nasogastric tube, the most appropriate next step in management is:**
 - A) Upper gastrointestinal study
 - B) Meckel's scan
 - C) Contrast enema
 - D) Laparoscopy
 - E) Laparotomy

ANSWERS

4. A
3. D
2. A
1. C

SUGGESTED READINGS

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