Chapter

11 Gastrointestinal Tract Infections

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Gastroenteritis

- Acute diarrhea: Abrupt increase of fluid content in stool (more than 10 mL/kg/d). Frequency of bowel movements ranges from 1 to 20 or more times per day
- Chronic diarrhea: Diarrhea lasting more than 14 days

Epidemiology/Risk Factors

- Worldwide: 1 billion episodes; 3 million to 5 million deaths annually in children
- US: 1 to 2 episodes per year in children younger than 5 years; 300 to 400 deaths per year
- Child care/nosocomial outbreaks (enteric viruses, *Giardia lamblia*); travel to developing country (*Campylobacter, Shigella*, or *Salmonella* spp., enterotoxigenic *Escherichia coli*); antibiotic-associated (*Clostridium difficile*); seafood (*Vibrio* spp., *Plesiomonas shigelloides*)

Etiology (Acute Infectious Diarrhea)

- **Viruses:** Rotavirus, calicivirus, astrovirus, enteric adenovirus (types 40 and 41)
- **Bacteria:**
  - Common: *Campylobacter jejuni*, *Shigella* spp., *Salmonella* spp., *E. coli*
  - Less common: *Yersinia enterocolitica*, *Bacillus cereus*, *C. difficile*
  - Rare: *Vibrio* spp., *Staphylococcus aureus*, *Clostridium perfringens*, *P. shigelloides*, *Aeromonas hydrophila*
- **Other:** See next section for discussion of intestinal parasites. Immunocompromised hosts may be infected with cytomegalovirus (CMV), herpes simplex virus (HSV), *Cryptosporidium ovale*.

Pathogenesis

- Many pathogens use more than one mechanism

- Noninflammatory: Affects proximal small bowel by enterotoxin adherence. Causes watery diarrhea. Examples: *Vibrio cholerae, Y. enterocolitica*
- Inflammatory: Invade GI tract epithelium. May cause dysentery. Examples: *Salmonella* and *Shigella* spp.

History

- Food- or water-borne illness
  - Incubation: Less than 6 hours (preformed toxin: *S. aureus, B. cereus*); 8 to 16 hours (*C. perfringens, B. cereus*); 16 to 96 hours (*Shigella*, *Salmonella*, *Vibrio* spp., invasive *E. coli*, *C. jejuni*, *Y. enterocolitica*, caliciviruses)
- Determine duration of illness, stooling pattern (frequency, volume, blood/mucus), travel and ingestion history (see "Epidemiology/Risk Factors"), hydration status
- Other symptoms: Fever, emesis, abdominal pain, rash, tenesmus

Physical Examination

- Signs of dehydration: Absence of tears, dry mucous membranes, decreased skin turgor, prolonged capillary refill, cool peripheral skin temperature, diminished pulse volume and elevated rate, and normal or low blood pressure
- Gastrointestinal: Tenderness, abdominal distention or mass, bowel sounds, rectal examination with hemoccult testing

Additional Studies

- Stool examination for blood and leukocytes
  - Positive fecal leukocyte examination indicates presence of an invasive or cytotoxin-producing organism such as *Shigella* spp., *Salmonella enteritidis, C. jejuni*, invasive *E. coli*, *C. difficile, Y. enterocolitica*, *Vibrio parahaemolyticus,* or *Aeromonas*
- Stool culture for bacteria (see Chapter 1)
- Consider stool antigen testing for rotavirus, adenovirus, *Giardia*, and *Cryptosporidium* (also see "Intestinal Parasites")

Differential Diagnosis

- Anatomic (e.g., Hirschsprung enterocolitis, short bowel syndrome, malrotation)
- Malabsorption (e.g., celiac disease, fructose intolerance, sucrase or lactase deficiency, Shwachman disease, glucose-galactose transport defect)
- Neoplasms (e.g., neuroblastoma, pheochromocytoma)
- Poisoning (e.g., heavy metals, mushrooms, scombroid)
- Endocrinopathy (e.g., thyrotoxicosis, Addison disease)
- Food allergy (e.g., cow milk or soy protein)

TABLE 11-1 Antimicrobial Therapy for Bacterial Enteropathogens

Bacteria	Indication	Antibiotic
Aeromonas spp.	Prolonged disease	TMP-SMX, ciprofloxacin
Campylobacter jejuni	Severe or systemic infection, immunodeficiency	Azithromycin, fluoroquinolones, erythromycin
Clostridium difficile	Symptomatic, not improving	Metronidazole (PO/IV) or oral vancomycin or cholestyramine
Escherichia coli	Severe or systemic infection	TMP-SMX, fluoroquinolones[a]
Salmonella spp.	Age <3 months, immunodeficiency, dissemination	Ampicillin, cefotaxime, ciprofloxacin, azithromycin
Shigella spp.	Dysentery	Ceftriaxone, azithromycin, fluoroquinolones, TMP-SMX
Vibrio cholerae	Treatment decreases illness duration	Ciprofloxacin, TMP-SMX, tetracyclines
Yersinia enterocolitica	Sepsis, immunodeficiency	Cefotaxime, TMP- SMX, fluoroquinolones

[a] Antibiotic management of *E. coli* 0157:H7 may increase risk of hemolytic-uremic syndrome.

- Miscellaneous (e.g., inflammatory bowel disease, vasculitis, laxative abuse)

Management

- Fluid and electrolyte replacement; precautions to prevent spread of enteropathogen; specific therapy if indicated (Table 11-1)

Complications

- Extraintestinal manifestations:
  - Erythema nodosum (*Campylobacter, Salmonella, Y. enterocolitica*)
  - Hemolytic-uremic syndrome (*E. coli, Shigella dysenteriae, Salmonella typhi, C. jejuni*)
  - Reactive arthritis (*C. difficile, C. jejuni, S. dysenteriae, S. enteritidis, C. ovale, Y. enterocolitica*)
  - Seizures (*S. dysenteriae*)

Intestinal Parasites

Epidemiology/Etiology

See Table 11-2.

TABLE 11-2 Parasitic Intestinal Infections

Parasite	Geographic Distribution	Treatment	Alternative Therapy
Stomach			
Anisakis sp.	Scandinavia, Holland, Japan, Pacific Coast of South America	Endoscopic or surgical larvae removal	—
Small Intestine			
Giardia lamblia	Prevalence highest in developing world (up to 30%)	Metronidazole (5 mg/kg TID × 3 d)	Tinidazole, mepacrine, furazolidone, paromomycin, quinacrine
Blastocystis hominis	Worldwide	Metronidazole (20–35 mg/kg divided TID × 10 d)	Furazolidone, tinidazole
Cryptosporidium parvum	Countries with high AIDS prevalence	Nitazoxanide (100–200 mg BID) (therapy only needed for patients with AIDS)	Azithromycin + paromomycin
Isospora belli	S. America, Africa, SE Asia	Trimethoprim (5 mg/kg)-sulfamethoxazole (25 mg/kg) BID × 7–10 d)	Pyrimethamine (50–75 mg/day) + folinic acid
Cyclospora cayetanensis	Developing countries	Same as for *Isospora belli*	—
Strongyloides stercoralis	Tropics, eastern Europe, Australia, southern US	Albendazole (400 mg BID × 3 d), ivermectin (200 ig/kg/d × 1–2 d)	Thiabendazole (25 mg/kg BID × 2–3 d)
Trichinella spiralis	Worldwide in communities consuming pork meat	Mebendazole (200 mg TID × 3 d, followed by 400 mg TID × 10 d)	—
Ascaris lumbricoides (roundworm)	Prevalence highest in developing world	Albendazole (200–400 mg single dose) or mebendazole (500 mg single dose)	Levamisole (5 mg/kg single dose), piperazine citrate, pyrantel pamoate
Ankylostoma duodenale (hookworm)	Africa, Asia, Australia, southern Europe	Mebendazole (100 mg BID × 3 d)	Albendazole (400 mg single dose)
Necator americanus (hookworm)	Central and South America, SE Asia, Pacific	Mebendazole (100 mg BID × 3 d)	Albendazole (400 mg single dose)
Taenia saginata	Worldwide, more in Central Africa	Praziquantel (5–10 mg/kg single dose)	Niclosamide (50 mg/kg single dose)

Risk Factors

- Immunocompromised host; immigration from or travel to endemic areas
- Day care attendance; contact with infected animals
- Contaminated food or water (including swimming pools)

Pathogenesis

- Transmission almost exclusively by fecal-oral route
- Involvement may vary from asymptomatic carriage to invasive infection

History/Physical Examination

- Travel and dietary history
- Abdominal pain, diarrhea, tenesmus, bloating, flatulence
- Fever, emesis, anorexia
- Wheezing (*Strongyloides stercoralis, Ascaris lumbricoides*)
- Muscle pain or skin rash (*Trichinella spiralis*)
- Pruritis ani (often nocturnal) (*Enterobius vermicularis*)
- Local skin reaction at the site of larvae penetration (*S. stercoralis, Ankylostoma duodenale*)
- Failure to thrive and growth impairment with chronic infections
- Evaluate for dehydration, abdominal obstruction or mass

Additional Studies

- Stool for ova and parasites (see Chapter 1): Several not found on standard ova and parasite testing (C*ryptosporidium parvum*, *Cyclospora cayetanensis*, and *Microsporidia* species)
- Duodenal aspirate (during endoscopy, or swallowed string test)
- Tape test (*E. vermicularis*)
- Mucosal biopsy (*G. lamblia*, *S. stercoralis*, C. *parvum*, *Entamoeba histolytica*)
- Enzyme-linked immunosorbent assay (ELISA) for giardiasis, amebiasis, cryptosporidiosis
- Serology for helmintic infections (*S. stercoralis*, trichinosis)
- Serum eosinophilia
- Muscle biopsy (*T. spiralis*)

Management

See Table 11-2.

Complications

- Hepatic abscess (amebiasis)
- Seizures (*Taenia solium*)
- Pneumonitis, myocarditis, encephalitis (*T. spiralis)*

- Intestinal and biliary obstruction, intussusception (*A. lumbricoides*)
- Iron deficiency anemia (*A. duodenale*)
- Megaloblastic anemia (*Diphyllobothrium latum*)
- Rectal prolapse (*Trichuris trichiura*)

Hepatitis

- Hepatitis: Clinical or biochemical evidence of hepatic dysfunction
- Classification: Acute (less than 6 months) or chronic (more than 6 months)

Epidemiology

- Schistosomiasis is most common cause worldwide (more than 200 million per year)
- Hepatitis B: 0.1% incidence in North America
- Hepatitis C: Prevalence is 1.8% of the general population in the United States, seroprevalence in children 0 to 12 years old is 0.2%

Risk Factors

- Poor hygiene, contaminated water (hepatitis A and E, parasites)
- Intravenous drug use; sex with an infected person; blood transfusion; hemodialysis; medical personnel exposed to blood; body piercing and tattooing (hepatitis B and C, HIV)
- Maternal-fetal transmission (hepatitis B and C, HIV)

Etiology/Pathogenesis (Box 11-1)

- Cellular hepatocyte damage may occur due to direct cytopathic effect or, more commonly, due to immune-mediated injury

History/Physical Examination

- Fever, fatigue, anorexia
- Jaundice, scleral icterus, abdominal pain, pruritus, diarrhea, dark urine
- Hepatomegaly (often painful), splenomegaly (with viruses)
- Rash (e.g., syphilis, Lyme disease, hepatitis B)

Additional Studies

- Elevated alanine aminotransferase (ALT) or aspartate aminotransferase (AST)
- ALT (mainly present in the liver) is more specific for liver disease than AST
- Elevated bilirubin, alkaline phosphatase, and γ-glutamyltransferase (GGT) suggest cholestasis
- Liver synthetic function: Serum albumin level, prothrombin time (PT) and partial thromboplastin time (PTT)

BOX 11-1 Causes of Infectious Hepatitis by Type of Organism

Virus
Hepatitis virus A, B, C, D, E, G
Cytomegalovirus
Epstein-Barr virus
Herpes simplex virus
Adenovirus
Enterovirus
Coxsackie virus
HIV
Echovirus
Reovirus

Bacteria
Salmonella typhi (typhoid fever)
Brucella melitensis (brucellosis)
Bartonella henselae (cat-scratch)
Borrelia burgdorferi (Lyme disease)
Leptospira interrogans (leptospirosis)
Rickettsia rickettsii
Coxiella burnetii (Q fever)
Treponema pallidus (syphilis)

Parasite
Entamoeba histolytica (amebiasis)
Plasmodium spp. (malaria)
Ascaris lumbricoides
Echinococcus granulosus
Schistosoma species
Clonorchis sinensis (liver fluke)
Fasciola hepatica
Leishmania donovani
Toxocara canis

Fungi
Candida species
Histoplasma capsulatum
Aspergillus species
Cryptococcus neoformans
Coccidioides immitis
Penicillium marneffei
Trichosporon cutaneum

- Serologic tests for hepatitis viruses (Table 11-3)
- Abdominal ultrasound of the liver, biliary tree, and spleen to diagnose anatomic abnormalities
- Percutaneous liver biopsy may be required for diagnosis

TABLE 11-3 Interpretation of Serologic Tests in Hepatitis A, B, C, D, and E

Virus	Test	Acute Disease	Chronic Disease	Complete Recovery
Hepatitis A	HA IgM	+	N/A	–
	HA IgG	+	N/A	+
Hepatitis B	HBsAg	+	+	–
	HBsAb	–	–	+
	HBcAb	+ (IgM)	+ (IgG)	+ (IgG)
Hepatitis C	HCV PCR	+	+	–
	HCV Ab	+	+	+
Hepatitis D	HDV Ag	+	+	–
	HDV IgM	+	–	–
	HDV IgG	–	+	–
Hepatitis E	HE Ag	+	N/A	–
	HE IgM	+	N/A	–
	HDV PCR	+	N/A	–

Differential Diagnosis

- Cholecystitis, drug/toxin-induced, autoimmune hepatitis, Wilson disease, α_1-antitrypsin deficiency, inborn metabolic errors, sclerosing cholangitis, hepatic malignancy, vascular disorders (e.g., Budd-Chiari), others (Crohn)

Management

- Antibiotic treatment of bacterial, parasitic, and fungal hepatitis depends on the individual organism and severity of disease
- Most viral hepatitides are self-limited (e.g., CMV, Epstein-Barr, hepatitis A and E)
- Hepatitis B and C may progress to chronic hepatitis and require specific therapy to minimize complications
  - Hepatitis B: Subcutaneous interferon-α (three times a week for 4 to 6 months), or oral lamivudine
  - Hepatitis C: Pegylated interferon, and oral ribavirin

Complications

- Chronic hepatitis B and C: Cirrhosis, portal hypertension, and hepatocellular carcinoma (1.5 cases per 100 patients with cirrhosis). Fulminant hepatitis in 5% with hepatitis B and D coinfection
- Ascariasis, schistosomiasis, fascioliasis: Abscess or biliary obstruction
- Echinococcosis: Hydatid cyst formation, anaphylaxis with cyst rupture

Peritonitis

- Primary spontaneous bacterial peritonitis (SBP): Pathogenic bacteria in peritoneal fluid *without* an identified intra-abdominal source of infection
- Secondary bacterial peritonitis: Peritoneal infection *secondary* to an abdominal source, such as perforation of an abdominal viscus

Epidemiology/Risk Factors

- Risk factors: Appendicitis; chronic renal failure (occurs in up to 17% of patients with nephrotic syndrome); liver failure; peritoneal dialysis; ventriculoperitoneal (VP) shunt
- Also occurs in 2% to 17% of processes that perforate intestine (e.g., trauma, necrotizing enterocolitis, volvulus)

Etiology

- Common: *Streptococcus pneumoniae* (previously healthy children), S. *aureus* (dialysis catheters, VP shunts), gram-negative enteric bacilli (cirrhosis), coagulase-negative staphylococci (VP shunts)
- Less common: *Candida* spp., *Neisseria meningitidis*, *Haemophilus influenzae* type b (unimmunized)

Pathogenesis

- Primary SBP: Hematogenous or lymphatic spread to peritoneum
- Secondary bacterial peritonitis: Intestinal perforation

History/Physical Examination

- 10% of patients are entirely asymptomatic
- Acute febrile illness (50% to 80%), generalized abdominal pain
- Rebound tenderness, decreased bowel sounds, diarrhea, hypotension

Additional Studies

Paracentesis:

- Free air, blood, or bile suggest intestinal perforation
- WBCs in peritoneal fluid greater than 250/mm^3 support the diagnosis of peritonitis (often more than 3000/mm^3)
- In secondary bacterial peritonitis, ascitic fluid analysis usually reveals: Total protein greater than 1 g/L; lactate greater than 25 mg/dL; Glucose less than 50 mg/dL

■ ***Blood cultures:***

- Blood cultures positive in 75% of primary SBP and occasionally with secondary bacterial peritonitis

■ **Differential Diagnosis**

- Other infections may mimic peritonitis: Mesenteric adenitis, gastroenteritis, streptococcal pharyngitis, lower lobe pneumonia, urinary tract infection

■ **Management**

- Empiric therapy: Cefotaxime or ceftriaxone
  - Add vancomycin for life-threatening or VP shunt–related infections
  - Add aminoglycoside for secondary bacterial peritonitis
  - Alternative regimens: Ampicillin-sulbactam, ticarillin-clavulanate, piperacillin-tazobactam, or carbapenem antibiotics
  - Repeat paracentesis may be indicated after 48 hours to ensure waning WBC count. If WBC count remains elevated or organisms continue to be cultured, suspect antibiotic-resistant organisms or secondary bacterial peritonitis.
- Secondary bacterial peritonitis: Surgical intervention to resolve underlying cause of abdominal infection

■ **Complications**

- Mortality: 30% to 40%; probability of primary SBP recurrence at one year is 70%; respiratory compromise may occur due to secondary to diaphragmatic spasm and abdominal rigidity

Cholangitis

- Pathologic biliary system inflammation

■ **Epidemiology/Risk Factors**

- Any disease with poor bile flow leading to biliary stasis. Especially:
  - Biliary drainage via a Roux-en-Y limb that approximates the small intestine to the porta hepatis (Kasai procedure for biliary atresia)
  - Liver transplantation (occurs in 10% of transplants, usually in first 2 months)
  - Intrahepatic cholestatic liver diseases (e.g., Alagille syndrome)

■ **Etiology**

- Common: *E. coli*, *Klebsiella* spp., *Enterococcus*, anaerobes (10% to 30% of cases)

- Less common: *Enterobacter* spp., *Pseudomonas aeruginosa*
- Rare: Other gram-negative bacilli, *Cryptococcus* (HIV), *Cryptosporidium*

Pathogenesis

- Bile is typically sterile
- Biliary infection due to either ascending infection from gut lumen or hematogenous spread from portal venous circulation during bacteremia

History/Physical Examination

- History of cholestatic liver disease
- Charcot triad (fever/chills, right upper quadrant pain, jaundice) in more than 50%

Additional Studies

- Elevated transaminases or bilirubin from baseline
- Alkaline phosphatase or GGT commonly are elevated
- Blood cultures positive in approximately 50%
- Bile or hepatic (via biopsy) cultures usually positive

Differential Diagnosis

- Esophagitis, gastritis, gastroesophageal reflux, cholecystitis, pancreatitis, appendicitis, Fitz-Hugh-Curtis syndrome, pneumonia

Management

- Empiric antibiotics: Ampicillin-sulbactam with or without aminoglycoside or cefotaxime plus metronidazole
  - Alternative regimens: Ticarcillin-clavulanate; carbapenems; ciprofloxacin plus metronidazole.
- If fever persists longer than 72 hours, consider percutaneous liver biopsy with culture
- No consistently demonstrated benefit of antibiotic prophylaxis for recurrences

Complications

- Pyogenic liver abscess; recurrent cholangitis