

## Infectious Diseases of Children

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### Introduction

Infections are the most common cause of acute illness in children. Most commonly these are respiratory infections which peak when the child starts to go to school or out-of-home day care. Although the majority of these diseases have benign course, they cause significant discomfort, anxiety, missed work, and stress to many families caring for children. Frequent office visits, and unnecessarily prescribed medications, and sometimes dubious home remedies can be reduced by following best evidence-based practice and having a good doctor-patient (and parent) relationship.

In developed countries, morbidity and mortality from infections have declined dramatically, and deaths from infectious diseases are uncommon. However, serious infections still occur, e.g., meningococcal septicemia, meningitis, and multidrug-resistant pathogens, and some have reemerged, for example, tuberculosis and PVL-toxin-secreting *Staphylococcus aureus*, which requires early recognition and treatment. With an increase of global air travel, tropical diseases are encountered in all countries. In addition, epidemics may spread widely, e.g., SARS and H1N1 influenza, with children (and the elderly) being the most vulnerable.

Family physicians spend about 10 % of their time caring for children. About two-thirds of practicing family physicians report that they provide care for children [1]. Thus, the family physician's role in early proper management of infections is of paramount importance. Office visits must concentrate on clinical evaluation and diagnosis, appropriate management and advice, and prevention and early detection of complications. In this chapter, the clinical presentations, differential diagnosis, and management of common acute infectious diseases in children will be discussed.

### Acute Upper Respiratory Tract Infections (URTIs)

The common cold or URTI is the third most common primary diagnosis in outpatient practice.

Patients seek care for URTIs throughout the year, especially in winter, with young children commonly experiencing five to eight colds a year [2, 3]. Day-care attendance is a major risk factor for URTI in young children. Other risk factors include smoking in the home, poor nutrition, and crowded living conditions [4–6]. Colds are most commonly caused by rhinovirus although other viruses have been isolated from children presenting with typical cold symptoms such as adenoviruses, coronaviruses, enteroviruses, influenza virus, parainfluenza virus, and respiratory syncytial virus (RSV) [7]. Direct inoculation has been the main mode of transmission; rhinoviruses are detectable on the hands of 40–90 % of cold sufferers; viruses also can be transmitted through coughing, sneezing, and nose blowing [8, 9].

Signs and symptoms of the common cold include some combination of nasal congestion and discharge, sore throat, cough, fever, hoarseness, mild fussiness or irritability, decrease in appetite, sleep disturbance, and mild eye redness or drainage. Although most of viral URTIs are self-limited, the family doctor must

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**Table 1** Differential diagnosis of a child presenting with cold symptoms

Diagnosis	Signs and symptoms	Diagnostic test	Management
Viral URI	Some combination of the following: Nasal congestion and discharge, fever, sore throat, cough, hoarseness, mild fussiness or irritability, decrease in appetite, sleep disturbance, mild eye redness, or drainage [3]	Clinical picture Usually no testing is needed	Symptomatic treatment: Complementary therapy such as vapor rub, zinc sulfate syrup, buckwheat honey (avoid in children <1 year old – risk of botulism), nasal irrigation with saline, high-dose inhaled corticosteroids (for children who are wheezing) Prophylaxis: Complementary therapies such as probiotics, Vitamin C, Chizukit herbal preparation, nasal saline irrigation [8]
Acute bacterial rhinosinusitis (ABRS)	Any of the following presentations: Persistent illness [nasal discharge (of any quality) <i>or</i> daytime cough <i>or</i> both lasting more than 10 days without improvement] A worsening course (worsening or new onset of nasal discharge, daytime cough, or fever after initial improvement) Severe onset (concurrent fever/temperature $\geq 39$ °C and purulent nasal discharge for at least 3 consecutive days) [10, 11]	NO routine imaging studies are needed CT or MRI for sinuses ONLY when a child is suspected of having orbital or central nervous system complications of ABRS [10, 11]	Antibiotic Rx for severe onset or worsening course (signs, symptoms, or both) Prescribe antibiotic therapy <i>or</i> offer additional outpatient observation for 3 days to children with persistent illness Amoxicillin with or without clavulanate is first-line treatment In penicillin-allergic patients, second of third-generation cephalosporins or levofloxacin or clindamycin plus a third-generation oral cephalosporin (cefixime or cefpodoxime) Reassess if there is either a caregiver report of worsening (progression of initial signs/symptoms or appearance of new signs/symptoms) or failure to improve within 72 h of initial management: *consider modification of antibiotic for the child initially managed with antibiotic if worsening symptoms or failure to improve * <i>or</i> initiate antibiotic treatment for the child initially managed with observation [10, 11]
Group A streptococcal pharyngitis (GAS)	Sudden onset of sore throat in a child aged 5–15 years Systemic symptoms (fever, headache, occasional nausea, vomiting, abdominal pain) Tonsillopharyngeal erythema, patchy tonsillopharyngeal exudates, palatal petechiae	Throat swab for rapid antigen detection test (RADT) and/or culture Negative RADT should be backed by throat culture Not indicated for children <3 years old [12]	Antibiotic for 10 days (except azithromycin for 5 days) as follows: for non-penicillin-allergic patients, penicillin or amoxicillin (drugs of choice); *for penicillin-allergic individuals (not anaphylaxis), first-generation cephalosporin Clindamycin, clarithromycin, or

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**Table 1** (continued)

Diagnosis	Signs and symptoms	Diagnostic test	Management
	Anterior cervical adenitis (tender nodes), scarlatiniform rash Winter and early spring presentation. History of exposure to strep pharyngitis [12]		azithromycin Adjunctive therapy to manage symptoms: acetaminophen or NSAIDs;*DO NOT use aspirin; *use of corticosteroids is NOT recommended [12]
Acute otitis media (AOM)	Moderate to severe bulging of the tympanic membrane (TM) <i>or</i> new onset of otorrhea not due to acute otitis externa <i>or</i> mild bulging of the TM <i>and</i> recent (less than 48 h) onset of ear pain <i>or</i> intense erythema of the TM [13]	AOM should not be diagnosed in children who do not have middle ear effusion (MEE) (based on pneumatic otoscopy and/or tympanometry) [13]	Analgesics if pain is present Antibiotics should be prescribed for all children less than 6 months old, children $\geq$ 6 months old with bilateral or unilateral AOM with severe signs or symptoms, and 6–23-month-old children with bilateral AOM without severe signs or symptoms Antibiotic therapy or observation offered with close follow-up for 6–23-month-old children with nonsevere unilateral AOM and $\geq$ 24-month-old children with nonsevere AOM (either unilateral or bilateral) [13]
Whooping cough (pertussis)	Coughing illness lasting 2 weeks with one classic sign of pertussis (paroxysmal cough, post-tussive emesis, or inspiratory whoop), without another apparent cause [14]	Culture and polymerase chain reaction (PCR) testing recommended by CDC [14]	Antibiotics: azithromycin, clarithromycin, or erythromycin base;*TMP/SMX for patients who cannot tolerate macrolides; clindamycin as third line Prophylaxis: same antibiotics in same doses for contacts of case within 21 days onset of symptoms in index case Prevention: vaccination [14]
Community-acquired pneumonia (CAP)	Fever, cough, dyspnea and tachypnea, pleuritic chest pain, abdominal pain, rhonchi [3, 15]	CXR, antigenic testing for RSV and influenza A and B [15]	Hospitalization vs outpatient treatment clinical decision Empiric antibiotic treatment for 7–10 days if the clinical diagnosis favors CAP: oral amoxicillin is the drug of choice for mild CAP; macrolides (azithromycin or clarithromycin) are good alternative for penicillin-allergic patients and are the drug of choice for children 6–18 years old Symptomatic treatment: analgesics antipyretics for fever and pain (acetaminophen or ibuprofen) [15]

(continued)

**Table 1** (continued)

Diagnosis	Signs and symptoms	Diagnostic test	Management
Acute bronchitis/ bronchiolitis	For bronchitis: Cough (lasting more than 7–10 days up to 3 weeks in older children) and or wheezing; no fever; no nasal congestion or rhinorrhea; no respiratory distress For bronchiolitis: Cough, fever, rhinorrhea, wheezing, labored respirations, occasional hypoxia [16, 17]	For bronchitis: Clinical diagnosis; no tests are necessary For bronchiolitis: No laboratory or imaging needed for diagnosis; selected severe cases need admission to hospital with work-up as clinically appropriate [16, 17]	For bronchitis: No antibiotics as routine empiric treatment Symptomatic treatment: NO antitussives or expectorants, may use corticosteroid inhalers for wheezing Alternative therapies ( <i>see treatment of cold symptoms in this table</i> ) For bronchiolitis: Clinical decision: hospitalization according to risk factors and severity, fluid hydration, oxygen as needed, palivizumab only used according to strict guidelines, NO albuterol, NO epinephrine, NO systemic corticosteroids, NO antibiotic Rx unless there is evidence of concomitant bacterial infection [16–18]
Epiglottitis	Toxic appearance, alteration in voice, severe sore throat and dysphagia, stridor, drooling [3]	Clinical diagnosis Occasionally lateral neck X-ray and WBC count if clinical diagnosis is unclear [3, 17]	Needs immediate evaluation at appropriate site and ENT consultation [3]
Croup	Hoarseness, barking cough, low-grade fever, different degrees of respiratory distress (e.g., nasal flaring, respiratory retraction, inspiratory stridor) [3, 19]	Clinical diagnosis Only selected severe or atypical cases need work-up to rule out other causes [19]	General care: keep child calm, comfortable positioning; AVOID croup tent; oxygen if hypoxia; systemic corticosteroids (dexamethasone); nebulized epinephrine for severe cases [19]

recognize the signs of a serious illness early (respiratory distress, low level of responsiveness and activity, dehydration and vomiting, meningeal signs, and the presence of petechiae or purpuric rash) [3]. A diagnosis of viral URI also must be differentiated from a group of diagnoses that require specific management (Table 1 summarizes these diagnoses, their clinical presentation, diagnostic methods, and principles of their management).

The most important strategy in management of the common cold is education of patients, parents, and caregivers; they should be educated on prevention, comfort measures, and treatment recommendations. Handwashing or the use of hand sanitizers has been recommended as the best method to prevent the spread of viral upper respiratory infection; in addition encouraging breastfeeding and evaluation of day-care conditions for children have shown reduction in duration and severity of ARTIs. Comfort measures commonly used by parents, including some of complementary therapies listed in Table 1, are good choices that may help to control the symptoms and avoid the unnecessary use of antibiotics which are not indicated in the treatment of viral URTIs. Parents should be advised against the use of OTC cold and cough medicines for children younger than 6 years of age both because of the lack of benefit and also the potential harm that these preparations can result in. In addition parents should be educated about the

office call-back instructions (If fever lasts 3 days or more, symptoms worsen after 3–5 days or if new symptoms appear, or if symptoms have not improved or resolved after 7–10 days) [3, 8].

### **Acute Bacterial Rhinosinusitis (ABRS)**

Though most viral ARTIs involve the paranasal sinuses, only a small minority are complicated by bacterial sinusitis (6–8 %), and the majority of ABRS follow viral URTIs. Diagnosis of ABRS is made based on the clinical picture. The color of nasal discharge cannot be relied on to differentiate between a viral or bacterial etiology. ABRS is usually caused by *Haemophilus influenzae*, and *Moraxella catarrhalis*, or *Streptococcus pneumoniae*. Antibiotic use remains the mainstay of treatment in the latest Infectious Diseases Society of America (IDSA) guidelines. Neither antihistamines nor decongestants are recommended because they are unlikely to be of benefit and may have adverse effects [10, 20].

### **Group A Streptococcal Pharyngitis (GAS)**

GAS is the most common bacterial cause of acute pharyngitis, responsible for 20–30 % of pharyngitis in children. Accurate diagnosis of streptococcal pharyngitis followed by appropriate antimicrobial therapy is important for the prevention of acute rheumatic fever and for the prevention of suppurative complications (e.g., peritonsillar abscess, cervical lymphadenitis, mastoiditis, and, possibly, other invasive infections). The signs and symptoms of GAS and nonstreptococcal pharyngitis overlap so broadly that accurate diagnosis on the basis of clinical grounds alone is unreliable. Therefore, it is advisable for family physicians to follow the IDSA clinical practice guidelines for proper diagnostic test use and antibiotic prescription for all children with GAS where possible (Table 1). In addition to viral pharyngitis, other less common or rare causes of pharyngitis must also be considered when the tests for GAS are negative, or the clinical picture is suggestive. Infectious mononucleosis caused by Epstein-Barr virus and diphtheria caused by *Corynebacterium diphtheriae* are examples [12].

### **Acute Otitis Media (AOM)**

AOM is usually a complication of eustachian tube dysfunction that occurs during a viral upper respiratory tract infection. *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella catarrhalis* are the most common organisms isolated from middle ear fluid. Accurate diagnosis in the updated American Academy of Pediatrics (AAP) guideline endorses stringent otoscopic criteria for diagnosis. Otitis media with effusion (OME) is defined as middle ear effusion in the absence of acute symptoms. If OME is suspected and the presence of effusion on otoscopy is not evident, pneumatic otoscopy, tympanometry, or both should be used to make the diagnosis. AAP guidelines recommend against antibiotic use in OME and also provide detailed guidelines of appropriate antibiotic use in children diagnosed with AOM [13, 21].

### **Respiratory Syncytial Virus Infections (RSV)**

Respiratory syncytial virus (RSV) causes respiratory tract infections in children. Lower respiratory tract infections (e.g., bronchiolitis, pneumonia) are more common in children younger than 2 years, whereas upper respiratory tract infections tend to affect older children. Since previous infection does not protect children against reinfection, it is common for the family doctor to see patients with repeated RSV infections. Adherence to the American Academy of Pediatrics clinical practice guidelines for the diagnosis and management of bronchiolitis can decrease unnecessary diagnostic testing and intervention. In most previously healthy children, an RSV infection is self-limited and responds to supportive care. Children with unrepaired cardiac disease or chronic lung disease are at increased risk of severe RSV infection. Premature children and the very young (less than 3 months old) tend to be more at risk of having severe symptoms and therefore may require hospitalization.

**Table 2** Differential diagnosis of viral exanthems in children

Viral exanthem	Etiology/infectivity	Clinical manifestations/incubation period (IP)	Diagnostic methods	Treatment	Prevention	Complications
<b>I macular and maculopapular exanthems</b>						
<b>Measles (rubeola)</b> [22, 23]	RNA measles virus/highly contagious	IP: 10–12 days Prodrome: fever, coryza, conjunctivitis, rhinorrhea, sore throat, and a dry cough Enanthem: Koplik's spots Exanthem: 3–4 days later, begins behind the ears and hairline area, spreads over the rest of the skin over few days, resolves in the same order as its appearance, and will often desquamate	Clinical presentation Serum measles IGM test for confirmation	No specific antiviral therapy for measles Treatment of symptoms	Measles vaccine alone or as part of MMR vaccine	Transient immune suppression Acute postinfectious encephalitis Subacute sclerosing panencephalitis (SSPE)
<b>Rubella (German measles)</b> [22, 24]	RNA rubella virus/highly contagious	IP: 3–4 weeks Prodromal symptoms, which include low-grade fever, headache, sore throat, and myalgias Exanthema stage: appears after 2–5 days and spreads in a cephalocaudal pattern Symmetrical lymphadenopathy in postauricular and occipital areas, arthralgias, and arthritis	Serum rubella IGM titer test	No specific antiviral therapy for rubella Supportive treatment	Rubella vaccine alone or part of MMR vaccine	Congenital rubella syndrome (deafness, cataracts, and cardiac disease)
<b>Erythema infectiosum (fifth disease)</b> [22]	DNA Parvovirus B19	IP: 1–2 weeks First stage: fiery-red facial erythema (slapped cheeks) Second stage: 3–4 days later (rash over proximal extremities) Third stage: exanthem recurs intermittently in response to stimuli (local irritation, high temperatures, and emotional stress)	Clinical Diagnosis ELISA test highly sensitive; however, false positive results may recur PCR test is available	Supportive At-risk patients may require transfusions or intravenous immunoglobulin therapy	No specific preventive measure Handwashing might be helpful during epidemics	Transient aplastic crisis, chronic red cell aplasia, hydrops fetalis, or congenital anemia

<b>Roseola infantum</b>	Human herpesvirus (HHV) types 6 and 7	Asymmetric large joint arthropathy (10 % of patients) IP: 5–15 days High fever (3–5 days), followed by the acute onset of a rosy pink, nonpruritic macular rash, predominantly on the neck and trunk; leukopenia	Clinical diagnosis No available standardized lab test	Supportive treatment	No specific preventive measures	Febrile seizures
<b>II vesicular and pustular exanthems</b>						
<b>Varicella (chickenpox) [22, 25]</b>	DNA varicella zoster virus (VZV) Highly contagious during IP and active skin rash	IP: 2–3 weeks Two different clinical presentations: Varicella manifestations: Prodromal stage: fever, malaise, and myalgias Exanthem stage: begins in the hairline and spreads in a cephalocaudal pattern, involving the scalp and mucous membranes, vesicle crust (within 4–5 days of onset of the initial lesion), older lesion crust over as newer lesions form (polymorphous exanthema); lesions may heal with hypopigmentation and scarring Herpes zoster (shingles) manifestation: unilateral vesicular skin eruption involving one to three dermatomes, may be painful or pruritic Usually a benign, mild, self-limiting disease (in immunocompetent individuals)	Clinical Diagnosis Can be confirmed by skin scraping testing for the antigen with immunofluorescence	Oral acyclovir (ACV) is not routinely recommended except for adolescents (for 5 days, starting within 24 h of rash development) Symptomatic treatment for fever (only use acetaminophen) and pruritus (calamine lotion and colloidal oatmeal baths)	Varicella vaccine	Immunocompetent children: bacterial superinfection, due to group A <i>Streptococcus</i> or <i>Staphylococcus aureus</i> Immunocompromised patients are at risk for severe and protracted varicella, multiorgan involvement, and hemorrhagic varicella
<b>Hand, foot, and mouth disease</b>	Coxsackie A16 virus, other Coxsackie,	IP: 3–7 days Prodrome: fever, lymphadenopathy Exanthem: 1–2 days later	Is a clinical diagnosis Can be confirmed by	No specific treatment Symptomatic	No specific measures Handwashing, surface	Rare: neurological or cardiopulmonary complication

(continued)

**Table 2** (continued)

Viral exanthem	Etiology/ infectivity and enteroviruses	Clinical manifestations/ incubation period (IP)	Diagnostic methods	Treatment	Prevention	Complications
<b>(HFMD)</b> [22]		painful vesicles on the palmar and plantar skin, buccal mucosa, and tongue Resolves in 5–7 days	isolating the virus from vesicles		cleaning, and disinfection	(meningoencephalitis or myocarditis)
<b>III Papular exanthem, e.g., papular acrodermatitis of childhood (PAC) [22]</b>						
<b>IV Other viral exanthems, e.g., pityriasis rosea, erythema multiforme, nonspecific viral exanthems [22]</b>						



Supportive treatment, including hydration, good airway management, and oxygenation, is the mainstay of RSV management [17, 18].

### **Croup/Epiglottitis**

Croup is a syndrome that includes spasmodic croup (recurrent croup), laryngotracheitis (viral croup), laryngotracheobronchitis, and laryngotracheobronchopneumonitis, with recurrent and viral croup being the most commonly encountered. The incidence of croup often peaks during the fall season, although sporadic cases may occur throughout the year. Croup is usually caused by viruses, with parainfluenza virus (type 1) being the most common. Other viruses that cause croup are enterovirus, human bocavirus, influenza A and B viruses, respiratory syncytial virus, rhinovirus, and adenovirus.

Both recurrent croup and viral croup have the same clinical presentation, with the exception that recurrent croup tends to recur and typically lacks associated symptoms of respiratory tract infection. Although croup tends to have a benign course, a differential diagnosis of more serious but less common conditions must be entertained. Bacterial tracheitis may result from a secondary infection, most often due to *Staphylococcus aureus* or *Streptococcus pneumoniae*, and usually leads to a more toxic appearance, with higher fever and severe respiratory symptoms. Bacterial tracheitis does not respond to usual croup treatment. Intravenous antibiotics are needed, and intubation may become necessary. Epiglottitis (supraglottitis) is a life-threatening bacterial infection of the upper airway almost always caused by *Haemophilus influenzae* type b (Hib). The incidence has declined dramatically as a result of the use of Hib vaccine. Other diagnoses to consider include foreign body aspiration, peritonsillar abscess, retropharyngeal abscess, and angioedema [19]. Principles of management of croup and epiglottitis are summarized in Table 1.

### **Viral Exanthems**

An exanthem is a widespread erythematous rash that is accompanied by systemic symptoms such as fever, headache, and malaise. In children, exanthems are usually associated with infections, and viral infections are the most common. Determining the cause of an exanthem is based on the characteristic morphology, distribution and time course of the eruption, and a careful assessment of infectious contacts, immunization status, and aspects of the physical examination. Table 2 shows the common skin rash morphologies associated with viral infections, their causative agents, clinical presentation, diagnostic tests needed, treatment and prevention methods, and complications. Although uncommon, serious acute illnesses with skin rash must be identified immediately; for example, a skin rash in a child with meningeal signs is an indicator of life-threatening condition (meningococemia) that warrants immediate hospital referral and treatment. Kawasaki disease also is a childhood illness with rash that must be diagnosed and treated early to ensure better prognosis. The classic viral exanthems have been discussed; other important skin rashes related to viral infections and bacterial infections (e.g., scarlet fever), in addition to other noninfectious causes such as drug eruptions, must be considered in the differential diagnosis. New viral-associated exanthems have been identified; papular acrodermatitis of childhood (PAC) is now recognized to be a manifestation of a number of infectious agents, including viruses. The ability to detect parvovirus B19 virus in seronegative patients using PCR has been useful in linking the virus to erythema infectiosum, as well as other viral exanthems. The viral role in another group of exanthematous disease is yet to be fully identified (e.g., Kawasaki disease, pityriasis rosea, and erythema multiforme) [22, 26].

## **Kawasaki Disease (KD)**

KD is an acute vasculitis of childhood that predominantly affects the coronary arteries. An infectious etiology is suspected based on epidemiological and clinical data; however as of today, the cause of KD remains unknown. In the United States, KD is more common during the winter and early spring months, in boys more than girls, in children younger than 5 years old, and in children of Asian ethnicity [27]. The classic clinical presentation of KD includes at least 5 days of fever plus four or more of the five major clinical features (conjunctival injection, erythema of the lips and oral mucosa, polymorphous skin rash, cervical lymphadenopathy (with one of the nodes being at least 1.5 cm in diameter), and swelling or redness of the extremities). The classic peeling of the fingers and toes (starting in the periungual region) usually does not occur until 2–3 weeks after onset of symptoms. In addition, classic KD can be diagnosed with three of the above clinical features if coronary artery abnormalities are observed on echocardiography. “Incomplete KD” refers to patients who do not fulfill the classic criteria and is more common in children younger than 1 year. In this group, the rate of coronary artery aneurysms is paradoxically higher if not treated. Some children with KD develop coronary artery aneurysms or ectasia, ischemic heart disease, and sudden death. Therefore early clinical suspicion and diagnosis are important [28]. Nonspecific lab tests such as the erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) may suggest the diagnosis of Kawasaki disease because they are often unusually highly elevated. In patients with compatible features, and elevated CRP levels or ESR, supplemental laboratory test results are often seen (these include leukocytosis with shift to the left, mild anemia, thrombocytosis, proteinuria and sterile pyuria on urine analysis, hypoalbuminemia, and elevated serum transaminases). Cardiac manifestations for any suspected case of KD might be detected earlier by performing echocardiography. Initial treatment with a single dose (2 g per kg) of intravenous immunoglobulins (IVIG) and high-dose aspirin (80–100 mg per kg per day, divided into four doses) is recommended. Treatment is preferably started as soon as possible, optimally within the first 10 days of fever; however, treatment is still recommended if patients present after 10 days and still have fever and manifestations of inflammation. Low-dose aspirin (3–5 mg per kg per day, given as a single dose) has an antiplatelet effect and should be continued for 6–8 weeks after disease onset if there are no coronary artery abnormalities or indefinitely if abnormalities are present. Children on long-term aspirin therapy should receive an annual influenza vaccination. Also, parents should be told to contact their physician if symptoms of influenza or varicella arise, because alternative agents to aspirin might be considered. Children who have Kawasaki disease without evidence of abnormalities on echocardiography appear to return to their usual state of health without any cardiac sequelae. The current American Heart Association guidelines provide a stratification system to categorize patients by their risk of myocardial infarction and provide guidelines for management [27, 28].

## **Gastrointestinal Infections**

### **Acute Gastroenteritis**

Although often considered a benign disease, acute gastroenteritis remains one of the major causes of morbidity and mortality in children around the world, accounting for 10.5 % of deaths among children younger than 5 years of age [29].

### **Etiology**

By far, viruses remain the most common cause of acute gastroenteritis in children, both in the developed and developing world. Rotavirus represents the most important viral pathogen worldwide; it is responsible for 20–60 deaths per year in the United States and up to 500,000 deaths from diarrhea worldwide [30].

Viral infections, primarily from rotavirus, cause 75–90 % of infectious diarrhea cases in the industrialized world. Bacterial pathogens cause another 10–20 % of cases, with as many as 10 % of these occurring secondary to enterotoxigenic *Escherichia coli* (e.g., traveler's diarrhea). Parasites such as *Giardia intestinalis* and *Cryptosporidium* cause fewer than 5 % of cases [31]. In the United States, routine rotavirus vaccination has led to a 60–75 % reduction in pediatric rotavirus hospitalization since 2006. With the continued decline of rotavirus-associated gastroenteritis, noroviruses (Norwalk-like viruses) have become the leading cause of medically attended acute gastroenteritis in children younger than 5 years in that country [32].

### **Clinical Picture**

The clinical presentation is the mainstay of diagnosis, and therefore careful history and physical examination will serve to differentiate gastroenteritis from other causes of vomiting and diarrhea in children. These will also help in estimating the degree of dehydration. Diarrhea is the main presenting symptom and is usually defined as three or more watery or loose stools in 24 h. The duration of diarrhea, the frequency and amount of stool, the time since the last episode of diarrhea, and the quality of stools must also be determined. Frequent, watery stools are more consistent with viral gastroenteritis, while stools with blood or mucous are indicative of a likely bacterial pathogen. Similarly, a long duration of diarrhea (>14 days) is more consistent with a parasitic or noninfectious cause of diarrhea. Vomiting is another important symptom, the duration of vomiting, the amount and quality of vomitus (e.g., food contents, blood, bile), and the time since the last episode of vomiting must be determined. Signs of systemic infection must be noted (fever, chills, myalgias, rash, rhinorrhea, sore throat, cough). Abdominal pain is another important symptom that the child or parent can report; in general, pain that precedes vomiting and diarrhea is more likely to be due to an abdominal pathology other than gastroenteritis. Urinary symptoms including frequency (measured by the number of wet diapers), time since last urination, color and concentration of urine, and presence of dysuria should be sought. Some important points in the general appearance and behavior are important to determine the degree of dehydration and subsequent management (weight loss, level of thirst, level of alertness, increased malaise, lethargy or irritability, quality of crying, and presence or absence of tears with crying). Travel history and recent antibiotic use are other important points in the history that may suggest the possibility of traveler's diarrhea or *C. difficile* infection [31, 33].

### **Management**

Signs and symptoms of dehydration are important to determine the severity of dehydration. Both the Centers for Disease Control and Prevention (CDC) and the American Academy of Pediatrics (AAP) recommend using a simple dehydration scale to classify the total body water loss occurring with dehydration as minimal/none (<3 %), mild/moderate (3–9 %), or severe (>10 %). Abnormal capillary refill (>2 s), decreased skin turgor, and abnormal respiratory pattern (hyperpnea) have been the most reliable signs of determining the severity of dehydration. The vast majority of children presenting with acute gastroenteritis do not require serum or urine tests, as they are unlikely to be helpful in determining the degree of dehydration. Laboratory values may be helpful in evaluating severe dehydration, for which intravenous fluids and electrolyte supplementation (especially potassium, bicarbonate, and sodium) are needed [31, 34]. Prevention of dehydration is the cornerstone of gastroenteritis treatment in children. A child with minimal or no dehydration should be encouraged to continue his or her usual diet plus drink adequate fluids. Early oral rehydration therapy using an oral rehydration solution (ORS), before the child becomes more severely dehydrated, is important and can be done at home.<sup>5</sup> The best way to accomplish early treatment is to train the physician's office staff to explain how to use an ORS when caregivers call for help at the beginning of a child's illness. Clear liquids, such as water, sodas, chicken broth, and apple

juice, should not replace an ORS because they are hyperosmolar and do not adequately replace potassium, bicarbonate, and sodium. These fluids, especially water and apple juice, can cause hyponatremia. An ORS is composed of sodium, dextrose, and bicarbonate in a ratio that does not overwhelm the hyperactive bowel with a hyperosmolar solution, but that replaces the electrolyte loss. In general, antidiarrheal medications should not be used in children with acute gastroenteritis because they delay the elimination of infectious agents from the gastrointestinal tract

### **Prevention**

Handwashing has been shown to reduce the incidence of gastrointestinal illness. Rotavirus vaccine is recommended as a routine immunization at 2, 4, and 6 months of age [35].

### **Pinworm Infestation (Enterobiasis)**

Pinworm infection is caused by a small, thin, white roundworm called *Enterobius vermicularis*. Although pinworm infection can affect anyone, it most commonly occurs among children, institutionalized persons, and household members of persons with pinworm infection. Pinworm is the most common worm infection in the United States. Humans are the only species that can transfer this parasite. Pinworm eggs can survive in the indoor environment for 2–3 weeks. People who are infected with pinworm can transfer the parasite to others for as long as there is a female pinworm depositing eggs on the perianal skin. A person can also re-infect themselves [36, 37].

### **Clinical Presentation**

A person infected with pinworm is often asymptomatic. However, perianal itching is the most common presentation. When the infection is heavy, it can present as a secondary bacterial infection in the perianal area due to the irritation and scratching. Often the patient will complain of bruxism and insomnia due to disturbed sleep. Infection of the female genital tract has been reported [36, 37].

### **Diagnosis and Treatment**

Because of the life cycle of the pinworm, eggs and worms are often scarce in the stool; therefore, examining stool samples is not recommended. Identifying pinworm can be done by finding the female worm, which is about 10 mm long, in the perianal region 1 or 2 h after a child goes to bed at night, or by using a low-power microscope to identify ova on cellophane tape. The ova are obtained in the early morning before the child arises by patting the perianal skinfolds with a strip of cellophane tape, which is then placed sticky side down on a glass slide and viewed microscopically. This procedure should be repeated on five successive mornings; if necessary, eggs may also be identified by examining scrapings from underneath the patient's nails.

Any one of three antiparasitic medications (mebendazole, pyrantel pamoate, and albendazole) can be used for treatment. A single dose of any of these medications is given followed by another single dose 2 weeks later. The medications do not reliably kill pinworm eggs. Therefore, the second dose is to prevent re-infection by adult worms that hatch from any eggs that are not killed by the first treatment. Repeated infections should be treated by the same method as the first infection. In households where more than one member is infected or where repeated, symptomatic infections occur; it is recommended that all household members be treated at the same time. In institutions, mass and simultaneous treatment, repeated in 2 weeks, can be effective. Handwashing after using the toilet, changing diapers, and before handling food is the most successful way to prevent pinworm infection. In order to help prevent the spread of pinworm and possible re-infection, people who are infected should bathe every morning to help remove many of the

eggs on the skin. Showering is a better method than taking a bath, because showering avoids potentially contaminating the bath water with pinworm eggs. Infected people should not co-bathe with others. Infected patients also must cut their fingernails regularly and avoid biting the nails and scratching around the anus. Frequent changing of underclothes and bed linens first thing in the morning is a great way to prevent possible transmission of eggs in the environment and risk of reinfection. These items should not be shaken and carefully placed into a washer and laundered in hot water followed by a hot dryer to kill any eggs that may be present [36, 37].

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