An Evidence-Based, Systematic Approach To Acute, Unexplained, Excessive Crying In Infants

Oscar was a 14-day-old Latino baby who presented to the children’s ED with the complaint of intermittent crying over the past 12 hours. His parents and aunt accompanied him, describing him as a happy baby who, since late the previous evening, had been persistently crying, except when feeding and sleeping for brief intervals. The birth and infant past histories were unremarkable and without risk factors, comorbid disease, or concomitant symptoms of acute illness. The physical examination was normal, and Oscar had continued to walk with great vigor throughout the entire encounter, until he was offered a bottle of formula, which he drank greedily. I had no explanation for the crying, but my initial impression was that of a well-appearing infant who in all likelihood did not have an immediate life- or limb-threatening problem. I explained this to the parents and aunt and recommended “some tests” to further evaluate the source of Oscar’s crying. The parents thanked me for seeing the baby and stated that they, too, did not feel he was sick. They did not think it necessary to do any tests, but wanted to leave, as they had an appointment with a priest in an hour to exorcise the bad spirit that was frightening the baby. The previous afternoon, while in the neighborhood grocery, a lady had held Oscar aloft and nearly dropped him. He had thrown out his arms and legs with a loud, startled cry and it was not long after the incident that the crying episodes had begun. Patiently the interpreter and I explained how the “startle” was a normal neonatal reflex (Moro), and infants of Oscar’s age do not remember frightening incidents (as far as I knew). They were insistent that they must leave, as now Oscar was once again screaming in the background. Personally I would have been relieved if Oscar had spiked a fever or suddenly had a bloody stool, because then I would know clearly how to proceed.

My dilemma with Oscar raised several interesting questions. How far should I push to keep this infant in the ED? Should I get Child Protective Services (CPS) involved, if I couldn’t convince the parents to stay? Would I be justified in doing so?

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CME Objectives
Upon completing this article, you should be able to:
1. Discuss the differential diagnosis of acute, unexplained, excessive crying in infants;
2. List life-threatening causes of acute, unexplained, excessive crying in infants; and
3. Describe the emergency department evaluation and management of infants with acute, unexplained, excessive crying.

Date of original release: March 11, 2005.
Date of most recent review: March 4, 2005.
See “Physician CME Information” on back page.

Special Double Issue
February/March 2005
Volume 2, Numbers 2 & 3

Author
Marilyn P. Hicks, MD, FACEP, FAAP
Director, Pediatric Emergency Medicine Education, WakeMed Health Systems, Raleigh; Adjunct Assistant Professor, Department of Emergency Medicine, University of North Carolina—Chapel Hill, NC.

Peer Reviewers
Stephen Docherty, DO, FACEP, FAAEM
Assistant Professor of Clinical Emergency Medicine, Keck School of Medicine, University of Southern California—Los Angeles, CA.
Lance Brown, MD, MPH, FACEP
Chief, Division of Pediatric Emergency Medicine; Associate Professor, Loma Linda University Medical Center and Children’s Hospital—Loma Linda, CA.

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What laboratory or radiographic “tests” might help elucidate the cause(s) of Oscar’s crying? Are there cultural differences in response to infant crying that influence infant and parental behavior? And the most important question: Can a normal, well-appearing infant present with acute, excessive crying as the sole symptom of a serious organic disease?

**INFANTS** cry more during their first 4 months than at any other time of life. Brazelton defined “normal” infant crying as 1 hour and 45 minutes at age 2 weeks, a peak of 2 hours and 45 minutes at age 6 weeks, decreasing to less than 1 hour at age 12 weeks. He also described a diurnal variation, with peak crying time from 3 pm to 11 pm. Wessel et al and Illingsworth had earlier described excessively crying infants as having “colic,” from the Greek for colon, because of the associated symptoms of grimacing, abdominal distention, and flatulence. Crying is the primary form of nonverbal communication for neonates and infants and is the principle means by which they express needs, anger, and frustration. William Dewees in 1825, in his Treatise on the Physical and Medical Treatment of Children, refers to crying as “...not always expressive of pain; it is intended very often as an appeal to the tenderness of the mother, when the child is impelled to make its necessities known — hunger and thirst, or sometimes, upon much more important occasions to itself, namely uneasiness...” Parents respond to their crying infants in a variety of ways. Most parents develop an intuitive sense for their infant’s needs and report that they can distinguish differences between crying associated with hunger and discomfort and the fussiness that accompanies fatigue or boredom. Parental response to crying is dependent upon their ability to cope with differing levels of crying intensity and duration, as well as their perception of what is “normal” or “abnormal” crying. By the time the parents present to the ED with their crying infant, most have exhausted their repertoire of consoling responses. Often the parents are anxious, frustrated, and sleep deprived. Many parents, especially mothers, have guilt feelings related to their parenting abilities because they have been unable to adequately console their baby. All of these conflicting emotions add to the difficulty of evaluating the nonverbal, uncooperative patient.

This issue of Pediatric Emergency Medicine Practice will present a systematic approach to the infant with acute, excessive crying in the ED setting. A summary of the pertinent past and current literature concerning crying syndromes and a detailed discussion of the differential diagnosis of pathologic conditions, of which crying may be a presenting or secondary complaint, will provide a basis for the evaluation and disposition of a subset of very challenging patients.

**Critical Appraisal Of The Literature**

There is an enormous volume of literature specific to infant crying, most of which concerns the emotional and behavioral aspects of crying. There is also a wealth of material about the etiology, characteristics, and management of colic. The majority of infant behavioral studies and colic literature is difficult to interpret and impossible to apply in the context of the ED. Variation in the definition of excessive crying, flawed methodology, and inadequate sampling characterize many studies. The literature concerning organic etiologies of excessive crying consists primarily of a few review articles, scattered case reports, and 1 prospective study of an ED population of “crying” infants that was published in 1991. Textbook presentations of the crying infant, if addressed at all, categorize a differential diagnosis with a discussion centered on the diagnosis and management of colic. With the exception of Poole’s article, which has established by default the only guideline for the evaluation of the crying infant, there has been no further study of the ED evaluation and management of these infants. By collating and condensing the literature of multiple pediatric and emergency medicine topics, an evidenced-based approach to the crying infant can be formulated.

**Epidemiology, Etiology, Pathophysiology**

**Epidemiology**

The incidence of excessive crying is estimated to be 1.5-43% of the infant population. **The wide variation in prevalence is largely due to conflicting definitions of excessive crying, based on parental perception and assessment.** The reported prevalence of excessive or persistent crying secondary to organic causes ranges from 5-76%. **The true incidence of crying due to organic disease is unknown; crying can be a presenting symptom of almost any pathologic process, if the infant has the physiologic ability to cry. The complaint tends to be more often primary in the younger infants, due to the limits of their stress responses and the inability of the parent to interpret the crying and to console the infant. The older child is more socially skilled and has a larger repertoire of behavioral responses to varying stimuli, allowing for greater specificity of complaints.**

**Etiology**

The etiology of excessive crying due to organic disease is largely related to the pain and discomfort associated with the underlying pathologic process. Infants react to pain with behavior changes, manifesting as persistent crying, irritability, inconsolability, increased fussiness, sleeplessness, and poor feeding. They may present with an isolated, acute episode of excessive crying that is the primary complaint or with crying as an associated symptom of many other complaints. Causes of recurrent or paroxysmal, excessive crying include colic, primary central nervous system dysregulatory disorders (often undiagnosed), and temperamentally “difficult” infants, which most authorities believe to be a variant of normal development. **Colic was originally described by Wessel in 1954 as the rule of 3: “Crying, irritability, or fussing lasting for more than 3 hours a day, occurring on more than 3 days per week, and severe if lasting for more than 3 weeks.” Numerous other definitions for colic can be found in the**
literature; most of which include the following: 1. episodes of paroxysmal inconsolable crying beginning at 1-2 weeks of age and resolving by 4 months; 2. crying concentrated in the late afternoon and evening; and 3. associated behaviors of clenched fists, arching back, distended abdomen, flexed legs, grimacing, regurgitation, and passing gas. Schmitt’s definition of “intermittent, unexplained crying during the first 3 months of life that reaches a point where the parents complain about it” is simple and takes into account the parental perception of excessive crying, which is often what prompts medical evaluation. Many believe that colic is a “disease” of western cultures only. Multiple African and eastern societies do not perceive crying as an “abnormal” behavior at all; these infants have a similar frequency of crying as western infants, but without the duration or intensity. Caregiving practices differ considerably, which may, in part, explain the behavioral differences; infant care in these traditional cultures is based on contingent responsibility, namely continuous holding and carrying and frequent feeding. Regulatory disorders are secondary to central neurological regulatory dysfunction that becomes manifest by age 6 months and are characterized by multiple behavioral abnormalities involving affect, feeding, motor activity, and attention. These infants exhibit fussiness, irritability, and crying much of the time. Beyond infancy these children often exhibit characteristics associated with autism, attention deficit disorder, or oppositional defiant disorder. The issue of maternal (parental) stress and anxiety is essentially a chicken-egg conundrum. Multiple studies have demonstrated the presence of maternal anxiety and depression that often accompanies chronic, excessive crying, especially when occurring over prolonged periods of time. However, there is little evidence to support a causation theory; rather, the maternal stress is more likely to be a result of the crying.

Pathophysiology
The pathophysiology of paroxysmal crying syndromes is largely behavioral. Organic disease accounts for only about 5% of infants with colic. Regulatory disorders are clinical behavioral abnormalities supported only by observational evidence. The theory of the “temperamental infant” is an unsupported assertion; most authorities believe these infants exhibit normal behavior variants. The pathophysiology of a single acute, excessive, unexplained crying episode is principally related to the process causing pain and / or discomfort. Infants experience headache as a result of meningitis and abdominal pain as a consequence of bowel distention, whether the latter is due to constipation or intussusception. Irritability may result from cerebral hypoperfusion secondary to sepsis, dehydration, or heart failure. Misery and discomfort can result from diaper rash or anal fissures. The neonate with poor suckling ability secondary to thrush may simply be suffering from a sore mouth and hunger.

Many researchers have analyzed the acoustic properties of crying in an attempt to distinguish between the cries of hunger, fatigue, or pain. The acoustic analysis of crying can reliably identify the infant who is highly aroused or distressed, but cannot distinguish between infants in pain and those who are cold or hungry. Pain associated with circumcision and heel stick is well documented in terms of physiologic responses, such as increased heart rate, blood pressure, and vagal tone, as well as the behavioral signs of facial grimacing, eye-squinting, and crying. Visual analog and linear scales are used to gauge the intensity of pain in infants and young children, but health care professionals and parents consistently choose lower pain scores for children’s pain than verbal children choose themselves. Is this because we do not understand infant crying or appreciate its meaning in the context of pain, or do we become desensitized to crying as a form of nonverbal communication? The investigation of excessive crying should begin with the premise that crying is “meaningful” and, as such, is the first clue to “a disturbance in the force.”

Differential Diagnosis
The differential diagnosis of the crying infant is extensive, involving every organ system. (See Table 1.) Nearly every pathologic process affecting infants and children is accompanied by crying; perhaps the differential diagnosis of excessive crying should be more aptly termed the differential diagnosis of “pain and suffering.” In Poole’s study of 56 febrile infants with acute, unexplained, excessive crying, 34 (61%) were found to have a serious condition. The duration of crying prior to arrival in the ED varied from 1 hour to 5 days in Poole’s study, reflecting the variation of parental perception and tolerance of excessive crying. But, of even greater importance, there was no correlation with the duration or characteristics of crying and the seriousness of the underlying cause. This suggests that acute, excessive crying in and of itself — not its intensity or duration — is the substance of the issue. Although Poole’s numbers are small, the acuity of the infants in his study was significant.

Table 1. Differential Diagnosis Of Life-Threatening Conditions.

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<td>Myocarditis</td>
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<td>Appendicitis (infant)</td>
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<td>Intracranial hemorrhage</td>
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<td>Hydrocephalus</td>
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<td>Malrotation/midgut volvulus</td>
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<td>Intussusception</td>
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<td>Supraventricular tachycardia</td>
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<td>Coronary anomalies and aneurysms</td>
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Acute Life-threatening Conditions

There are certain conditions that are fortunately rare in infants and children, and that emergency physicians fear they will miss. Among these are: compensated shock, impending respiratory failure, surgical abdomen, meningitis, and nonaccidental trauma. With the exception of nonaccidental trauma, the incidence of these conditions is low in the general population of children, and the average emergency physician, unless working in a high-volume pediatric ED, will encounter them only a few times in his or her career. But the gravity and consequences of missing these diagnoses in their early presentation may result in physical devastation for the child and emotional and financial devastation for the physician, which is why a heightened awareness and appreciation for the infrequent subtle presentation of these disorders is critical. Excessive crying in the neonate and very young infant is a nonspecific symptom and is oftentimes the behavioral change that prompts the parent to seek medical evaluation. They may not know the infant is febrile or that a few episodes of vomiting might be important, but only recognize a behavioral change in their infant. The sometimes insidious, nonspecific nature of disease in the very young can be misleading, and one must be vigilant against becoming distracted by the crying.

Compensated Shock

The most common causes of shock in infants and children are sepsis or hypovolemia from trauma or dehydration, and cardiac disease. Septic shock most often occurs in neonates and children who are immunoincompetent, either as a result of chemotherapy, congenital immunodeficiency syndromes, or HIV. Also at risk are children with congenital heart disease and urinary tract abnormalities, and victims of multiple trauma or extensive burns. Rarely do normal, healthy children become septic beyond early infancy. Shock as a result of dehydration occurs in all age groups, but neonates and young infants are particularly vulnerable, because they need proportionately more fluid per kilogram of body weight than older children and adults; the average newborn’s body fluid content is 75-80%, compared with 60% in adults. The thin skin of infants and their large surface area to volume ratio results in more evaporative fluid loss than in older children. Young infants are also more prone to electrolyte abnormalities, especially bicarbonate loss, due to immature and inefficient kidneys. Infants with cardiogenic shock with ducal-dependent obstructive left heart syndromes (hypoplastic left ventricle, critical coarctation, aortic stenosis, tricuspid atresia) tend to present with decompensated shock and impending death. Supraventricular tachycardia (SVT) and myocarditis, however, may present as compensated shock. SVT and myocarditis can cause coronary ischemia, myocardial failure, and acute myocardial infarction, as can congenital coronary anomalies or coronary aneurysms from past Kawasaki disease. Kawasaki disease in young infants is often difficult to diagnose and may go undetected or misdiagnosed, presenting at a later time as acute coronary ischemia or myocardial infarction. Chest pain (angina) is a frequent complaint of older children with these conditions and may result in crying and increased fussiness when present in the preverbal infant.

Compensatory physiologic mechanisms occur during the early phases of shock to preserve tissue perfusion, regardless of the underlying etiology. Principal among these are increased heart rate and respiratory rate. Heart rate is the major mechanism by which young infants raise cardiac output. Respiratory rate increases in response to increased carbon dioxide production and metabolic acidosis that results from the shift from aerobic to anaerobic metabolism. The persistence of tachypnea and tachycardia in infants and children is often the first clue to serious disease. The sensitivity of tachypnea and tachycardia as an early indication of shock is lost in the infant who has persistent crying, as the crying itself is accompanied by tachycardia, and quantifying respiratory rate in a crying child is virtually impossible. In order to assess the heart and respiratory rates in crying infants, frequent measurements must be recorded to establish trends or to capture rates if the infant ceases to cry. The most sensitive indication of decreased perfusion is subtle change in mental status. Mothers note changes in their infant’s behaviors that are not apparent to other observers; crying and/or irritability may be an early indication of decreased cerebral perfusion in early shock. Other measures of decreased perfusion are diminished peripheral and central pulses, cool skin temperature, pallor or mottling, prolonged capillary refill, poor pulse oximetry waveform, and decreased urine output. Septic shock may present initially as “warm shock,” characterized by warm extremities, bounding pulses, and adequate urine output, as well as persistent tachycardia and tachypnea. Recognition of the early signs of septic shock and aggressive fluid resuscitation can result in significant decreases in morbidity and mortality. Fever is usually an early symptom of sepsis, but hypothermia in neonates and young infants can occur and is often a more ominous sign than hyperthermia. Normothermia is rare in sepsis; however, Ruiz-Conteras reported a case series of 6 infants who presented with persistent crying as the chief complaint, and who were subsequently found to have sepsis. The total duration of crying ranged from 2-26 hours and was the only clinical manifestation for 2-10 hours in 5 infants before the onset of fever (one infant never developed fever). Knowledge of the subtle signs of physiologic instability, a high index of suspicion, and vigilant reassessments are necessary when evaluating the crying, uncooperative infant with early shock.

Impending Respiratory Failure

Impending respiratory failure usually results from unrelenting respiratory distress and associated fatigue, central hypoventilation, or acute airway obstruction (ie, severe croup, foreign body, acute asphyxial asthma). Impending respiratory failure and crying seem like contradictory states. It is often reassuring when the infant who is “billed” as respiratory distress at triage arrives to the
treatment room with vigorous, loud crying. Infants with respiratory pump failure may present with significant hypoxia and/or hypercarbia without obvious respiratory distress. Hypoxia, and to a lesser extent hypercarbia, can manifest as irritability, confusion, and agitation, and as a result crying may be a symptom associated with hypoxia in nonverbal infants. Other causes of respiratory pump failure are CNS infection (encephalitis) and CNS tumors. Hypoxemia with varying degrees of respiratory distress also occurs with ventilation-perfusion mismatch and intrapulmonary shunting. Ventilation-perfusion mismatch arises when alveoli are ventilated but not perfused, resulting in a dead space. Conditions causing ventilation-perfusion mismatch are pulmonary embolus, pulmonary infarction, pulmonary hypertension, and obstructive lung disease. Children at risk are those with indwelling lines, heart disease, collagen vascular disease, dehydration, immobility, and malignancy, especially acute myeloid leukemia. The most common cause of pulmonary infarction in infants and children is acute chest syndrome (ACS), a complication of sickle cell disease. Young infants with ACS may be irritable with inconsolable crying due to chest pain and hypoxia. Intrapulmonary shunting results from pneumonia, atelectasis, pulmonary hemorrhage, pulmonary edema, and pneumothorax and is accompanied by hypoxia and varying degrees of respiratory distress. Common causes of atelectasis in children are infection (especially RSV), foreign body aspiration (not acute), and immobilization. Pulmonary edema occurs most frequently as a complication of cardiac disease; pneumothorax in infants and young children is most often the result of spontaneous rupture of a congenital pulmonary bleb. Hypoxemia is easily identified with pulse oximetry, and hypercarbia can be measured by arterial, venous, or capillary blood gases with equal accuracy. In the absence of respiratory compromise or decreased perfusion, the oxygen saturation should be 97-100% in room air. The hypoxia associated with respiratory pump failure, ventilation-perfusion mismatch, and intrapulmonary shunting is responsive to the application of supplemental oxygen, pending definitive therapy. All infants with excessive crying should be screened on admission with pulse oximetry to identify those with marginal respiratory status.

**Surgical Abdomen**

The diagnosis of an acute abdominal emergency in young infants can be difficult in the best of circumstances and challenging to the most experienced practitioner, when crying complicates the abdominal examination. We rely to a large extent on the presence of abdominal pain and tenderness to assess underlying pathology; these physical findings may be lost or at least inconsistent in the infant with excessive crying. Also, it is difficult to appreciate abdominal distention, presence or absence of bowel sounds, or organomegaly in an uncooperative patient. Malrotation and intussusception are causes of acute bowel obstruction in young infants who are otherwise healthy. Delays in diagnosis can result in significant morbidity and occasionally death. Malrotation of the midgut occurs when the normal rotation and fixation of the intestine fails to occur in early pregnancy and has an incidence of 1 in 500 live births. The abnormally fixed small bowel twists on itself, causing a proximal small bowel obstruction with subsequent bowel ischemia and infarction. The morbidity and mortality associated with malrotation is directly related to the degree of bowel ischemia and necrosis. Malrotation can present at any time of life, but the majority of patients present in the first year of life, half within the first month. The twisting can be intermittent, but 2/3-3/4 of neonates will have midgut volvulus. Vomiting and abdominal pain are present in nearly 100% of patients; the emesis is bilious, the hallmark of proximal bowel obstruction, and the abdominal pain is often manifest as crying or irritability. There is a paucity of physical findings, unless there is significant bowel ischemia or necrosis and perforation. Infants who have bowel necrosis present with peritonitis, dehydration, and hemodynamic compromise requiring aggressive resuscitation and emergent surgical consultation. However, most infants with malrotation will present with crying and vomiting and a

**Figure 1. Malrotation.**

The ligament of Treitz in malrotation is either absent or abnormally located, and the duodenum and small intestine lie on the right side of the abdomen. Duodenal obstruction may be partial (caused by Ladd bands, as seen here) or complete (caused by volvulus).
Intussusception may be normal, or the infant may sleep or become very lethargic. A subset of infants presents with lethargy or obtundation, rather than irritability and crying; some researchers believe the ischemic bowel stimulates the release of endogenous endorphins, causing a decrease in the level of consciousness. Vomiting is frequent, initially nonbilious, but with continued obstruction can become bilious. Examination of the abdomen while the infant is crying will yield little useful information, but with vigilance and reexamination during a quiet period, a mass or fullness may be palpated in two thirds of infants, and is most often detected in the right upper quadrant (RUQ). While colicky abdominal pain and vomiting are suggestive of intussusception, the nonspecific nature of the complaints are not predictive; however, in association with bloody stool or hemoccult-positive stool, they become highly diagnostic. The classic “currant-jelly stool” is a late manifestation, and when present suggests significant bowel ischemia. Abdominal films often show subtle signs of intussusception, but may be overlooked by the inexperienced observer. Highly diagnostic signs on plain radiographs include the target sign, the crescent sign, and the absence of the subhepatic angle. Barium or air contrast enema is the gold standard for both diagnosis and reduction of intussusception. The reduction rate for barium and air enema is approximately 95%, with a very small complication rate. Contraindications for barium or air enema are signs of peritonitis or perforation and hemodynamic instability; these infants require rapid fluid resuscitation, antibiotics, and surgical intervention. Ultrasound may be considered for patients having low to moderate clinical probability for intussusception, but its success is highly operator-dependent. Visualization of a doughnut-shaped mass or crescent-in-doughnut mass by ultrasound is pathognomonic of intussusception, and a contrast enema should be performed immediately for reduction. However, if the ultrasound is normal and significant uncertainty still exists as to whether the infant has intussusception, a contrast enema must be performed in this case, as well. The decision to use ultrasound as a diagnostic tool should be considered only if a highly skilled ultrasonographer is available to reliably rule out intussusception on ultrasound. Some institutions with high volumes of pediatric patients and readily available pediatric radiologists use ultrasound exclusively to screen for intussusception. The recurrence rate for intussusception is about 10%, of which approximately 30% recur within 48 hours. The postreduction management is somewhat controversial, ranging from 8 hours of ED observation to 23-hour admission. Decisions to admit or to observe in the ED are largely dependent upon institutional practice, parental reliability, and geographical considerations.

Appendicitis is the most common surgical emergency in children and is often misdiagnosed on the first patient encounter in infants and young children, due to nonspecific presentation and paucity of physical findings. It rarely occurs in neonates, but has a mortality rate of greater than 80% in this group. Appendicitis in children younger than 3 years is also relatively uncommon; the morbidity

**Figure 2. Intussusception.**

is significant in this group, due to delays in diagnosis and very high perforation rates. The nonspecific nature of the presentation in the infant and nonverbal young child makes this a very difficult diagnosis. Clinical features are abdominal pain, irritability, and nonbilious vomiting. The abdomen is difficult to evaluate in the crying, irritable infant; localization of tenderness to the RLQ occurs about half the time and is problematic to interpret. Frequently there is also a history of loose stools, which can mislead one toward the diagnosis of gastroenteritis. (For a full discussion on the differential diagnosis of gastroenteritis, see Pediatric Emergency Medicine Practice, Volume 1, Number 5, Gastroenteritis: An Evidence-Based Approach To Typical Vomiting, Diarrhea, And Dehydration, December 2004.) The diagnosis becomes easier once peritoneal signs appear; the previously crying infant often becomes very quiet, preferring to lie still, crying with stimulation and pain only. Laboratory evaluation is not consistently helpful; elevated acute phase reactants such as WBC, sed rate, and CRP are not always abnormally elevated nor are they specific for appendicitis. Ultrasound is an excellent imaging modality in the evaluation of the hemodynamically stable neonate or infant with abdominal pain of unknown etiology, particularly if the operator is skilled in the ap-

Table 2. Differential Diagnosis By System.

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<tr>
<th>HEENT</th>
<th>Genitourinary</th>
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<tr>
<td>Trauma</td>
<td>Testicular torsion</td>
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<td>Rash</td>
<td>Inguinal hernia</td>
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<td>Foreign body: eye, ear, nose, pharynx</td>
<td>Hydrocele</td>
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<td>Corneal abrasion</td>
<td>Urinary tract infection</td>
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<td>Glaucoma</td>
<td>Metastatic stenosis</td>
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<td>Nasal congestion (&lt; 6 months)</td>
<td>Balanoposthitis</td>
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<td>Thrush, stomatitis, pharyngitis</td>
<td>Genital tourniquet</td>
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<td>Neck</td>
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<td>Torticollis</td>
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<td>Hirschsprung’s disease</td>
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plication of pediatric ultrasound. The sensitivity for appendicitis is reported to be 80-98%. A cost-effective approach for abdominal imaging for appendicitis is ultrasound, followed by abdominal CT with rectal contrast, if the ultrasound fails to visualize the appendix, or the results are equivocal.

Other causes of abdominal catastrophes in the neonate and infant include small bowel obstructions secondary to stenosis or congenital webs, Hirschsprung’s disease, and incarcerated inguinal hernia. (See Table 2 on page 7.) The clinical presentation of these conditions can be a crying, irritable infant with nonspecific associated signs and symptoms. Hemodynamically unstable infants should be rapidly identified, aggressively resuscitated, and the appropriate surgical specialists consulted. The remaining infants require a systematic approach of thorough history and physical examination, frequent reassessments, and selective imaging.

Meningitis
The clinical presentation of early neonatal meningitis can be very subtle. Astute mothers notice minor variations in behavior, such as anorexia, irritability, and increased fussiness. Other symptoms include fever, hypothermia, lethargy, and vomiting. Overt signs of CNS involvement may not be apparent, although paradoxical irritability should alert the examiner to the possibility of meningeal irritation. Presenting symptoms indicative of more advanced disease, with increased intracranial pressure and hemodynamic instability, portend increased morbidity. Group B strep (late onset) and E. coli are the etiologic agents in the majority of cases of neonatal meningitis, these organisms obtained from the maternal genitourinary tract during birth. Since the consequences of meningitis are so grave, unexplained irritability and persistent crying or poor feeding are indications for lumbar puncture in the neonate and select older infants. Minor mental status change is often the factor that distinguishes early bacterial meningitis from nonspecific viral illness in older infants. The ability of these older infants to interact socially allows us to appreciate these subtle differences in behavior. Bacterial meningitis in infants older than 8 weeks is principally caused by Streptococcus pneumoniae and Neisseria meningitidis. Invasive pneumococcal infection is uncommon in neonates, but when it does occur is associated with significant morbidity and mortality. Since the introduction of PCV7 (Prevnar®), the number of invasive infections caused by vaccine-serogroup pneumococcus has decreased more than 75% in infants 2 months to 2 years of age.

Herpes encephalitis should always be considered in the irritable neonate with abnormal cerebrospinal fluid findings. Untreated herpes encephalitis or encephalitis is neurologically devastating and results in death or permanent disability in 90% of infants affected. Only a minority of infants with herpes encephalitis or sepsis have the typical skin lesions (vesicles) at presentation. A diligent search for a vesicle on an erythematous base should be made during the physical examination of all neonates. (Figure 3.)

In addition to a pleocytosis, the cerebrospinal fluid may contain red cells or gross blood that doesn’t clear as fluid is removed. Empiric treatment should be instituted in the absence of cutaneous lesions when CSF and other clinical findings are suggestive of herpes encephalitis, or when the mother has a positive history of genital herpes.

Nonaccidental Trauma
Approximately 1400 infants and children were reported to die of child abuse in 2002; nearly half of those deaths were in infants less than 1 year of age. Homicide is the leading cause of death in infants younger than 1 year – the majority these deaths result from abusive head injury. Ninety-five percent of serious intracranial injuries and more than 69% of head injuries in infants less than a year old are due to child abuse. Blunt abdominal trauma as a result of child abuse is much less frequent than abusive head injury, but the morbidity and mortality, as with head trauma, is very high. A fatal case of colic appeared in Pediatric Emergency Care in 1992, detailing the case report of a 3-month-old infant seen in an ED with the complaint of crying. The infant was discharged with the diagnosis of colic and returned 9 hours later via EMS in full arrest as a consequence of shaken baby syndrome. It is estimated that even now, with heightened awareness, as many as 75% of child abuse cases presenting to EDs are being missed. Many of these are cases of mild head injury, fractures, dislocations, cutaneous, oral, dental, and auricular injuries, ALTEs, and Munchausen syndrome by proxy. Details of the history that are vague, changing, or evolving, specifically related to injuries that are unexplained or “magical,” or injuries mechanistically or developmentally impossible, are common with nonaccidental trauma and should be highly suspect. Delay in seeking care and inappropriate affect of the caregiver are also red flags for child abuse. While dropping infants or infants falling from the couch, bed, or other surfaces happen frequently, serious injuries rarely result from these mechanisms. Non–life-threatening injuries in infants and young children may manifest as irritability, excessive crying, decreased activity, and poor feeding. Many children who sustain fatal injuries from child abuse are found to have evidence of old injuries, and a number of these children were seen by physicians for previous injuries that went unrecognized as abuse. A comprehensive discussion of child physical abuse is presented in Pediatric Emergency Medicine Practice, Volume 1, Number 2, Child Physical Abuse: A State-Of-The-Art Approach, September 2004.

Head and Neck Conditions
Common causes of pain in infants are earache, sore throat, and mouth sores; the discomfort is compounded by the associated feeding difficulty, further adding to the infant’s irritability. Acute otitis media is the most often diagnosed pediatric infection in the United States; in verbal children pain is almost universally associated with ear infection and often manifests in infants as crying and fussing.
Herpetic gingivostomatitis and pharyngitis are frequent in infants and can be associated with generalized irritability or just crying with feeding/swallowing. Oral candidiasis (thrush), affecting predominately neonates and young infants, produces pain, anorexia, and poor feeding and can be the sole reason for excessive irritability. Oral Candida colonization is usually acquired during birth from the infected maternal vaginal mucosa; it can also be transmitted during nursing from the skin of the mother’s breast or from poorly cleansed baby bottles. Infant teething has been blamed by both parents and professionals for a multitude of maladies, including excessive crying and irritability, but these beliefs are largely cultural myths. The misconception that teething causes illness or excessive discomfort can delay evaluation and treatment of true underlying pathologic processes and should not be considered a source of inconsolable crying. Corneal abrasion and/or foreign bodies should always be considered as a cause of inconsolable crying, but infants exhibit few obvious clinical signs, and the diagnosis can be easily missed unless appropriately evaluated.

Congenital glaucoma can result in loss of vision, if not recognized and appropriately treated. Unfortunately, the clinical signs and symptoms may be confused with other, more common benign ophthalmologic disorders, such as conjunctivitis. Clinical findings include a hazy cornea or dull red reflex; more severe cases exhibit corneal opacity and an increase in corneal diameter. Intraocular pressure should be evaluated with digital tonometry in infants with inconsolable crying who have photophobia or squinting without other physical findings.

Infants can sustain serious intracranial injury without significant external evidence. Headache is common with head injury, and infants with persistent or unexplained crying associated with minor signs of head or facial trauma, such as hematomas, bruising, or edema, should be evaluated for occult head or facial injury. Nonaccidental trauma is the leading cause of serious head injury in infants younger than 1 year and is frequently missed, due to nonspecific clinical presentation and lack of physical findings suggestive of trauma. An unusual cause of subdural hematoma and retinal hemorrhages is glutaric aciduria type 1 (GA1), an autosomal, recessive inborn error of metabolism, which can occasionally present with nonspecific neurologic findings, such as irritability and vomiting. In the absence of trauma,
GA-1 may be mistaken for nonaccidental injury. Other causes of headache in infants, of which crying may be the predominant or an associated symptom, include meningitis, hydrocephalus, pseudotumor cerebri (benign intracranial hypertension), migraine, and strokes. The clinical presentation of increased intracranial pressure and expanding mass lesions may be more subacute and nonspecific in infants, compared with older children and adults, due to the open fontanels and widening sutures of the infant skull.

A relationship between breath holding spells and iron deficiency anemia has long been recognized, but poorly understood. Children with iron deficiency anemia also have other neurologic disorders that cause irritability and headache, such as cerebrovascular accidents and pseudotumor cerebri. The clinical manifestations of pseudotumor cerebri (benign intracranial hypertension) are headache, irritability, and papilledema. Infants with iron deficiency anemia and excessive crying should have dilatation of their pupils for an adequate fundoscopic examination for the presence of papilledema. Diagnosis of pseudotumor cerebri is established by the demonstration of increased cerebrospinal fluids opening pressure and the absence of hydrocephalus on head CT. Treatment of the iron deficiency anemia often resolves the intracranial hypertension.

Torticollis can be congenital or acquired. Congenital torticollis is thought to be secondary to abnormal intrauterine positioning or birth trauma, resulting in hematoma formation in the body of the sternocleidomastoid muscle. With subsequent fibrosis of the hematoma, the muscle develops a deformity with limitation of rotation and lateral bending of the head and neck. If the muscle contracture is left untreated, craniofacial disfigurement with flattening of the face on the affected side will occur over time.

The presentation of retropharyngeal cellulitis or abscess is variable; however, common symptoms are fever, meningismus, dysphagia, and respiratory distress. The presentation in young infants may be subtle and nonspecific, with unexplained crying, irritability, and poor feeding. Neck pain and decreased range of motion is common to all children with retropharyngeal abscess, but may be the only obvious physical finding besides fever in some young infants. Soft tissue neck x-rays are not always diagnostic and are difficult to interpret; CT with IV contrast is the preferred imaging modality. Other causes of neck pain in infants include cervical adenitis, brachiocephalic cysts (abscesses), and cystic hygromas, all of which are readily apparent on physical examination.

**Chest Pain and Cardiac Conditions**

Chest pain is usually considered an adult complaint, but many of the same conditions cause chest pain in infants as in older patients. Trauma, infection, and cardiac disorders are the principal causes of chest pain in infants and children. Fractures of the ribs and distal clavicles in infants are due to nonaccidental trauma nearly 100% of the time, with exceptions being serious accidental trauma or disorders of bone fragility. Neonatal mastitis has been reported as a cause of inconsolable infant crying, with the appearance of crying before the onset of fever or the typical cutaneous findings. Paradoxical irritability is common with neonatal mastitis, due to increased pain with movement or compression of the chest wall. Chest pain associated with pneumonic consolidation secondary to pleural inflammation is frequent and usually accompanied by symptoms of cough, fever, and tachypnea, as well as splinting or grunting. Cardiac causes of chest pain in infants include pericarditis, myocarditis, supraventricular tachycardia (SVT), coronary aneurysms, and congenital coronary artery anomalies. SVT occurs frequently in infancy, often with nonspecific complaints, such as increased fussiness, poor feeding, sweating with feeds, and sometimes excessive crying. Neonates and infants with SVT typically have heart rates in excess of 200 beats per minute. Many infants generate sinus tachycardia with rates greater than 200 bpm, if hypovolemic or extremely agitated; however, the tachycardia is very responsive to fluid resuscitation and calming measures. Sustained rates in excess of 200 bpm should alert one to the possibility of SVT. The natural history for SVT with onset in early infancy, and in the absence of structural heart disease, is resolution within 1 year. Hemodynamically stable SVT is usually easily converted with adenosine. There is, however, a subset of infants with complex or recurrent SVT who require more sophisticated antiarrhythmic therapy, such as amiodarone or sotalol. Acute myocarditis frequently presents with life-threatening arrhythmias and congestive heart failure, though some infants and children may have more vague, nonfocal symptoms, such as decreased activity, vomiting, and irritability. There is usually a history of a prodromal flu-like illness that precedes the onset of cardiac symptoms by days or weeks. The most common arrhythmia associated with myocarditis is sinus tachycardia out of proportion to that caused by fever or agitation, and which is sustained in spite of temporizing measures. Infants with myocarditis may have subtle signs of decreased cardiac output, such as malaise, peripheral mottling, decreased distal pulses, and decreased urinary output. These findings in association with vomiting can initially suggest dehydration, which in turn leads to the therapeutic administration of IV fluids. Sustained sinus tachycardia, nonresponsive to volume replacement or associated with signs of congestive heart failure, strongly suggests myocarditis and should prompt rapid evaluation and treatment. Low-voltage QRS complexes are also a common EKG finding; other arrhythmias include ectopic atrial tachycardia, atrial flutter, and third-degree heart block. Myocarditis can cause coronary ischemia and acute myocardial infarction (AMI) with typical ST segment changes. Congenital coronary artery anomalies are extremely rare and are of 3 distinct types: normal origin of the left coronary artery from the pulmonary artery (ALCAPA); coronary fistula (fistulous flow between coronary artery and heart chamber); and coronary stenosis. These anomalies can occur in associa-
tion with other congenital heart defects, and as such are usually recognized early in life and corrected, although isolated lesions may go undetected at birth only to present later as heart failure and/or ischemia or sudden death. ALCAPA and congenital coronary stenosis present in the first months of life and are characterized by “effort irritability” (crying occurring during or soon after feeding), as a result of myocardial ischemia and angina. Mahle reported a case of ALCAPA in a 12-week-old infant who had been misdiagnosed and treated for colic for 10 weeks before heart disease was suspected. Other associated findings that can help identify these infants are: respiratory distress, congestive heart failure, murmur, cardiomegaly, and ischemic changes on EKG. Coronary fistulae are typically diagnosed in older infants, have characteristic continuous murmurs, and rarely manifest as heart failure or ischemia. Acquired coronary stenosis or occlusion occurs in infants as a result of Kawasaki disease, with an incidence of 5-10% in treated patients and 20-25% in untreated patients, and it may present as congestive heart failure, angina, or acute myocardial infarction. Other cardiac manifestations of Kawasaki disease are pericarditis, myocarditis, arrhythmias, and cardiogenic shock. The individual clinical features of Kawasaki disease are nonspecific and associated with many childhood disorders; it is the constellation of symptoms that establishes the diagnosis. AHA guidelines have been developed to assist in recognition, but the disease may present in an atypical manner without fulfilling all the guideline criteria. As a result it may be misdiagnosed or thought to be a benign viral illness. To further complicate the problem, the cardiac symptoms may occur subacutely or months after the initial illness. Myocardial infarction is the primary cause of death from Kawasaki disease and typically presents in infants as inconsolable crying, irritability, respiratory distress, and vomiting or cardiovascular collapse. Chest pain secondary to vasoocclusive events involving the bony thorax is a common complaint among children with sickle cell disease (SCD); nonverbal infants with SCD typically express pain as crying and irritability. Subtle signs of chest pain in infants include tachypnea, splinting, and decreased breath sounds; grunting or hypoxemia suggests significant respiratory compromise. Pulse oximetry may not be accurate in children with severe anemia; low oxygen saturation should be confirmed by arterial blood gas. Acute chest syndrome (ACS) is the leading cause of death with sickle cell disease and is defined as “a new pulmonary infiltrate in combination with fever, chest pain, or respiratory symptoms.” Vichinsky et al analyzed 671 episodes of ACS in 537 patients with SCD and found that nearly half presented with pain, were afebrile, and subsequently developed respiratory symptoms with infiltrates on chest x-ray after admission, which was interpreted as suggesting that pain is a prodrome of ACS. In a smaller study (n=50) of infants and children with ACS, only 27 were febrile on presentation, and all had significant chest x-ray changes. The etiology of ACS is infection, pulmonary infarction, or pulmonary fat embolism. Infection is common in infants and younger children, particularly with mycoplasma, RSV, and parvovirus. Other infectious agents associated with ACS in children are chlamydia, S. aureus, and pneumococcus. The possibility of acute chest syndrome should always be considered in the infant or young child with SCD who presents with crying and irritability, even in those with few other symptoms or physical findings. Fever, chest pain, increased work of breathing, wheezing, or decreased aeration should prompt immediate evaluation for ACS.

Gastrointestinal Conditions

The association of esophageal pathology with dysphagia, odynophagia, and chest pain is well established in adults and older children. Crying, irritability, and sleep disturbances are known to occur with gastroesophageal disease (GERD) in infants. All infants experience some regurgitation with feeding (spitting); recurrent vomiting occurs in 50% of infants in the first 3 months of life, in two thirds of 4-month-olds, and as many as 5-10% of infants at age 1 year. Reflux becomes clinically significant only when associated with adverse effects such as esophagitis, hematemesis, aspiration, or failure to thrive. Some infants are thought to experience significant pain with GERD, as evidenced by episodes of inconsolable crying during and after feeding; irritability, restlessness, and increased motor activity, including drawing the legs up toward the abdomen and kicking movements, are also frequently associated with feeding in infants found to have GERD. Heine et al reported the presence of pathologic GERD, defined as moderate to severe reflux by esophageal pH monitoring, in 22 of 70 infants (31.4%) less than a year old with irritability and the presumptive diagnosis of reflux. Other studies have shown conflicting results, using various methods of analysis, but the general consensus is that crying and irritability can be symptoms of esophageal disease. There is also a small subset of infants known to have pathological GERD in the absence of vomiting, with only symptoms of crying and irritability. These infants can only be identified by esophageal pH monitoring or esophagoscopy with biopsy. Another recognized cause of odynophagia in infants is allergic eosinophilic esophagitis, caused by an allergic response to certain foods, specifically milk, soy, wheat, eggs, and peanuts. Allergic esophagitis is one of several gastrointestinal manifestations associated with immunologic reactions to foods (see below). These infants have typical symptoms of esophagitis and reflux, but they do not respond to conventional therapy, have normal esophageal pH monitoring, and often have an atopic history. The disorder is characterized by increased and/or persistent esophageal intraepithelial eosinophils on biopsy; approximately 50% of infants have a significant peripheral eosinophilia. As many as 50% of infants less than 1 year of age with GERD are suspected of having milk allergy associated or induced disease. Conditions that are associated with bowel distention and increased peristalsis cause abdominal pain and discomfort. Common among these disorders are gastro-
enteritis, adynamic ileus, constipation, and a constellation of gastrointestinal manifestations that are adverse immunologic reactions to foods, primarily milk, soy, eggs, and cereals. More serious conditions are those causing peritonitis, and although they are rare, have significant mortality and morbidity. Foremost among these are appendicitis and peritonitis secondary to infantile nephrotic syndrome. Excessive crying can be the presenting symptom of gastroenteritis, which becomes a retrospective diagnosis only after the onset of vomiting and diarrhea and the exclusion of more serious conditions.\(^5\) Pain associated with gastroenteritis is often crampy in nature accompanied by hyperactive bowel sounds. Adynamic ileus can be associated with gastroenteritis and/or electrolyte abnormalities or can be a side effect of antimotility drugs; it is characterized by abdominal distention and hypoactive or absent bowel sounds.

Constipation is the most common cause of abdominal pain in childhood, accounting for 3-5% of pediatric office visits and a quarter of pediatric gastroenterology referrals.\(^{156,157}\) There is great variation among patients and professionals as to what constitutes constipation; the North American Society for Pediatric Gastroenterology and Nutrition defines constipation as a “delay or difficulty in defecation, present for 2 or more weeks, and sufficient to cause significant distress to the patient.”\(^{156}\) Parents have many misconceptions regarding stooling in infants — a great source of anxiety for many. Infants typically have about 4 stools per day during the first week of life, gradually decreasing to a mean of 1.7 stools per day by age 2 years.\(^{156}\) Normal infants may have wide variation in stooling frequency, with breast-fed babies having fewer stools than those taking formula. Some breast-fed infants may not stool for several days, and some formula-fed babies may have a small, seedy stool with each bottle. In the absence of abdominal distention, vomiting, bloody stools, feeding difficulties, or disturbances of growth and development, reassurance is all that is necessary.\(^{156}\) The majority of constipation is functional, caused by painful bowel movements with subsequent voluntary withholding of feces. Over time the rectal muscle habituates to the enlarging fecal mass and the urge to defecate ceases. Eventually, as the amount of colonic stool increases, the infant or child experiences abdominal pain and distention, irritability, and anorexia. Occasionally 1 or 2 episodes of vomiting may accompany the pain, but frequent or persistent vomiting should prompt evaluation for other pathology. Organic causes of constipation include hypothyroidism, electrolyte abnormalities, occult spinal cord disorders, cystic fibrosis, Hirschsprung’s disease, cow’s milk protein intolerance, and certain drugs, (ie, opiates, anticholinergics, and sympathomimetics).\(^{156,158}\) Many over-the-counter pediatric cold and cough preparations have anticholinergic and sympathomimetic properties.\(^{159}\) Hirschsprung’s disease is the most common cause of lower intestinal obstruction in neonates, with most cases becoming evident shortly after birth with failure to pass meconium, abdominal distention, and vomiting. However, 8-20% of cases of Hirschsprung’s disease may go undetected until later in infancy, and occasionally short segment disease may continue into childhood. Enterocolitis, an uncommon complication of Hirschsprung’s disease with a mortality rate of 20%, typically occurs in the first 3 months of life with initial symptoms of fever, abdominal distention, and explosive, bloody diarrhea.\(^{156}\) Infants with this presentation and a history of previous “constipation” should be presumed to have enterocolitis and undergo emergent surgical consultation. A thorough history and physical examination will identify most cases of functional constipation. Red flags, such as failure to thrive, recurrent vomiting, abdominal distention, abnormal neurologic findings, or bloody stools, should alert one to look for organic disease.\(^{156,158}\) Typical physical findings with functional constipation are nonlocalizing abdominal tenderness, normal or hyperactive bowel sounds, and frequently there is palpable stool in the lower abdomen. Digital rectal examination should be performed to assess perianal sensation and tone, rectal size, amount and consistency of stool, and stool hemoccult.\(^{156,157}\) Constipation is associated with normal anal sphincter tone and a normal or enlarged rectal vault; contracted sphinctor and rectum, and absence of stool are characteristic of Hirschsprung’s disease.\(^{156}\)

Cow’s milk allergy (CMA) is associated with crying episodes, excessive fussiness, and sleeplessness.\(^{164}\) It is reported to cause GERD, constipation, and “colic.”\(^{160,163,166}\) The entity of cow’s milk allergy is not a single disorder, but a constellation of gastrointestinal diseases caused by immune-mediated reactions to dietary antigens; in infants these are primarily milk, soy, cereal, and eggs. There is often confusion concerning the clinical manifestations, resulting in a “shotgun” approach of dietary management, with infants undergoing unnecessary, multiple formula changes. The prevalence of CMA is estimated to be between 2% and 7.5% of otherwise normal infants; careful history and physical exam will suggest the diagnosis in many affected infants.\(^{161,162,163}\) Immediate gastrointestinal hypersensitivity develops within minutes to 2 hours postgestation of the responsible food allergen.\(^{161,162}\) Typical manifestations are abdominal pain, vomiting, and diarrhea; however, in young infants, vomiting is not always a consistent finding and may occur only intermittently, and abdominal pain, crying, and irritability may be the initial symptoms.\(^{161}\) The temporal relationship of symptom onset with feeding, as well as a personal or family history of atopy, may be helpful, but has no predictive value in diagnosis.\(^{165}\) Frequently these infants have anorexia, poor feeding, and failure to thrive.\(^{161,162}\) Allergic eosinophilic esophagitis (above), gastritis, and gastroenterocolitis are IgE-mediated and characterized histologically by eosinophilic infiltration of the esophagus, stomach, and/or intestinal walls.\(^{161,162}\) All of these disorders are accompanied by irritability, crying, sleep disturbances, and failure to thrive, with 50% of affected infants having peripheral eosinophilia and 50-70% of infants having a past history of other allergic symptoms.\(^{167}\) In addition, gastrointestinal bleeding is common in gastritis and gastroenterocolitis, either
episodic or inconsolable crying is not a prominent symptom.

Although these infants are often irritable, episodic or inconsolable crying is not a prominent symptom. Bloody diarrhea is the hallmark of dietary protein enterocolitis and enteropathy and is often severe, with typical stool containing blood and many leukocytes. These disorders have a spectrum of clinical severity, ranging from mild symptoms in dietary protein proctitis, with only blood-streaked stools and slight anemia, to protein-losing enteropathy characterized by steatorrhea, severe anemia, hypoalbuminemia, dehydration, and malnutrition. All of these disorders occur in breast-fed as well as formula-fed infants, with soy being the offending agent as often as milk. Excessive crying or irritability alone is not an indication for random formula change, which only delays the definitive evaluation of these infants and gives parents a false hope that is short-lived when the crying behavior continues. The well-appearing, thriving infant who is feeding normally, not having vomiting, diarrhea, or bloody stools, and is hemocult negative, is unlikely to have one of these conditions. But even if the crying is an early symptom of food allergy, in the absence of other symptomatology or signs of end-organ disease, acute intervention is not indicated.

Peritonitis is caused principally by 3 conditions in infants — appendicitis, pancreatitis, and primary peritonitis, all of which are rare, but associated with significant morbidity and mortality. The initial symptom of each is abdominal pain, which in the nonverbal infant is communicated by crying. Primary peritonitis (also known as spontaneous bacterial peritonitis or subacute bacterial peritonitis) is caused by infection of the peritoneal cavity with an intact intestinal tract and may occur without predisposing disease. Conditions commonly associated with primary peritonitis in infants are nephrotic syndrome, malignancy, and viral hepatitis, with ascites as the common denominator in all these diseases. Organisms typically isolated from peritoneal fluid include E. coli, Klebsiella species, and pneumococcus. The onset is insidious, beginning with abdominal pain, followed by fever, vomiting, and diarrhea. The presence of jaundice, hepatomegaly, and abnormal liver function tests strongly suggest the diagnosis of hepatic disease. Signs of underlying malignancy include hepatosplenomegaly, abdominal mass, and hematologic abnormalities. Onset of congenital or childhood nephrotic syndrome may be more subtle with periorbital or facial edema and abdominal distention. Both facial edema and abdominal distention may not be obvious in the chubby infant with a normally protuberant abdomen. These children are immunoincompetent, due to T-cell dysfunction and loss of immunoglobins in the urine, and as ascites develops, they are predisposed to hematogenous seeding of their peritoneum. The presence of significant proteinuria, decreased total protein and albumin, and hyponatremia (dilutional pseudohyponatremia) suggest a protein-losing nephropathy. Once the presence of ascites is confirmed, either clinically or by abdominal ultrasound, diagnostic paracentesis will confirm the diagnosis.

The most common cause of pancreatitis in children is blunt abdominal trauma, sustained in motor vehicle crashes, falls, or bicycle handlebar injuries, and a third of which is secondary to child abuse. Other etiologies include viral infections, hepatobiliary disease, hemolytic syndromes, collagen vascular disorders, cystic fibrosis and medications, such as corticosteroids, valproic acid, and trimethoprim/sulfamethoxazole. Typical clinical symptoms are several hours of abdominal pain and anorexia with subsequent fever and vomiting. The physical findings are limited to the abdomen, unless there is dehydration and/or hemodynamic instability. Abdominal tenderness may be diffuse or focal, with guarding and mild distention secondary to ascites; paradoxical irritability may be present if there is significant peritoneal irritation. Early in the course of the illness the infant or child may be relatively well-appearing, with nonspecific signs and symptoms suggestive of benign viral illness or gastroenteritis; however, the abdominal pain tends to be persistent and unrelenting. An adequate abdominal exam is virtually impossible in the crying, uncooperative infant, but the diagnosis should be entertained in the infant who has symptoms suggestive of continued abdominal pain. In cases of child abuse, there may be few or no external signs of trauma with serious intraabdominal injury. Infants and children with traumatic pancreatitis as a result of non-accidental injury present later in the course of the illness, usually have multiple intraabdominal organ injuries, and as a result are much sicker and have higher morbidity and mortality. They often require aggressive resuscitation and emergent abdominal CT and surgical consultation.

Intestinal obstruction in the neonate may be due to a variety of disorders, including atresia and stenosis, malrotation, intestinal duplication, meconium ileus, or Hirschsprung’s disease. Intestinal atresias are usually identified prenatally by ultrasound or soon after birth, due to bilious emesis and failure to pass meconium rectally. Occasionally an infant with a stenotic lesion will be discharged home, to appear in the pediatrician’s office or the ED a few days later. The clinical presentation may be relatively acute, with bilious vomiting, hypovolemia, and cardiovascular decompensation, or the course of the illness may be subacute, with poor feeding, intermittent vomiting, crying, and irritability. Distal small bowel and colonic stenosis are typically associated with abdominal distention, although this may not be easily appreciated in crying infants. Duodenal lesions most commonly affect the postampullary segment of the duodenum and on plain abdominal radiographs may appear as the characteristic “double bubble” sign with a large air-filled stomach and a dilated, air-filled proximal duodenum. The diagnosis is confirmed by upper GI series. There are also rare case
reports of nonobstructing antral or duodenal webs causing poor feeding and episodes of incontrollable crying. Jejunoileal stenosis has the same clinical presentation as duodenal stenosis and appears on plain abdominal x-rays as dilated proximal small bowel loops, often with air fluid levels. These findings in association with a malrotated microcolon on barium enema suggest the diagnosis. Colonic stenosis is very rare and may be confused with Hirschsprung’s disease, which is excluded by intestinal biopsy.

Internal abdominal hernias are a rare cause of acute and chronic abdominal pain in childhood with clinical presentation from early infancy to adolescence. While the frequency is unknown, it is estimated that 0.5-3% of all intestinal obstructions are due to internal hernias. One third of patients are asymptomatic throughout their lifetime, the hernias only discovered on abdominal exploration for unrelated conditions or at postmortem; a third manifest as acute abdominal obstruction, which has a 50% mortality rate, primarily related to delayed preoperative diagnosis and frequent complications. The remaining third of patients experience chronic abdominal pain, recurrent vomiting, and alternating diarrhea and constipation. Plain abdominal radiographs are unlikely to reveal abnormality, except with acute obstruction; upper GI and small bowel barium contrast studies may show prestenotic dilatation, delayed gastric emptying, and retrograde peristalsis.

The incidence of inguinal hernia in infants and children is reported to be 0.8-4.4%, but is steadily rising, due to the increased survival of premature infants, of whom 30% have hernias. Inguinal hernias are typically asymptomatic and are often noted by parents as an enlarged scrotum or a groin bulge. Femoral hernias account for less than 0.5% of all pediatric hernias, but they have a high incidence of incarceration and strangulation and should be quickly repaired, once discovered; if the clinical distinction between femoral and groin hernias is unclear, ultrasound will differentiate the 2 conditions. It is also sometimes difficult to clinically distinguish between a scrotal hernia and hydrocele, or a groin hernia and inguinal lymphadenitis, with ultrasound easily differentiating the diagnosis in these instances, as well. Umbilical hernias are very common in low birth weight and African American infants, and more than 80% will undergo spontaneous closure before age 5 years. Hernias with an internal defect greater than 2 cm or those that persist longer than 4 years are less likely to close spontaneously and should be surgically repaired, as the risk of incarceration and strangulation increases with age. Incarcerated hernias are exquisitely painful, causing irritability and crying in the infant, which increases intraabdominal pressure, thereby diminishing the likelihood of spontaneous reduction. Unless specifically instructed, parents may not recognize the association between the incontrollable crying and the hernia. After a short time, vomiting and abdominal distention develop, and with strangulation and bowel ischemia, rectal bleeding occurs. An incarcerated hernia is an acute surgical emergency requiring speedy manual reduction or operative intervention.

Musculoskeletal Conditions
Developmental dysplasia of the hip (DDH), the most common congenital defect in the newborn, is usually identified at birth by the typical finding of “clicking hip(s)” on physical examination, with subsequent confirmation on ultrasound. As is the case with other congenital defects, occasionally the condition is not identified at birth, or the parent fails to understand the necessity of follow-up, and the condition continues into infancy or childhood. There are 2 categories of “clicking hips”: one that has demonstrated abnormality on ultrasound, but eventually develops into a normal hip, and one that deteriorates to some form of dysplasia, including complete dislocation (true DDH). True DDH has an incidence of 5 per 1000 hips. Risk factors include female sex, with risk for girls 4 times that of boys, and breech presentation at birth. There is also an increased familial incidence, but this is not a statistically significant risk factor. The truly dysplastic hip is painful, and affected infants experience varying degrees of discomfort, which is often exacerbated by movement of the extremity. They may have general irritability, paradoxical irritability, episodic crying, or pseudoparalysis. Characteristic physical findings are asymmetry and shortening of the affected leg (inconsistent findings with bilateral DDH) and positive Ortolani and Barlow maneuvers (see Physical Examination section below). Complications of untreated true DDH include avascular necrosis of the femoral head and degenerative joint disease. Diagnosis is confirmed by demonstration of subluxation/dislocation on plain radiographs or ultrasound of the hip.

There has been a recent resurgence of 2 “old diseases” that can cause bone abnormalities and bone pain in young infants. The incidence of rickets and congenital syphilis increased significantly in the late 1980s and into the 1990s, and case reports continue to appear in the literature. The increase in rickets is due largely to an increase in nutritional, or vitamin D-deficient, rickets; risk factors include exclusive breastfeeding without vitamin supplementation, dark skinned ethnicity, and lack of exposure to sunlight. Other etiologies of rickets include vitamin D resistance, malabsorption syndromes, hepatic and renal disease, and phosphate depletion, due to excessive antacid use in the treatment of colic and GERD. Rickets has a variable presentation, ranging from minor laboratory abnormalities of calcium, phosphate, and alkaline phosphatase, to tetany and hypocalcemic seizures. The clinical manifestations of rickets are typically growth and developmental delay, limb pain, bowing, and fractures; tetany and seizures occur with very low levels of serum calcium. Bone abnormalities include osteopenia, osteomalacia, and bowing of the long bones, and metaphyseal fraying and widening secondary to demineralization of the growth plates. These abnormalities manifest clinically as pain and swelling of the wrists and ankles, bowing of the legs, and the classic “rachitic rosary” of the ribs.
Infants and young children may present with irritability and crying, paradoxical irritability, pseudoparalysis, and fractures secondary to minor trauma, which may initially suggest nonaccidental injury. Laboratory findings are hypocalcemia, hypophosphatemia, and elevated alkaline phosphatase secondary to increased osteoblast activity. The overall incidence of acquired syphilis has declined over the past decade, since its dramatic rise in the early 1990s; however, it is still a significant problem in urban areas and the south. Morbidity and mortality associated with congenital syphilis continues to be high, with 40% of untreated prenatal infections resulting in spontaneous abortion, stillbirth, or perinatal death. The increased incidence and high mortality of congenital syphilis are associated with lack of prenatal care and maternal substance abuse, specifically the use of cocaine. The surviving infant may have clinical manifestations at birth or may be asymptomatic; if the serologic status of the mother is not determined, the asymptomatic, infected infant will go undetected, to present with early symptoms of disease, usually within the first 2 months of life, with late manifestations after 2 years. Common early symptoms include maculopapular (occasionally vesiculobullous) rash involving the hands and feet, fever, hepatomegaly, and persistent rhinitis ("snuffles"). Bony manifestations include painful periostitis of the long bones and osteochondritis involving the wrists, elbows, ankles, and knees, which may occur alone or in a constellation of symptoms, characterized as irritability, crying, and/or pseudoparalysis. Other abnormalities include anemia, thrombocytopenia, and abnormal liver function studies. If there is central nervous system involvement, the CSF will show elevated protein, a mononuclear pleocytosis, and a positive serologic test.

Septic arthritis (SA) occurs most frequently in infants under 2 years of age, with the most commonly involved joints being the hips and knees. Symptoms of pain, soft tissue swelling, warmth, and erythema are easily recognized if they involve the knee; however, SA of the hip in the nonverbal infant may not be so obvious. Early symptoms may be quite nonspecific, among them irritability, crying, and vomiting; presentation of abdominal pain, with a normal hip exam, has been reported to occur early in the course. As the disease progresses, the infant typically becomes more ill-appearing, with pseudoparalysis of the involved extremity and increased crying with range of motion of the hip, especially with internal rotation. Definitive diagnosis can be made only by joint aspiration and examination and culture of the synovial fluid, however other laboratory and radiographic studies can be helpful in making the diagnosis. Erythrocyte sedimentation rate (ESR) greater than 20 mm/hr and C-reactive protein (CRP) greater than 10 mg/L are more often associated with SA than with noninfectious causes of an acutely painful hip. Presence of joint effusion, as evidenced by widening of the joint space and displacement of periarticular fat pads, is also associated with SA, but is not diagnostic. Temperatures greater than 38.5°C and CRPs greater than 20 mg/L have been reported to have a sensitivity of 100% and specificity of 97% for septic arthritis. Ultrasound is more sensitive for the detection of joint effusion, but does not differentiate SA from other causes of effusion. The presence of fever, inability to bear weight, elevated sed rate and CRP, and the presence of joint effusion are reported to be independent predictors of SA, with the presence of 4 or more being associated with a high probability of septic arthritis of the hip. Any infant suspected of having SA should have an emergent orthopedic evaluation and further evaluation by joint aspiration or MRI.

Osteomyelitis is relatively rare in neonates and young infants compared with older children and is less likely to present in infants with classic symptoms of fever or localizing signs, such as focal tenderness, soft tissue erythema and swelling, or cellulitis over the area of infection. Symptoms are frequently irritability, crying, poor feeding, or lethargy. Infection can involve one or multiple bones; common sites are the femur, tibia, and fibula, and the infant may have pseudoparalysis with increased crying on range of motion. White blood count (WBC) is often elevated, but has little predictive value; CRP will rise early in the course of the disease and is often greater than 40 mg/L at presentation. Plain radiographs are typically not useful, as bony changes are not visible until 7-10 days after onset of symptoms. Bone scan is helpful in the young infant in whom the involved site is not well localized on physical exam, but MRI is a better imaging modality, if the site of involvement can be determined by physical findings. Blood cultures are positive in just half or fewer patients. Upon identification and localization of the infection, the diagnosis can be confirmed by aspiration of subperiosteal pus, with subsequent culture of the causative organism. Discitis, or intervertebral disc space infection, generally affects children under 5-years-old and on occasion is seen in young infants. Clinical presentation is often determined by the verbal skills of the child, with older children most commonly complaining of back pain. Nonverbal infants typically refuse to bear weight, have gait abnormalities, or refuse to crawl, depending upon their individual motor skills. A few infants present with increased irritability, fussiness, and crying, without the accompanying gait disturbance. Discitis occurs almost exclusively in the lumbar spine, and most children are well-appearing and afebrile with normal physical findings, with the exception of limitation of lower back and hip girdle movement. History of refusal to ambulate, in conjunction with a careful examination of the lumbar spine and pelvis, should lead one to evaluate the infant for causes of back and hip pain. A significant number of children will have abnormalities on plain radiographs of the spine consistent with discitis, such as decreased height of the disc space and erosion of the vertebral endplates. Children with normal or indeterminate findings on spine radiographs should have evaluation by MRI. The pathophysiology of discitis is poorly understood; blood and disc space cultures are generally sterile and patients usually...
recovery with only supportive therapy.\textsuperscript{186}

The most common manifestation of sickle cell disease is vasoocclusive pain crisis, which is caused by end-organ ischemia due to red cell sickling and aggregation, with subsequent microvascular obstruction. Young infants experiencing pain crisis can present with crying and irritability, with minimal or no physical findings or associated symptoms. All newborns are screened for sickle cell disease, but initial results may be inconclusive, or the infant may be discharged from the nursery before results are available. If the parent fails to follow up or to complete retesting, the diagnosis may be lacking at the time of presentation in the ED. Infants can have dactylitis, painful hands and feet with characteristic fusiform swelling of the fingers or toes (Figure 4), as their first clinical manifestation of sickle cell disease. Fingers and toes are peripheral sites of hematopoiesis in young children and, as such, are common sites of vaso-occlusion; dactylitis is not seen in older children because hematopoiesis occurs more centrally in the arms, legs, and ribs.\textsuperscript{188} The presence of dactylitis is nearly pathognomonic of sickle cell disease in a young African American infant, and pain crisis involving other areas may be very confusing initially, due to lack of physical signs. Anemia, reticulocytosis, and hyperbilirubinemia should prompt evaluation for hemolytic anemia and sickle cell disease.

The first known, reported case of tourniquet syndrome occurred in 1612. The report described a child with hair, ribbon, and string tied around his penis to prevent enuresis and nocturnal emission.\textsuperscript{189} In recent years there have been multiple reports of hair-thread tourniquet syndrome, most often involving the toes, less often the fingers and genitals, and in 2 cases involving the uvula.\textsuperscript{189-191,193-195} The appendage becomes encircled with hair, thread, or other materials, producing ischemia and eventually necrosis, if not recognized and treated. Young infants less than 6 months old typically have involvement of fingers or toes, whereas genital tourniquet syndromes are more common in older children.\textsuperscript{189,191,194} Infants are frequently described as irritable and may present with crying as the chief complaint, if the parents have failed to recognize the constricted body part.\textsuperscript{189-192} The appearance of the constricted appendage varies from erythema and edema (Figure 5) to necrosis and gangrene. The constricting hair or thread cuts through the skin and becomes embedded deep within the subcutaneous tissues. There are even case reports of skin reepithelializing over the constricting band.\textsuperscript{190} There is a strong association between toe tourniquet and sleepwear with enclosed feet, and finger tourniquet with the use of infant mittens to prevent self-inflicted fingernail injuries.\textsuperscript{190,191} It has also been suggested there is a temporal relationship between hair tourniquet and the maternal postpartum hair loss that occurs 3-4 months after childbirth.\textsuperscript{192} Child abuse is also a likely cause in some instances, especially in cases involving multiple digits or in which the constricting material has a figure of 8 loops or knots.\textsuperscript{193} Several case reports describe physical signs and symptoms noted days before medical care was sought. Can this not be construed as medical neglect, if not outright abuse? Tourniquets involving the penis, clitoris, or

**Figure 4. Dactylitis.**


**Figure 5. Hair Tourniquet.**

vulva, especially in older children, are difficult to rationalize as accidental; child abuse or self-mutilation should be strongly considered.193,194 A diligent search for constricting bands should be made of all crying and/or irritable infants, with careful examination of the genitalia and each finger and toe.

The clinical presentation of fracture in the nonverbal infant is like that of all the painful conditions affecting bones and joints. Irritability, crying, paradoxical irritability, and pseudoparalysis may occur singly or in combination. Palpation and movement of the involved bone or limb will exacerbate pain, accompanied by facial grimacing and intensification of crying. There is often little swelling or erythema associated with fractures in infants, unless there is bony angulation or deformity. Moderate to severe force is required to produce fractures, and the clinical history should reflect a mechanism of injury capable of causing the specific injury and compatible with the developmental capacity of the infant. Fractures due to accidental injury in nonmobile infants are uncommon in the absence of major trauma.69,70,101 A significant number of fractures in infants less than 1 year old are due to child abuse.100-102 Rib fractures, vertebral fractures, and metaphyseal chip and “bucket handle” fractures are pathognomonic of abuse.99,107 Spiral fractures of the long bones in infants are strongly associated with child abuse; proximal physeal and supracondylar fractures of the femur are also frequently the result of nonaccidental injury in children under 2 years of age.101,102 The emergency physician must have a high index of suspicion and not be afraid to pursue an evaluation for child abuse, if history and/or physical findings are suspicious for nonaccidental injury.

Genitourinary Conditions
Urinary tract infection (UTI) is a frequent bacterial infection in children and the most common serious bacterial infection in neonates and young infants. The incidence is reported to range from 8.7-13.6% in febrile infants less than 3 months of age; the prevalence for highly febrile, white females less than 1 year of age is estimated at 15-17%, and uncircumcised males have a 5- to 20-fold increased risk for UTI in the first year of life.195,196,198,200,202,211 Infants often have nonspecific presentations, with poor feeding, irritability, or vomiting, though fever may be the only symptom. Infants also have UTI in the absence of fever, with the sole complaint of increased crying or irritability, presumably due to abdominal and/or flank pain or to discomfort associated with urination; however, there are no data referable to the incidence of afebrile UTI in infants or to the sensitivity or predictive value of crying or irritability in the assessment of UTI.5,196,197,200,211 Older children and adults routinely complain of pain associated with UTI, and since there is ample evidence that three fourths of children with febrile UTI have pyelonephritis on renal scan, it would seem reasonable that afebrile infants should also suffer pain and discomfort.195,196,203,211 UTI should be considered in all young infants as a source of fever or the cause of unexplained crying; even infants with another fever source, such as upper respiratory infection, otitis media, pharyngitis, bronchiolitis, or gastroenteritis, have a significant incidence of concomitant UTI.57,204-210 Urine should be collected by bladder catheterization or suprapubic aspiration. Note that bag specimens are often contaminated, resulting in confusion and unnecessary treatment.195,211 Occasionally parents refuse bladder catheterization, but often relent when presented with a detailed explanation of the risks and benefits. Infants younger than 2 years should have a complete urinalysis (including microscopic) and a urine culture performed.195,196,203,204,211 Neonates and infants at risk (ill appearance, prolonged fever, history of previous UTI, or urinary tract abnormality) may benefit from enhanced urinalysis and/or urine gram stain, both of which have increased sensitivity and specificity compared with routine urinalysis.199-202

Testicular torsion is a urologic emergency and occurs from infancy throughout adulthood, but it has a bimodal distribution that peaks in the neonate and adolescent. The onset of testicular torsion in the infant is often accompanied by crying and irritability, and the parents may or may not note the scrotal swelling and erythema. The classic “bell clapper” deformity of horizontal or high-riding testicle may be difficult to appreciate in the crying, agitated infant. Testicular torsion should be considered in any neonate or young infant with sudden onset of crying associated with scrotal enlargement, redness, and tenderness. Clinical differentiation between testicular torsion, epididymitis, and incarcerated scrotal hernia may be difficult in the infant and often requires an imaging study. The choice of Doppler sonography or radionucleotide imaging is usually dependent upon institutional preference and availability; both modalities have a small incidence of false negatives and false positives.239 Intravenous access is not required for sonography, and it also has the advantage of direct visualization of scrotal contents, with a higher specificity for hydrocele and inflammatory processes.239 Difficulty with ultrasound arises when blood flow is not demonstrated in the normal testis. Observing flow in small testes with ultrasound is sometimes technically difficult, and the adequacy of the exam is dependent upon comparison of flow of the affected testes with that of the normal testes. Urology should be emergently consulted as soon as the diagnosis of testicular torsion is considered. An imaging study may be necessary for diagnostic confirmation, but urology consultation should not be delayed pending results of the study. (For more information, see Pediatric Emergency Medicine Practice, Volume 1, Number 4, Urogenital Emergencies In Boys: An Evidence-Based Approach To Sensitive Issues, November 2004.)

Dermatologic Conditions
Painful skin infections, such as cellulitis or abscesses, are common in children. Neonates are particularly vulnerable to mastitis, omphalitis, facial cellulitis, and superficial abscesses. These infants often have increased fussiness, crying, and paradoxical irritability and may be afebrile at presentation.130,140 Common pathogens causing skin infec-
Insect bites are common in infants and children, causative within 1 to 2 hours, though this target lesion may appear as a small papule or vesicle, which gradually localized itching, erythema, and pain. The bite initially often unknown for several hours, until the site develops hypertension. Bites from brown recluse spiders are also diagnosis is often one of exclusion. Symptoms generally hospitalization for observation and evaluation, and the drug ingestion, may be necessary. Most infants require in the absence of a history of spider bite, and exclusion Definitive diagnosis is very difficult in the young child still and has increased crying with movement. A signifi- in contrast to the infant with peritonitis, who prefers to lie typically spares the inguinal creases and perianal area, unless the infant has diarrhea, whereas candida almost always involves intertriginous areas. The rash may be a bright erythema with a glazed appearance that subsequently peels, often resembling a burn. Moist, macerated skin is particularly susceptible to colonization by Candida, which is a secondary infection in as many as three fourths of babies with diaper dermatitis. The dermatitis typically spares the inguinal creases and perianal area, unless the infant has diarrhea, whereas candida almost always involves intertriginous areas. Candida is also characterized by the presence of satellite lesions, which are papulopustular lesions scattered on the periphery of the rash. Diaper dermatitis can cause dysuria in both sexes, and urinary retention in males, especially those with metritis or balanitis.

**Generalized Conditions**

Neonatal hyperthyroidism is exceedingly rare, usually occurs in infants born to mothers with Graves’ disease, and is caused by transfer of maternal thyrotropin-receptor-stimulating autoantibodies. These infants have intraperitoneal tachycardia or develop symptoms of thyrotoxicosis shortly after birth, which persist until maternal antibodies clear at approximately 4 months of age. There is a second form of congenital hyperthyroidism that is non-autoimmune, familial, and transmitted via
an autosomal dominant mode. Some of these infants have symptoms at birth, while others do not develop symptoms until later in infancy or childhood. Symptomatic infants have thyroid hyperplasia and typically exhibit tachycardia, irritability, hyperexcitability, and poor weight gain. These infants usually do not have ophthalmoscopy or proptosis, which is an important distinction of familial non-autoimmune hyperthyroidism.

Neonatal hypocalcemia — which occurs early, in the first 24-28 hours after birth — is common in premature infants or infants of diabetic mothers. These infants are usually irritable and jittery, and may occasionally have seizure activity. Infants with neonatal transient hypoparathyroidism develop hypocalcemia later in the neonatal period. Most infants present with seizures; however, Tseng et al reported a 6-day-old neonate who presented with irritability, high-pitched crying, and opisthotonus. Neonatal hypoparathyroidism is characterized by hypocalcemia, hypomagnesinemia, and hyperphosphatemia, and the diagnosis is confirmed by measurement of low parathyroid hormone.

Premature, low birth weight infants and infants born to diabetic mothers are also prone to hypoglycemia in the first few days of life; symptoms are tremor, jitteriness, irritability, and poor feeding. Older infants with hypoglycemia may manifest irritability or decreased activity and somnolence, but do not have adrenergic symptoms, such as tremor and sweating, that are characteristic of hypoglycemia in adults. Causes of hypoglycemia in neonates and older infants include inborn errors of metabolism, toxic ingestions (salicylates, ethanol, propranolol), sepsis, and malabsorption syndromes. Infants in general have limited glycogen stores and reduced ability to produce glucose via gluconeogenesis and, as a result, hypoglycemia may also occur with decreased oral intake due to fasting, anorexia, vomiting, or decreased absorption with diarrhea. Checking bedside glucose should be a priority in the evaluation of all infants who are toxic, ill-appearing, or who are at risk for hypoglycemia by history.

Infants and children are exposed to the toxic effects of drugs in several ways. Maternal drug abuse during pregnancy may result in neonatal intoxication or withdrawal syndromes. The clinical presentation of neonatal drug withdrawal is variable and dependent on the drug abused, the timing and amount of the last maternal use, and maternal and infant metabolism and excretion. Maternal abuse of opiates results in Neonatal Abstinence Syndrome (NAS), characterized by irritability, high-pitched crying, tremor, sleep disturbance, and gastrointestinal symptoms, which include poor feeding, vomiting, and diarrhea. These infants also have autonomic symptoms, such as fever, sweating, nasal congestion, and sneezing. At the extreme of symptomatology, 2-11% experience seizures. Prenatal exposure to barbiturates and sedative-hypnotics also produce an abstinence syndrome similar to that of opiates. The onset of symptoms can occur from hours to 2 weeks after birth; however, 90% of infants who develop NAS do so within 96 hours of birth. The clinical presentation of NAS may be mistaken for sepsis, inborn errors of metabolism, GERD, or “colic.” Obtaining an accurate prenatal history is vital to making a rapid diagnosis, though naturally many mothers will not readily admit to drug abuse, or they will minimize the amount of use. Historical clues that are suggestive of maternal drug use are lack of prenatal care, previous spontaneous abortions or stillbirths, abruptio placenta, and hypertensive episodes. Clues from the infant history associated with prenatal drug abuse are prematurity, intrauterine growth retardation, and urogenital anomalies. Neonatal effects of intrauterine cocaine exposure are more consistent with symptoms of cocaine effect rather than withdrawal, such as irritability, tachycardia, hypertension, and hyperthermia. Stimulant-exposed neonates (cocaine, amphetamines) tend to be less symptomatic than those exposed to opiates. Infants of mothers who ingest large quantities of alcohol during pregnancy are at risk for fetal alcohol syndrome (FAS), characterized by growth retardation, microcephaly, abnormal facial features, and central nervous system disorders. Neurologic manifestations of FAS during the neonatal period may include seizures, apnea, abdominal distention, and opisthotonus. Infants of alcoholic mothers may also develop physical dependence to alcohol in utero, and as a consequence they do experience withdrawal symptoms after birth — these infants may not have the classic features of fetal alcohol syndrome. Symptoms of abstinence/writhal withdrawal usually begin by the third day of life, continue for an indeterminate period of time, and include inconsolable crying, tremor, sleeplessness, hypertonia, and hyperreflexia. Withdrawal symptoms are also observed in infants exposed to heavy maternal smoking during pregnancy. Heavy smoking is defined as roughly 1 pack or more of cigarettes per day; the infants’ withdrawal symptoms are similar to those with opiate or alcohol withdrawal. Excessive crying and irritability continue beyond the immediate postpartum period in many infants of smoking mothers. Sondergaard et al studied 1820 smoking mothers from 16 weeks gestation to 8 months postpartum and found that infants of mothers who smoked more than 15 cigarettes daily during pregnancy or in the postpartum period had double the risk of colic. Recent studies suggest a link between exposure to cigarette smoke and infant colic, based on increased plasma and intestinal motilin levels, which are, in turn, linked to an increased risk for colic, GERD, and esophagitis. Certain psychotropics used during pregnancy can cause fetal and neonatal toxicity. Extrapyramidal symptoms, such as hyperactivity, tremors, agitation, hypertonicity, and shrill crying, are associated with large doses or high potency antipsychotic drugs; specifically, risperidone, fluphenazine, haloperidol, and thiothixene. Maternal benzodiazepine use can lead to a withdrawal syndrome in neonates, causing agitation, irritability, tremor, and inconsolable crying that can last for several months after birth. Drugs can be transferred to the infant from the mother via breast milk; unfortunately, there are limited data on...
the drug accumulation in breast milk of many common drugs. The milk-to-plasma concentration ratio (m/p ratio) defines the extent to which a medication is transferred from the mother’s blood to her breast milk, but only a select number of medications have appropriate data to calculate the m/p ratio. Most recommendations concerning drug safety for breastfeeding infants are based on case and adverse event reports. Multiple reports have implicated the stimulant drugs of abuse — cocaine and amphetamines — passing from mother to infant via breast milk, causing irritability, crying, agitation, tremor, and seizures. Other drugs transferred from breast milk and reported to cause crying, irritability, and feeding and sleep disorders include fluoxetine, clemastine, caffeine, and dextromethorphan. It is also known that drugs with a pKa greater than 7.2 are likely to be sequestered in breast milk, resulting in a high milk/plasma ratio — diphenhydramine has a pKa of 8.3-9.0, and pseudoephedrine has a pKa of 9.7. Both cause irritability, crying, sleeplessness, and tachycardia in infants.

Infants may suffer adverse events from drugs administered by parents as home remedies or as a form child abuse or neglect. Many parents do not consider over-the-counter cough and cold preparations to be medications and will not disclose they are administering these drugs, unless specifically questioned. Adverse reactions to antihistamines, decongestants, and cough suppressants are well described, causing agitation, confusion, crying, sleep disturbance, and tachycardia in children. Life-threatening effects, such as hypertension, seizures, stroke, acute myocardial infarction, and death, have been reported from misuse of these medications. Drugs, such as diphenhydramine or cocaine, are sometimes administered to infants to induce sleep. Toddlers may ingest drugs left lying on low furniture or on the floor. Toxic drug ingestions should be suspected when symptoms resembling anticholinergic or sympathomimetic toxidromes are present. (See Table 3.)

Many infants experience minor side effects following immunizations, primarily erythema, swelling, and pain at the injection site, transient fever, and irritability. Some infants may also have episodes of inconsolable crying following diphtheria-tetanus-pertussis (DTP) vaccine, with the crying typically beginning within 24 hours of injection and persisting for up to several hours. The character of the cry is also often abnormal during these episodes, and has been described as screaming and high-pitched. Unfortunately, crying secondary to immunizations is often a diagnosis of exclusion, after eliminating other more serious causes, particularly if the infant has inconsolable crying for several hours.

Infants with failure to thrive (FTT) are often irritable and fuss, and parents may seek medical evaluation for the fussiness and crying without recognizing the growth failure. It is estimated that 15-30% of young children seen in inner city EDs have some degree of growth deficit. Failure to thrive is due to undernutrition and, unless the infant has significant malnutrition, may not be readily recognized. A child is considered to have FTT when the weight-for-age falls below the fifth percentile or falls more than 2 major percentile lines on standard growth charts. Certain groups of children may exhibit growth variations secondary to premature birth, genetic syndromes, or ethnicity; modified growth charts should be used to plot weight and height for these children to avoid the over diagnosis of FTT. If the infant is growing along a curve and does not have significant decreases in interval growth, FTT is unlikely. The causes of FTT fall into 4 major categories: inadequate caloric intake, inadequate absorption, increased metabolism, and defective utilization. The etiology is often apparent after a careful history and physical exam. Specific inquiry should be made concerning diet, feeding behavior, chronic illness, and social and family history. Underfeeding may be due to poverty, improper preparation of formula, or parental neglect. Chronic illness may result in an increase in caloric demand, or congenital syndromes or metabolic defects may contribute to defective caloric utilization. Infants with malabsorption syndromes, cystic fibrosis, or short gut syndrome typically have loose stools and steatorrhea. Frequent spitting or crying with feeds is suggestive of GERD and esophagitis. Developmental status should be evaluated, as children with FTT have a higher incidence of developmental delay than is observed in children without growth deficit. Dysmorphic features suggest genetic or chromosomal abnormalities; craniofacial anomalies or otorrhea can interfere with sucking, swallowing, or chewing. The infant should be assessed for signs of underlying disease, such as undiagnosed heart or lung conditions, malignancy, and neurologic disorders. There must be careful examination for signs of abuse or neglect, as well as assessment of the parent-infant relationship. An attempt should be made to estimate the degree of undernutrition by comparing the child’s current weight with the expected weight-for-age at the 50th percentile. If the weight is less than 60% of that expected, the FTT is severe, and 61-75% indicates moderate FTT. There are no specific laboratory tests to identify FTT, except when findings on exam suggest a particular condition (ie, anemia, liver disease, or malabsorption). Infants with signs of nonaccidental injury or neglect should have a child abuse evaluation and be referred to CPS for investigation. If the safety of the child is questionable, admission may be necessary in order to complete the evalua-

<table>
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<th>Table 3. Anticholinergic And Sympathomimetic Toxidromes.</th>
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<td>Anticholinergic</td>
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<td>Altered mental status</td>
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<tr>
<td>Tachycardia</td>
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<tr>
<td>Large pupils</td>
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<tr>
<td>Dry skin</td>
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<td>Decreased bowel sounds</td>
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<td>Urinary retention</td>
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tion. Infants with severe malnutrition should be admitted; admission should be considered for those with moderate malnutrition or those with signs of underlying, potentially serious disorders.

**Prehospital Care**

Transportation to the hospital is the primary function of prehospital personnel for the vast majority of crying infants. Given the seriousness of some of the conditions that can cause crying in infants, signing out against medical advice should be strongly cautioned against.

**ED Evaluation**

**History**

The history should be obtained from the primary caregiver, if available, and somewhat tailored to the age of the child. Birth history may not be as important in the 18-month-old infant as in the neonate. The parents of a crying, irritable infant are often upset and anxious and may not be able to present the history in a chronologic and logical manner. Onset and duration are important, but may not correlate with the severity of illness. Parental tolerance of crying is highly variable, as is the definition of abnormal crying. The history for the crying infant should be comprehensive and must include certain salient details in addition to the usual questions. (See Table 4.)

**Table 4. History.**

<table>
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<tr>
<th>History of present illness</th>
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<td>Onset and duration</td>
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<tr>
<td>Frequency: First episode or recurrent?</td>
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<tr>
<td>If recurrent: Frequency, time of occurrence, duration, prior evaluations</td>
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<tr>
<td>Interventions: What makes it better?</td>
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<tr>
<td>Associated activities: Feeding, sleep disturbance</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Review of systems</th>
</tr>
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<tbody>
<tr>
<td>Fever</td>
</tr>
<tr>
<td>Vomiting: Bilius, partially-digested food, bloody</td>
</tr>
<tr>
<td>Diarrhea: Frequency, consistency, bloody</td>
</tr>
<tr>
<td>Rhinorrhea, cough, respiratory distress</td>
</tr>
<tr>
<td>Rash</td>
</tr>
<tr>
<td>Abnormal behavior, movements, spells</td>
</tr>
<tr>
<td>Recent trauma</td>
</tr>
<tr>
<td>Exposures: Household, daycare</td>
</tr>
<tr>
<td>Feeding: breast, formula, solids, recent changes, amount, frequency</td>
</tr>
<tr>
<td>Formula: Type, changes</td>
</tr>
<tr>
<td>Breast: Maternal meds, drugs, nicotine, breast disease</td>
</tr>
<tr>
<td>Stooling: Frequency, consistency, blood, recent changes</td>
</tr>
<tr>
<td>Urination: Frequency, color, odor, time of last urination</td>
</tr>
<tr>
<td>Sleeping: More, less</td>
</tr>
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<table>
<thead>
<tr>
<th>Birth history</th>
</tr>
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<tbody>
<tr>
<td>Prenatal: Maternal illness, meds (Rx, OTC), illicit drugs</td>
</tr>
<tr>
<td>Perinatal: Maternal GBS status, gestational age, complications, birth weight, newborn screening</td>
</tr>
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<table>
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<tr>
<th>Past medical history</th>
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<tbody>
<tr>
<td>Illnesses, hospitalizations, weight gain, developmental milestones</td>
</tr>
<tr>
<td>Medications: Rx, OTC</td>
</tr>
<tr>
<td>Immunizations: What and when</td>
</tr>
<tr>
<td>Medication allergy</td>
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<tr>
<th>Family history</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inherited disease: ie, SCD, hemophilia, asthma, mental illness</td>
</tr>
<tr>
<td>Medications in household</td>
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</tbody>
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<tr>
<th>Social history</th>
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<tbody>
<tr>
<td>Number living in household</td>
</tr>
<tr>
<td>Siblings (ages)</td>
</tr>
<tr>
<td>Living arrangement: House, apartment, shelter</td>
</tr>
<tr>
<td>Daycare</td>
</tr>
<tr>
<td>Smoking exposure</td>
</tr>
<tr>
<td>Illicit drugs or alcohol in household</td>
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**Birth History**

Inquiry should be made of maternal illness, medications, and illicit drug use. Also question whether alcohol and cigarettes were used during pregnancy. The mother should be asked to quantify her use of drugs, alcohol, and nicotine as specifically as possible. It is important to know if the mother has a history of prenatal sexually transmitted diseases, particularly herpes or syphilis, and, if so, was she treated. It is helpful to know as much as possible about the neonate’s newborn screening. The mother may not have specific knowledge of the testing; however, she should know if the infant was retested or if there had been a request for retesting, which could be an indication of an undiagnosed condition. Specific risk factors include prematurity, low birth weight, premature rupture of membranes, maternal or infant perinatal fever, and maternal infection with group B strep.

**Feeding and Growth History**

Is the infant breast-feeding or taking formula? How much and how often is the infant feeding? The average newborn will take 2-3 ounces of formula every 2-3 hours, or breast-feed 10-20 minutes per breast every 2-3 hours. The amount of feeding will increase as the infant grows, but the frequency will gradually decrease. Most infants will lose roughly 10% of their birth weight in the first week of life, but quickly regain the lost weight in the ensuing 7-10 days; thereafter most infants gain a half to a full ounce daily, until the birth weight is doubled at 56 months of age. Significant variation from the typical feeding and growth patterns may be an indication of disease or maternal neglect or abuse. Height and weight should be plotted on age-appropriate growth charts, if there is suggestion of failure to thrive or growth retardation.

If the infant is breastfeeding, specific inquiry about maternal prescription or over-the-counter medications, drug or alcohol use, and cigarette smoking is important. The temporal relationship of feeding and the onset of crying, or the occurrence of other symptoms during feeding, such as fatigue, sweating, cyanosis, or grimacing, suggest underlying organic disease.

**Stooling History**

Frequency and consistency of stools are important, particularly if the stools are large and bulky. Large, firm stools are often associated with anal fissure, painful defecation, and functional constipation. History of blood in the stool is always meaningful, whether it is caused by anal fissure or intussusception. A history of “constipation” and frequent use of laxatives, enemas, or rectal stimulation in an infant younger than 1 year may be a symptom of short-segment Hirschsprung’s disease. Mucoid, foul-smelling stools are often related to malabsorption syndromes, cystic fibrosis, or liver disease.

**Drug Exposure**

In addition to exposure to drugs via breast milk, infants are often given over-the-counter medications or herbal remedies. Parents may not volunteer this important information, and it may be obtainable only by specific questioning. Also inquire as to what medications or drugs are in the home, even if the infant is nonmobile. Toddler siblings have been known to give infants “medicine,” and drug intoxication is a common form of Munchausen Syndrome by Proxy. Older infants who are crawling or walking can ingest drugs found lying on the floor or furniture without the parent’s knowledge.

**Physical Examination**

**Vital Signs**

The physical examination begins with vital signs, unless the presentation of the patient is so emergent that life-sustaining measures take precedence. Infants with excessive crying are generally not so ill that nursing triage and measurement of vital signs cannot be accomplished. Temperatures in neonates and young infants should be taken rectally; tympanic and axillary temps are highly unreliable. Measuring accurate heart and respiratory rates in a crying infant is problematic, and repeated assessments may be necessary. Pulse oximetry should be obtained on all infants, regardless of the complaint, and as with the temperature, if abnormal, should immediately alert one to the presence of an organic process and to a certain degree suggest a particular mode of evaluation. Routine measurement of blood pressure in infants and very young children is not standard practice in many EDs, as it is a difficult and time-consuming procedure in a squirming and uncooperative patient. The accuracy is also questionable, as the result may be adversely affected by an improperly sized cuff, patient anxiety, and behavior. All infants and children who appear ill or toxic should have prompt assessment of blood pressure, with measurements repeated as appropriate throughout their evaluation and treatment. Weight should be obtained at triage and recorded in kilograms, as nearly all pediatric medications are dosed by weight in kilograms. Infants and children need to be undressed to the diaper or underwear and placed in an appropriate loose-fitting gown to allow a thorough examination. Important physical findings will be missed if the entire child is not examined; focal exams are not appropriate for infants and young children.

**General Appearance**

The general appearance of the infant can be ascertained before any hands-on examination. Does the infant or child look sick or gravely ill? Is the infant active and alert, or is it inattentive and unengaged with his surroundings? The look sick or gravely ill? Is the infant active and alert, or is it inattentive and unengaged with his surroundings? The look sick or gravely ill? Is the infant active and alert, or is it inattentive and unengaged with his surroundings? The quality of the cry is important; it is lusty and vigorous, which is usually reassuring, or is it feeble and whining, which may indicate the child is weak, debilitated, or seriously ill. A screeching, high-pitched cry may indicate central nervous system disease; a hoarse, low-pitched cry may occur with upper airway disease. The child who cries only in response to frightening or noxious stimuli, but otherwise is playful and smiling, is usually well or only moderately ill with a benign process. The child who cries
constantly with little or no consolation may be more seriously ill. The “lights are on, but no one’s home” phenomenon is characteristic of altered mental status in the infant and, in the absence of increased work of breathing (primary respiratory distress) or signs of decreased perfusion (shock), is indicative of CNS pathology. Paroxysmal irritability manifests as crying only when the child is picked up or moved about. This is often associated with CNS disease, especially meningitis, or pain in motion, such as peritonitis, a long bone fracture, or joint effusion. Pseudoparalysis, lack of spontaneous movement of an extremity, may also indicate a bone or joint abnormality. The facial expression of the infant can indicate pain, anxiety, anger, or the dull expression of mental deficiency. Hypotonicity or hypertonicity can be inferred by truncal or extremity or the facial expression of the infant can indicate pain, anxiety, anger, or the dull expression of mental deficiency. Hypotonicity may be apparent in the infant who hasn’t met developmental milestones and is unable to sit or crawl. Hypertonicity may manifest as spasticity or opisthotonus associated with cerebral palsy or other forms of brain injury. Development is also gauged by the infant’s response to his surroundings. General characteristics of the skin, such as pallor, jaundice, or mottling should be noted. Neonates and young infants may exhibit motting or acrocyanosis — bluish discoloration of the hands and feet — in cold ambient temperatures, due to thin skin and vasomotor instability. Closer inspection of the skin for rashes, lesions, cellulitis, petechiae, or ecchymoses should occur when examining specific body areas.

Head
The color, texture, and amount of hair should be noted. The hair of the newborn is totally replaced by 3 months of age. Lack of hair in infants is usually familial, but can also be due to hyperthyroidism or progeria. Brittle, coarse hair is seen in hypothyroidism and hypoparathyroidism. Asymmetry of the head is found in children with premature and irregular closure of the cranial sutures. Flattening of one part of the head occurs when an infant lies in a single position for prolonged periods of time and may be associated with parental neglect, developmental delay, or unusually soft bones, as in rickets. Infants with congenital torticollis may have flattening of one side of the head or face, due to the inability to move the head from side to side. The scalp should be examined for scaling or crusting, due to seborrheic dermatitis or eczema, both of which may be painful or pruritic. Infections of the scalp occur infrequently, but can manifest as small superficial abscesses or cellulitis. Organisms typically involved are S. aureus or group A strep; these lesions should be cultured prior to empiric treatment, due to the recent increase of skin infections from community-acquired MRSA in normal children.122-124 The scalp should be palpated for sutures, fontanels, and fractures. The posterior fontanels usually close by the end of the second month, but the anterior fontanels may be open as long 2 years. The anterior fontanel is rarely larger than 4-5 centimeters and, when larger, may be associated with increased intracranial pressure, subdural hematoma, rickets, hypothyroidism, and osteogenesis imperfecta. The fontanel is best examined in the sitting or upright position; the physiologic bulging which occurs during crying does so only in expiration, and if it persists during inspiration is pathological. A truly bulging, tense anterior fontanel is associated with increased intracranial pressure. On occasion an infant is encountered with a bulging anterior fontanel, due to extracranial hydrocephalus, a benign condition resulting from accumulation of cerebrospinal fluid between the dura and scalp. Evaluation by head CT will confirm normal brain and normal size ventricles. An abnormally sunken fontanel is found with dehydration or malnutrition. A small anterior fontanel is usually normal, but can be a sign of microcephaly. Delayed closure of the anterior fontanel is seen with hydrocephalus and rickets. Slight pulsation of the fontanel occurs in normal infants. Marked pulsations occur with increased intracranial pressure, venous sinus thrombosis, increased pulse pressure, due to an arteriovenous malformation, or patent ductus arteriosus. Until approximately 2 years of age, the head circumference is roughly the same or slightly larger than that of the chest. Marked disproportions between head and chest measurements indicate microcephaly, hydrocephaly, or increased intracranial pressure and should be confirmed on standard growth charts. Microcephaly is due to cerebral dysgenesis, premature closure of sutures (craniostenosis), or overall growth failure. Hydrocephalus, caused by chronically increased intracranial pressure, is characterized by macrocephaly, enlarged fontanels, supraorbital bulging, and open sutures. Hydrocephalus ordinarily is apparent at birth or shortly thereafter; however, it may occur as late as age 4-9 months, due to congenital syphilis. Craniotabes is the elicitation of a ping-pong ball snapping sensation when the temporal-parietal or parietal-occipital scalp is pressed, representing a softening of the outer table of the skull. It is found in premature infants, some normal infants, and in infants with rickets, congenital syphilis, and hydrocephalus. Facial asymmetry will be very apparent in the crying infant and, when the weakness involves the muscles of the forehead and eyelid, indicates a peripheral facial nerve lesion, which is most often due to trauma or otitis media in infants. Unilateral paralysis of the face excluding the muscles of the forehead indicates a central facial nerve weakness, as seen in children with brain lesions like cerebral palsy. Generalized facial edema is seen with allergic reactions and infantile nephrotic syndrome. Localized swelling may involve the upper lip or jaw as a result of dental abscess, periorbital areas in infantile nephrotic syndrome, parotid glands due to bacterial or viral infection, stones in the parotid duct, leukemia, or sarcoidosis. Submaxillary and sublingual glands are ordinarily not palpable and enlargement and tenderness usually indicates mumps, cystic fibrosis, local infection, or infection in the teeth. Chvostek’s sign, elicited by tapping the cheek just below the zygoma causing an ipsilateral facial grimace, is difficult to elicit in crying children, but when present indicates tetanus or tetany secondary to hypocalcemia.
**Eyes**

The examination of the eye is difficult even in the quiet, cooperative child and is particularly problematic in the crying infant, yet it is vital to the evaluation. Foreign bodies in the eye and corneal abrasions are well known causes of acute, excessive crying in infants. A newborn sees only light and opens his eyes infrequently during the first weeks of life. To elicit eye opening in the neonate and young infant, cup your hands under the infant’s axilla, balancing the back of the head with your fingers, and lift the infant upright while gently rocking back and forth. Most infants will open both eyes and look forward, allowing inspection of the exterior eye. By age 1 month the infant can discern objects, and by 2 months can see rough outlines and follow moving fingers. By 6 months most infants can focus for short periods of time. Sclera may be blue in very young children, due to thinness of the scleral tissues, but is also a characteristic of osteogenesis imperfecta and Ehlers-Danlos syndrome. Yellow or muddy sclera may be the first indication of clinical jaundice. Carotenemia, yellowing of the skin due to dietary pigment in yellow vegetables, is distinguished from jaundice by normal sclera. Bilateral exophthalmos (lid retraction) occurs with hyperthyroidism and, when unilateral, one should suspect congenital glaucoma. Proptosis (bulging eye) can be secondary to retroorbital or orbital tumors, neurofibromatosis, lymphangiomias, or hemangiomas. Sunken eyes are observed in children with dehydration or malnutrition; true enophthalmos (sunken or small eye) is due to cervical sympathetic nerve damage or microphthalmus. The position of the eyes at rest should be noted, and if the irises appear to be beneath the lower lid (setting-sun sign), suspect increased intracranial pressure. P toesis may be congenital or related to brain or peripheral oculomotor nerve injury sustained at birth. P toesis may also be an early sign of myasthenia gravis or amyotonia congenita and can occur in infants with encephalitis, as well. The conjunctiva should be examined for evidence of infection, hemorrhage, or foreign body. Conjunctival injection alone will occur with crying. Pingueculae are small, yellow, wedge-shaped lesions near the cornea and, when seen in infants, are almost pathognomonic of Gaucher’s disease. Styes typically occur on the lower lid, but may occur on the inside of the upper lid, as well. Opacities of the cornea are usually due to ulceration secondary to trauma or herpetic keratitis. With interstitial keratitis due to congenital syphilis, the entire cornea may have a steamy, white appearance. Glaucoma is characterized by enlargement and generalized haziness of the cornea. The eyelids should be everted and examined for foreign bodies and the corneas closely examined and stained with fluorescein for abrasion or foreign body. If the infant is crying due to a painful corneal abrasion or foreign body, he or she will often stop crying when the topical anesthetic is instilled into the affected eye. If a foreign body is visualized and cannot be easily removed, sedation may be necessary for removal and thorough examination of the eye. The pupils should be compared for size and shape. Irregularities are usually due to congenital malformations; however, the sudden appearance of an irregular pupil should alert one to the possibility of a penetrating foreign body. Examination of the optic fundus of the crying infant will yield no more than the red reflex (grey in very dark-skinned infants), if one is lucky. Absence of the light reflex or the appearance of a white opaque membrane is associated with opacities of the cornea or lens, retinal detachment, or retinoblastoma. Retinal hemorrhages appear either as red spots or red spots surrounded by white haze, but are usually not appreciated in the undilated eye.

**Ears**

One of the most common causes of crying in infants is ear infection. The examination of the ears, nose, and throat is typically deferred until the end of the physical exam, since it often elicits crying, which one tries to avoid as long as possible. The external ear should be inspected for abnormal appearance and position, both of which can be associated with congenital anomalies of other organ systems. Discharge from the external ear canal may be secondary to otitis externa, but often denotes perforation of the tympanic membrane (TM). The nature of the discharge is significant; green, foul-smelling discharge occurs with pyocyanes infections, purulent discharge is usually due to bacterial infections, and bloody discharge is due to trauma of a foreign body or basilar skull fracture. The infant should be lying flat with the hands restrained for the otoscopic exam. Mothers sometimes want to hold infants in their lap for the ear exam, but it is difficult to perform an adequate examination in this position. In infants the ear canal is directed upward, so the external ear should be pulled down to view the TM. Likewise in older children, the canal faces down and forward, so the tip of the auricle should be pulled up and back for visualization of the drum. Erythema of the TM alone is not indicative of otitis media, as redness or injection of the drum may occur with crying or manipulation. The light reflex of the normal TM is cone-shaped and sharply demarcated with the apex at the center of the drum, with the base spread over the anterior-inferior portion of the drum. In acute supplicative otitis media, the light reflex is lost or scattered diffusely over the TM, which is bulging outward and brilliantly red. The landmarks of the middle ear are lost to visualization and the TM is immobile with insufflation. Instillation of benzocaine eardrops for the treatment of pain provides nearly instant relief of earache. Infants crying due to otitis will generally stop and fall asleep within minutes of its use. Contraindication to use of topical benzocaine drops is perforation of the TM, and care should be used when using and prescribing them. If cerumen is present, one can sometimes look around the cerumen to see the drum, if the speculum is big enough or the external ear is moved around a bit. If the canal is occluded with cerumen, it can be softened with instillation of Colace® drops in the canal and gentle irrigation with warm water in about 20 minutes. Removal of cerumen with ear curettes is fraught

*Continued on page 27*
The evidence for recommendations is graded using the following scale. For complete definitions, see back page. **Class I**: Definitely recommended. Definitive, excellent evidence provides support. **Class II**: Acceptable and useful. Good evidence provides support. **Class III**: May be acceptable, possibly useful. Fair-to-good evidence provides support. **Indeterminate**: Continuing area of research.

**This clinical pathway is intended to supplement, rather than substitute for, professional judgment and may be changed depending upon a patient’s individual needs. Failure to comply with this pathway does not represent a breach of the standard of care.**

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Clinical Pathway: Life-Threatening Or Urgent Causes Of Excessive Crying In The Neonate (continued)

Sustained heart rate greater than 200–220 beats per minute?  

NO

Bilious emesis?  

YES

Paradoxical irritability, vomiting, full fontanel, with or without temperature instability?  

YES

Vesicular rash or history of maternal genital herpes?  

YES

Irritability, tremor, poor feeding, vomiting, diarrhea, tachycardia, hypertension?  

YES

Consider more benign causes of excessive crying (including corneal abrasions and hair tourniquets). If etiology remains unclear, admission or transfer to a pediatric bed for observation and further evaluation is prudent.

Suspect supraventricular tachycardia  
- Obtain 12-lead electrocardiogram  
- Administer adenosine 0.1 mg/kg IV (Class II)  
- Repeat dose 0.2 mg/kg IV if needed  
- Synchronized cardioversion 0.5 J/kg (Class II)  
- Admit or transfer to pediatric bed with pediatric cardiology consult available

Suspect malrotation with midgut volvulus  
- Prompt pediatric surgery consultation is required – arrange transfer  
- Upper GI study (if hemodynamically stable) (Class I)

Suspect intracranial infection or nonaccidental trauma  
- Perform a lumbar puncture (Class I)  
- May consider CT scan prior to LP for children with a focal neurologic examination (Indeterminate)  
- Administer empiric antibiotics (Class I)  
  - Ampicillin 100mg/kg IV  
  - Cefotaxime 50 mg/kg IV  
- Admit or transfer to a pediatric bed with social work/child protective services consult (Class II)

Suspect herpes encephalitis  
- Acyclovir 20 mg/kg IV (Class I)

Suspect neonatal withdrawal syndrome, congenital hyperthyroidism, or neonatal hypoparathyroidism  
- Obtain serum calcium, magnesium, and phosphorus levels (replace if low) (Class II)  
- Obtain thyroid studies (Class II)  
- Admit or transfer to an appropriate pediatric bed for social services consultation and/or endocrinologic workup (Class II)

The evidence for recommendations is graded using the following scale. For complete definitions, see back page. Class I: Definitely recommended. Definitive, excellent evidence provides support. Class II: Acceptable and useful. Good evidence provides support. Class III: May be acceptable, possibly useful. Fair-to-good evidence provides support. Indeterminate: Continuing area of research.

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with danger and should be attempted very carefully with a small, pliable ear curette. The infant must be adequately restrained to prevent any movement of the head during the procedure. Complications are frequent and include trauma to the canal with subsequent bleeding, perforation of the tympanic membrane, and disruption of the ossicles in the middle ear. Making the diagnosis of otitis media is not as imperative as in past years, especially in the older child. Recent AAP guidelines offer the option of careful observation and reassessment for the older infant and child with uncomplicated otitis media. The young, afebrile, well-appearing infant who does not have persistent, unconsolable crying and has an ear full of wax can go home, to follow up with the primary care physician. If Colace and irrigation fail to dislodge cerumen impactions in the infant with continued crying, further observation may be necessary with the use of other cerumenolytic drugs, as needed.

**Nose**

Inspection of the nose should rule out obstruction secondary to choanal atresia, foreign body, polyps, or mucosal edema. Infants younger than 6 months are obligate nose breathers and can develop significant upper airway obstruction secondary to upper respiratory infections. Not only is their ability to breathe affected, but also feeding is impaired, due to difficulty with suck and swallow. These infants can become very irritable and fussy, due to partial upper airway obstruction and hunger. Bulb suction alone may be inadequate to relieve the obstruction. Deep nasal suction in these infants is both therapeutic and diagnostic, as they will often stop crying and feed normally. Choanal atresia will be readily apparent, when it is impossible to pass a small catheter for deep suction.

**Oropharynx**

Inspection of the lips should be made before attempting to examine the mouth and throat. Cheilosis — chapped lips — are frequent in children. Rhagades, associated with congenital syphilis, are deep fissures or their resultant scars, extending from nose to lip or outward from the lips. Cheilitis — deep, radiating fissures extending from the ends of the lips — occur with nutritional disturbances, especially with B-vitamin deficiencies and candida infection. Examination of the mouth and throat of the uncooperative infant requires a certain amount of physical strength, fortitude, and a photographic memory. One must learn to get in and out quickly, while still recognizing and remembering what has been seen. The presence of trismus may result in a true inability to open the mouth and will be characterized by spasm of the masseter muscles. Trismus in infants is associated with tetany, infantile Gaucher’s disease, encephalitis, and brain tumors. One of the most common causes is dystonic reaction secondary to phenothiazine or “phenothiazine-like” medications. The infant must be properly restrained for the examination of the mouth and throat, which should immediately follow that of the ears. The hands need to be restrained and the head held to prevent movement. The young infant with excessive crying may require nothing more than restraint, since the crying alone opens the mouth sufficiently. The older, more obstinate infant will immediately clamp his mouth closed when approached with light and tongue blade. The tongue blade can be slipped between the lips rather easily, allowing inspection of the teeth and gums. Delayed appearance of deciduous teeth beyond the first year of life can be normal, especially in obese infants, but is also common in congenital hypothyroidism, congenital syphilis, rickets, and Down Syndrome. Poor tooth formation is also associated with congenital syphilis and rickets, as well as hypoparathyroidism and hypocalcemia. Dental caries and evidence of trauma should be noted. The gums should be inspected for signs of infection or trauma. Tearing of the frenulum of the upper lip, without associated history and signs of external trauma, is frequently due to child abuse, common mechanisms being either shoving a bottle into the mouth or clamping a hand over the mouth. The gums in herpetic gingivostomatitis are brilliantly red, swollen, and tender, associated with vesicles on the tongue, buccal mucosa, and inner lips. Dental abscesses are characterized by local areas of edema, which are erythematous and painful with palpation. Thrush is common in neonates and infants younger than 6 months and can be distinguished from undigested milk adhering to the oral mucosa by gently scraping away the milk residue. Thrush is often associated with pain on sucking and poor feeding, manifesting as irritability and crying. Infants have little salivation until about 3 months of age, and thereafter drooling is normal until 2 years of age. Excessive salivation is difficult to judge in the crying infant, but may be associated with teething, dental caries, and infections of the mouth and throat, such as herpetic stomatitis or herpangina, or infection of salivary glands. The mouth can be further opened by sliding the tongue blade along the inside cheek to the posterior aspect of the mouth, working the tongue blade gently between the back gums or teeth and sliding it into the oropharynx, causing the gag reflex. This allows a quick look at the pharynx for signs of infection, trauma, or foreign body. With practice, one can learn to prolong the gag for better visualization. A red, inflamed pharynx is characteristic of infection, most often viral in infants. The presence of small vesicles on an erythematous base is typical of herpangina, caused by coxsackie A infection. Small, maculopapular lesions of the pharynx can be seen with a variety of upper respiratory viral infections. Group A beta-hemolytic strep (GABHS) is rare before 2-3 years of age, occurring in 2-3% of 2- and 3-year-olds. Adenovirus is very common in this age group and typically manifests as exudative pharyngitis. Epstein-Barr viral (EBV) infections also cause exudative tonsillopharyngitis. Adenovirus, EBV, and GABHS cannot be distinguished clinically; any infant or young child with exudative pharyngitis should be tested for GABHS. The one clinical feature that is always present with pharyngitis, regardless of pathogenesis, is pain. Poor feeding often accompanies the pain, which
adds to the discomfort and irritability. Outpouching, or fullness of the posterior pharyngeal wall, should alert the examiner to the possibility of retropharyngeal cellulitis or abscess, especially in association with fever and poor feeding.

**Neck**

The quality of the cry (voice) is important, if abnormal. Hoarseness in the neonate may be due to hypocalcemia, congenital laryngeal or epiglottic anomalies, thyroglossal duct cyst, or laryngeal nerve injury, all of which can cause upper airway obstruction. In infancy hoarseness, or stridor, may also be associated with tracheal vascular ring, hypothyroidism, croup, retropharyngeal abscess, or foreign body. The neck should be inspected for edema, signs of trauma, masses, or adenopathy. Cystic masses in the high midline, which are freely moveable and move upward with swallowing, are thyroglossal duct cysts. Midline cystic structures that do not move freely are more likely to be dermoids. Palpable mass in the lower third of the sternoclavicular region is consistent with congenital torticollis and associated with pain and limitation of movement of the head and neck from side to side. Oval, cystic moveable masses in close proximity and anterior to the sternoclavicular muscle are branchial cleft cysts. These may become infected with subsequent cellulitis and abscess formation. One should attempt to palpate the thyroid gland, which is difficult in the small infant, though the thyroid may be visualized by laying the infant supine, placing a hand under the shoulders, and gently lifting, allowing the head to tilt back and exposing the anterior neck. One can then palpate the gland with the other hand. Thyroid enlargement is associated with hyperthyroidism, malignancy, and goiter. Neck mobility can be assessed by observation of the infant from afar. Neonates have minimal head control, but have reasonable movement in the horizontal plane, which can be tested by stroking the infant’s cheek, eliciting the rooting reflex and rotation of the head toward the stimulated side of the face. Most infants have good head control by age 3 months, with full flexion and extension. Stiff neck can result from many conditions, most commonly pharyngitis, viral illness with paracervical muscle spasm, cervical adenitis, and traumatic torticollis. More serious causes include meningitis, retropharyngeal abscess, subluxation of cervical vertebrae due to retropharyngeal or peritonsillar abscess, cerebellar herniation with increased intracranial pressure, and with generalized hypertonia secondary to degenerative CNS disease.

**Torso**

The clavicles should be examined for tenderness or deformity; fracture of the midclavicle is often associated with birth trauma and will be unnoticed initially in the newborn, becoming apparent when callus formation occurs at approximately 2 weeks postinjury. Fractures of the distal clavicles are not associated with birth trauma, often result from child abuse and should prompt evaluation for further injury. Ill-defined, soft masses above the clavicle, which change in size with crying or respiration, are cystic hygromas arising from the mediastinum. Structural abnormalities of the chest wall are often associated with specific disease processes. The rachitic rosary is swelling at the costochondral junction and may be the first indication of rickets. Harrison’s groove, a depression of the chest wall in the area of the 8th to 10th ribs, where the muscle of the diaphragm exits from the chest wall, is exaggerated in premature infants with rickets and chronic pulmonary disease. Children are abdominal breathers until age 6 or 7 years; little intercostal movement occurs in normal breathing. Intercostal muscle use occurs in infants with respiratory distress and with painful abdominal conditions, such as peritonitis. Suprasternal retractions are more often characteristic of upper airway disease, and intercostal and substernal retractions more commonly occur with lower airway obstruction; however, with severe respiratory disease, retractions may occur in all areas. Chest expansion should be observed for splinting, often signaling pain with inspiration, but decreased chest motion may be associated with pneumonia, pneumothorax, obstruction secondary to foreign body, or atelectasis. Chest asymmetry with precordial bulging may be a sign of right ventricular hypertrophy, but more often results from bony deformity of the chest wall or spine. The breast of the neonate and young infants should be closely examined for signs of infection; neonatal mastitis can manifest as pain and paradoxical irritability before onset of fever or cellulitic changes. The chest should be palpated for the presence of cardiac thrill or heave, both of which are associated with significant heart disease. The rate and character (regularity, depth) of respirations are impossible to judge in the crying infant. Distress during breathing is termed dyspnea in adults. Respiratory distress in children, characterized by tachypnea, retractions, and nasal flaring, is referred to as “work of breathing.” Increased work of breathing can be assessed even in the crying child. With severe distress and maximal work of breathing, the child will cease to cry and may only whimper in response to pain and anxiety. Cough caused by significant infection, pulmonary anomaly, bronchospasm, foreign body, or congestive heart failure will not be surprised by crying — they will continue concomitantly with the crying. Listening for lung sounds in the crying infant is somewhat challenging, but with practice, one learns to listen carefully during inspiration. Crying can actually be an advantage, because it forces the infant to take a deep breath. Often, noncrying infants take very shallow breaths, which doesn’t allow for adequate auscultation of the lower lung fields. In this instance one can “squeeze the wheeze,” which forces the child to take a deep breath. To squeeze the wheeze, the examiner places the palm of one hand flat against the chest, with the stethoscope in the other hand against the child’s back, and very gently squeezes the hands together. The child cannot resist deep breathing, allowing one to listen to the lung bases. Rhonchi, coarse bronchial sounds, are referred from the upper airway. One can discern the upper airway origin by listening to the
excitement. Innocent murmurs are typically soft, grades I or II, nonradiating, and they change character with variations in position or phase of respiration. Congestive heart failure in infants and children begins with tachypnea and mild increase in work of breathing. With progression, the liver enlarges (the liver edge may be palpable in normal children), and work of breathing increases, which often interferes with feeding. The presence of a gallop rhythm is pathognomic of heart failure. Infants rarely develop cervical venous distention or peripheral edema, unless the heart failure is chronic. Pulmonary edema is a late finding and often presents with respiratory failure in infants.

Infants who have acute intraabdominal catastrophes may present with obvious peritonitis and hemodynamic instability secondary to bowel necrosis and/or perforation. Abdominal emergencies can present early, with nonspecific signs and symptoms in infants who are robust and vigorous. It is impossible to do a thorough examination of the abdomen of a crying child, but with patience and reexams, it is possible to obtain useful information. First, observe for distention, which is usually caused by air or fluid in the bowel or peritoneal cavity. All infants have “Buddha bellies,” due to thin abdominal musculature and exaggerated lordosis, except those who are severely dehydrated or malnourished. Umbilical hernias are common in infants up to 2 years of age and, in African American infants, may persist until age 4-5 years. Infection of the umbilical stump with cellulitic extension onto the abdominal wall, or omphalitis, is a medical emergency, and like mastitis, it is a painful condition that may begin with irritability and abnormal crying. The abdomen should be closely inspected for signs of trauma; bruising caused by nonaccidental injury can be very subtle and is often missed. Life-threatening intraabdominal injuries can occur with little external evidence of trauma. Auscultation for bowel sounds should be attempted and may be heard, if one listens carefully during inspiration. Bowel sounds are frequent and high-pitched in gastroenteritis, obstruction, and early peritonitis. Absence of bowel sounds in the crying infant has no significance. Palpation should also be attempted during the inspiratory phase of crying, when the abdominal wall relaxes. If the abdominal wall remains tense during repeated palpation while the infant is inspiring, abdominal pathology may exist. Localization of tenderness is very difficult and has little correlation with underlying pathology. The spleen is palpable 1-2 cm below the left costal margin during the first few weeks of life, and the spleen tip may be palpable in thinner children beyond infancy. The liver edge is palpable 1-2 cm below the right costal margin during the first year of life and can remain palpable throughout childhood without pathological significance. Palpation of the liver more than 2 cm below the costal margin is associated with a variety of abnormalities. Stool may be palpable in the left lower quadrant as multiple small, firm masses in children with constipation. Infants with pyloric stenosis may have a palpable small mass in the RUQ, best appreciated just after an episode of vomiting. The mass associated with intussusception is more likely to be palpated immediately after an episode of pain and is most often in the RUQ, but may be in the RLQ or LUQ. The femoral areas should be examined for hernias and abnormal lymph nodes, and the femoral pulses checked for intensity and equality. The diaper and perianal areas should be inspected for rash, as diaper dermatitis is a common cause of irritability and discomfort in infants. The genitalia should be inspected for ambiguity, which may be associated with other genitourinary abnormalities or congenital adrenal hyperplasia. Scrotal swelling may result from hernia, hydrocele, epididymitis, and testicular torsion; differentiation may be difficult clinically, requiring ultrasound evaluation for definitive diagnosis. Incarcerated inguinal hernia is the most common cause of intestinal obstruction in infants younger than 1 year (intussusception is the most common intraabdominal cause). Adhesions of the labia minora are common in female infants and are of little clinical consequence, unless they are so severe as to cause urinary obstruction. The buttocks should be examined for coccygeal masses, tufts of hair, or pilonidal dimples, which may be associated with tumors or occult spinal abnormalities. The buttocks are common areas of nonaccidental injury and should be carefully examined for subtle contusions and abrasions. Anal fissure, a cut or tear in the mucosa, is a cause of constipation and rectal bleeding in infants under 2 years of age and is frequently associated with infant irritability. (See Figure 6 on next page.) The buttocks should be gently spread to expose the perianal area to examine for anal fissure. Rectal exams in infants are indicated to check for the presence of stool, fecal impaction, and blood. Infants with chronic constipation will have a rectum distended with stool, whereas
infants younger than 1 year with a history of “constipation” and an empty rectum are suspect for Hirschsprung’s disease.

Extremities
Pain and tenderness in the extremities of children are usually due to trauma or infection. Examination of infant extremities begins with the observation of general appearance. Infants exhibit pseudoparalysis — voluntary lack of motion — when movement results in pain. Crying infants typically flail their arms and legs, and voluntary guarding of an extremity limits pain due to movement. Localized swelling may be due to periosteal hemorrhage secondary to acute fracture, cortical thickening of congenital syphilis or infantile cortical hyperostosis, increased calcification of callus formation following fracture or in rickets, or to bone cysts or tumors. Bony, painful swelling of the epiphysis adjacent to the knee or wrist is almost always due to rickets. Symmetrical, painful swelling of the fingers or toes (dactylitis) in African American infants occurs with the hand-foot syndrome of sickle cell anemia. Parents and caregivers may be unaware of the syndrome and not recognize it as a cause of pain in the infant with SCD. Swelling with point tenderness, increased warmth, and erythema near, but not involving, a joint is characteristic of osteomyelitis. Acute arthritis in infants and children is caused by rheumatoid arthritis, acute rheumatic fever, allergic, toxic, and infectious arthritis, serum sickness, hemarthrosis, or osteochondritis. Neonates and young infants should be assessed for congenital hip dysplasia with the Ortolani and Barlow maneuvers, the provocative dislocation and relocation of a dislocated hip. With the infant lying supine, the flexed knees are grasped between thumbs and forefingers, and the tips of the middle fingers are placed over the lateral aspects of the flexed hips. When the hips are abducted and externally rotated, the femoral head can be felt sliding out and back into the acetabulum, which sometimes can be heard as a “click.” Congenital hip dysplasia may also cause shortening and external rotation of the affected extremity, much like that of hip fracture in the adult. The spine should be examined for masses, abnormal curvature, abnormal growths of hair, and dimples. Vertebral osteomyelitis or discitis in infants is characterized by truncal immobility, paradoxical irritability, and point tenderness on careful palpation of the spine. Muscle mass and tone should be assessed. Neonates and young infants are normally more “hypertonic” than older infants, exhibiting moderate flexion of major joints when at rest. Full extension of extremities in these infants represents hypotonia, which is seen in malnutrition, the muscular dystrophies, cerebral palsy, lower motor neuron disorders, hypothyroidism, Down Syndrome, hypokalemia, and selected congenital metabolic disorders. Increased muscle tone occurs with any condition causing muscle spasm, most commonly injury or infection of the muscle, bone, or joint. Generalized hypertonicity occurs in metabolic disorders and upper motor neuron lesions. Spasticity, the prolonged and steady contracture of muscle, is a characteristic of upper motor neuron disease and degenerative brain diseases. Both muscle spasm and spasticity is very painful and is often accompanied by crying in infants and young children.

Each finger and toe should be individually inspected for evidence of constricting bands, small foreign bodies, or signs of trauma.

Neurologic Exam
Most of the neurologic exam is actually performed via the examination of each body part or system; however, it may be repeated, in part or as a whole, if abnormalities are suggested on the initial exam, or findings are inconsistent. Of greatest importance is the infant’s mental status and developmental ability. The examiner gets a general impression of the state of consciousness and developmental age during the initial observation of the infant’s interaction with the caregiver and reaction to environmental stimuli. Generalized irritability can be a prominent symptom of any painful or uncomfortable condition, or may indicate a primary CNS disorder. Ordinarily infants are more irritable when lying on the examining table than when being held by the parent, except when movement elicits pain (paradoxical irritability). It is somewhat reassuring if the crying infant is consolable or distractible, but this should not mislead the examiner into a premature conclusion that the infant does not have a serious illness. Developmental milestones should be addressed in the history and verified during the general exam. Incoordination, tremors, or abnormal movements will be apparent during the course of the exam; testing of cranial nerves and primitive reflexes.
can also be done as part of the routine general exam. Total absence of rooting, sucking, and grasping in young infants suggests significant illness, as these reflexes are instinctive. Absence of Moro reflex in a neonate, or its persistence beyond 5 months of age, indicates severe CNS injury or disease. Absence of Moro reflex in an arm suggests brachial nerve palsy or fracture of the humerus or clavicle. Absence or abnormality of Moro reflex in one leg is associated with lower spinal injury/disease or dislocated hip. Deep tendon reflexes are obtained by tapping the biceps, triceps, patellar, and Achilles tendons with the finger. Patellar reflex is usually present at birth, the Achilles and brachial reflexes by 1 month, and the triceps reflex should be present by age 6 months. It may be difficult to interpret the results of deep tendon reflex testing, due to the imprecise and inconsistent nature of response in the uncooperative young infant, and abnormal reflexes should be retested for confirmation. Testing of Babinski reflexes should be avoided in infants, as they are abnormal until about 18 months of age. The Oppenheim maneuver — running the thumb down the medial aspect of the tibia — produces a more interpretable response than stimulation of the sole of the foot. Kernig’s and Brudzinski’s signs are also difficult to interpret in infants less than 6 months old, and testing will only lead to confusion.

Skin

The examination of the skin, like the neurologic exam, is primarily done with the specific body parts from head to toe. Any lesion or rash that causes pain, discomfort, or pruritus may be the cause of crying and irritability. Neonates are prone to skin infections, and careful attention should be given to inspection of the scalp, face, breasts, umbilical stump, and surrounding abdominal wall for signs of cellulitis or abscess. Erythema and induration may be initially subtle, especially in dark-skinned babies. Infants with mastitis or omphalitis may exhibit paradoxical irritability, due to pain with movement. Cutaneous signs of nonaccidental trauma include bruises, burns, punctures, lacerations, and abrasions. Nonmobile infants should not exhibit any of these findings and, if they are present, the nature of the injury should be plausible with respect to mechanism of injury, as well as the developmental age of the infant. Mobile toddlers often have bruises involving the extensor surfaces of the lower extremities and the forehead, due to frequent minor falls; bruises on flexor surfaces, the trunk, back, perineum, or buttocks do not occur as a result of normal activity. Also, multiple abrasions or scars of old wounds are highly suspect. Burns, even those of a minor nature, should prompt a thorough examination of the child for other signs of old or new injury.

Diagnostic Studies

Historical and physical findings should be used to determine appropriate diagnostic studies in the evaluation of the crying, irritable infant. A “window-shopping” approach is expensive, often invasive, and may not result in a diagnosis. The age of the infant or child, coupled with pertinent history and specific physical findings, usually will lead to the correct diagnosis — if not a definitive diagnosis, then at least reasonable knowledge of the patient’s state of health. Often it is not necessary to know what is wrong, but only that something is wrong, and the patient can’t be discharged from the ED. The one exception to the “window-shopping” approach is the neonate who is fussy, irritable, has poor feeding, or decreased activity and increased somnolence. This infant is ill regardless of vital signs or risk factors. The differential diagnosis is very broad, with the most common cause being infection. The incidence of serious bacterial infection in infants 0-1 month of age is between 8.8-13.3%.210,240,241 Most neonates have viral infections, which often are not benign in the very young — they are associated with significant mortality and morbidity and are clinically difficult to distinguish from serious bacterial infections.242,243 All of these infants should have a septic workup, receive IV antibiotics, and be admitted, pending culture results and further evaluation. The nonspecific symptoms of crying, irritability, poor feeding, and increased somnolence are also symptoms of congenital heart disease, inborn errors of metabolism, renal failure, congenital adrenal hyperplasia (CAH), shaken baby syndrome, congenital syphilis, and neonatal leukemia. If vomiting and/or abdominal distention or bloody stools are present, in addition to one or more of the above symptoms, the differential diagnosis expands to include bowel obstruction, Hirschsprung’s disease, malrotation, congenital nephrotic syndrome with secondary peritonitis, and necrotizing enterocolitis. The neonate with symptoms suggestive of congenital heart disease should have a chest x-ray to assess the heart size and pulmonary vasculature and an EKG; if either the chest x-ray or EKG is abnormal, or if the infant has a heart murmur with or without other cardiovascular findings on physical exam, an echocardiogram is indicated. Routine screening with complete blood count (CBC), platelet count, electrolytes including CO2, calcium, magnesium, phosphorus, and BUN, creatinine, glucose, and serum ammonia will either eliminate or suggest inborn errors of metabolism, renal failure, CAH, and neonatal leukemia. Serologic studies of blood and spinal fluid will identify the neonate with congenital syphilis.244-248 Neonates with neurologic signs or symptoms should have a noncontrasted head CT to evaluate for congenital anomalies and intracranial injury. Child abuse, particularly shaken baby syndrome, should always be considered in this age group, and additional studies — including skeletal survey, bone scan, or MRI — may be necessary to define subtle injuries.71,75,91,92,107 Neonates with bilious emesis have malrotation until disproved, regardless of other symptoms; the study of choice is an upper GI and small bowel follow-through in infants who are hemodynamically stable. Those who are not stable require aggressive resuscitation and emergent surgical intervention. Very young neonates (less than 1 week of age) who present with irritability, abdominal distention, and infrequent stools should also have emergent surgical consultation and evaluation for Hirschsprung’s disease.
Diagnostic studies in older infants can be tailored more by history and physical examination. The one laboratory study that all young infants should undergo is catheterized uranalysis with urine culture, as crying and irritability without fever, can be the presenting complaint for urinary tract infection. Specific studies can be grouped into those appropriate for certain physical findings or suspected disorders, ie, chest x-ray, EKG, and echocardiogram for cardiac disease, Doppler ultrasound for testicular torsion, or cranial computed tomography (CT) for head injury.

**Presumptive Neurologic Etiology**

ED diagnostic evaluation of the infant with neurologic disease consists primarily of neuroimaging and analysis of the cerebrospinal fluid. Noncontrast cranial CT is the most rapid imaging tool for the evaluation of head injury, congenital structural abnormality, and nontraumatic intracranial hemorrhage. Magnetic resonance imaging (MRI) is useful in the evaluation of diffuse axonal injury and detection of small intraparenchymal lesions, ischemic injuries, and vascular abnormalities; however, it is rarely useful during the ED evaluation, due to lack of emergent availability, prolonged procedure times, and the frequent need for sedation. Children at risk for intracranial injury after accidental head trauma who should undergo emergent CT scanning are those with altered mental status, focal neurological findings, signs suggestive of basilar skull fracture, loss of consciousness greater than 5 minutes, skull fracture, protracted vomiting, severe headache, and infants younger than 2 months. In addition to these children, Greenes et al found that infants and young children less than 2 years old who were asymptomatic after accidental head injury were at risk if they had scalp hematomas involving the temporal and parietal scalp. Children with unexplained neurologic deficits or acute severe headache should have emergent head scans, and often MRI is necessary for the diagnosis of ischemic strokes, vascular abnormalities, or small tumors. Lumbar puncture and cerebrospinal fluid (CSF) analysis is mandatory for infants suspected of having meningitis or encephalitis. A CSF white blood count greater than 5-7 WBC/mm is usually considered abnormal, except during the first week of life, when there may be as many as 32 WBC/mm. Typically, the number of CSF white blood cells is several hundred to more than 1000, with a predominance of neutrophils in cases of bacterial meningitis; however, the cell count can be less than 100 with bacterial infection, and often a neutrophilic predominance occurs with viral meningitis, especially enterovirus. The CSF cell count and differential should not be relied upon to differentiate between bacterial and viral meningitis. There should be no RBCs in cerebrospinal fluid in atraumatic taps; however, RBCs are diagnostic criteria for herpes encephalitis and subarachnoid hemorrhage. Normal CSF glucose is usually about two thirds that of the serum glucose, and normal CSF protein is typically less than 40 mg/dL, again with the exception of the neonate, for whom both values may be normally higher. The CSF gram stain is positive in 60-80% of cases of bacterial meningitis, with an alarming number of cases that are gram-stain-negative. Several other CSF assays are available to aid in distinguishing bacterial from viral meningitis, such as polymerase chain reaction (PCR) for viral and bacterial detection and rapid antigen detection of selected pathogens. Recent improvement in PCR methodology has increased the sensitivity and specificity to 87% and 100%, respectively; unfortunately, PCR is not readily available in many institutions. Low to moderate sensitivity of rapid antigen detection has resulted in limited utility since the decline of Haemophilus influenzae type b meningitis; however, the recent improvement of sensitivity has been shown using ultrasonic enhancement of the CSF specimen. CRP has been investigated as a marker for bacterial infection in gram-negative meningitis. Sormunen et al found significant differences in CRP values between patients with bacterial and viral meningitis using a threshold value of 20 mg/L (2 mg/dL). Most children will require sedation for lumbar puncture and reliable measurement of opening pressures. Data on normal values for opening pressures in children are limited, but most authorities consider 7.5 cm to be the upper limit of normal in infants younger than 2 years, 13.5 cm between age 2 and 5 years, and less than 20 cm after the age of 5 years. CT scanning is also mandatory prior to the LP, since these children present with headache and often have papilledema, both of which are common symptoms of increased intracranial pressure associated with mass lesions and hydrocephalus. There is limited utility for CT in the evaluation of meningitis, unless the diagnosis is uncertain or the patient exhibits clinical signs of increased intracranial pressure (ICP) or localization, suggesting the presence of cerebral edema or a mass lesion. There is no indication for the use of CT to screen for increased ICP in the neurologically intact patient, and significant clinical symptoms of increased ICP have been shown to be present with normal CT findings.
heart failure includes a chest x-ray and EKG, followed by an echocardiogram, which delineates structural abnormalities, pericardial effusion, and left ventricular function. The diagnostic use of cardiac enzymes in pediatric cardiac disease is somewhat unclear, partly due to the differences in assay methods and changing reference points for infants and children. However, elevations of troponin and creatine kinase (CK-MB) are highly specific for myocardial injury and infarction associated with congenital heart disease, myocarditis, and Kawasaki disease. Studies evaluating troponins in children with congestive heart failure, myocarditis, and Kawasaki disease without EKG or echocardiographic evidence of myocardial injury have yielded conflicting results. CK-MB fractions are rarely abnormal in myocarditis or Kawasaki disease, whereas elevation of troponin occurs in 34-100% of patients with myocarditis and in approximately 40% of children with Kawasaki disease. However, normal values do not exclude other diagnosis.

Presumptive Gastrointestinal Etiology
The evaluation of abdominal pain in the infant is largely dependent upon age, acuity of illness, and associated sign and symptoms. If the infant has signs of an acute surgical emergency, ie, peritonitis or obstruction, the infant’s age may narrow the differential diagnosis. During the first week of life common causes of peritonitis are Hirschsprung’s enterocolitis and necrotizing enterocolitis (NEC), both of which are characterized by abdominal distention, bloody stool, and rapid decompensation. Abdominal films typically reveal massive distention of the sigmoid or descending colon with Hirschsprung’s enterocolitis. The classic findings on plain films with NEC are intraluminal air (pneumatosis intestinalis) and intrahepatic portal vein air. Pneumoperitoneum indicates spontaneous perforation, which is a complication of both conditions. Hirschsprung’s enterocolitis can occur beyond the neonatal period into infancy and childhood. Barium enema is the study of choice to assess for intraabdominal abscess. Definitive diagnosis of primary peritonitis is made by paracentesis, with laboratory analysis and culture of the peritoneal fluid. Procedure in some institutions, especially if the diagnosis is uncertain. Plain film findings of the crescent, target, and absent liver edge signs are highly suggestive of intussusception, but are usually very subtle and may not be appreciated. Obstruction due to internal abdominal hernias is rare and difficult to diagnose and, as a consequence, has high rates of morbidity and mortality. Plain films may reveal dilated loops of bowel or air-fluid levels, but are more likely to show nonspecific findings. Acute obstruction can be confirmed with abdominal ultrasound or CT; however the hernia itself may not be visualized, if very small. Internal hernias also cause chronic, recurrent abdominal pain with episodes of vomiting, in which case upper GI and small bowel barium contrast studies may show prestenotic dilatation, delayed gastric emptying, or retrograde peristalsis. In the absence of definitive radiographic results, the diagnosis is often made intraoperatively during exploratory laparotomy.

Appendicitis in the young infant is very rare and the presentation is often nonspecific, with minimal abdominal findings, until the occurrence of peritonitis secondary to perforation. Neither WBC nor plain abdominal radiographs are sensitive or specific for appendicitis. Ultrasound for the evaluation of appendicitis is highly operator-dependent, and abdominal CT has become the imaging modality of choice in many institutions. Abdominal CT has a high degree of accuracy, especially with IV and rectal contrast. The use of ultrasound, followed by abdominal CT with rectal contrast, when the ultrasound is nondiagnostic, has been shown to have an accuracy of 94% in the diagnosis of appendicitis in children. Primary peritonitis in infants and young children secondary to nephrotic syndrome, viral hepatitis, or malignancy may present with hemodynamic instability with sepsis and shock, or subcutely with abdominal pain, vomiting, and diarrhea, which may initially suggest the diagnosis of gastroenteritis. Abdominal distention and rebound tenderness are frequently present, but may be subtle and difficult to appreciate in the irritable, crying infant. The presence of jaundice, hepatosplenomegaly, or an abdominal mass should suggest the diagnosis of hepatic disease or malignancy. Most infants with nephrotic syndrome have some degree of peripheral edema, especially involving the periorbital areas, but again this may not be obvious in the chubby faced, crying infant. The laboratory evaluation includes CBC, blood cultures, U/A, electrolytes, and renal and liver function studies. The radiologic evaluation of the infant with abdominal pain, tenderness, and distention includes plain films to evaluate for signs of bowel obstruction or perforation. Ultrasound is an excellent modality for the initial visualization of the gallbladder and hepatobiliary tree and may, in addition, also identify the presence of ascites and signs of pancreatitis (see below). Abdominal CT also evaluates the liver and pancreas and is the study of choice to assess for intraabdominal abscess. Definitive diagnosis of primary peritonitis is made by paracentesis, with laboratory analysis and culture of the peritoneal fluid.
atritis in infants is also often nonspecific, with abdominal pain preceding vomiting and fever. The diagnosis is rarely suspected early in the course of the presentation and typically only becomes apparent when laboratory or radiologic abnormalities suggest the diagnosis. The sensitivity (75-95%) and specificity (20-60%) of serum amylase are considerably lower than the sensitivity (86-100%) and specificity (50-99%) of serum lipase; however, sensitivity and specificity of both tests approach 100% when the upper limits of normal are increased 3-4 times. As such, both assays are highly diagnostic of pancreatitis. Abdominal x-ray findings are usually nonspecific, but the diagnosis is suggested by the presence of a sentinel loop of small bowel, a radiolucent “halo” around the left kidney, or loss of the psoas margins; however, these findings are subtle and may not be appreciated. Abdominal ultrasound is a quick, noninvasive method for initial evaluation of the hemodynamically stable infant without history of trauma who has abdominal pain and tenderness. Positive ultrasound results for pancreatitis include an enlarged, edematous pancreas, decreased echogenicity, and peripancreatic fluid. In addition, ultrasound may also identify the presence of ascites or peripancreatic pseudocyst. Children with history of blunt abdominal trauma or those who have signs of child abuse typically have injury not only to the pancreas, but also to the liver, bowel, and kidneys, and they should undergo emergent abdominal CT concomitant with surgical consultation.

The diagnosis of constipation can usually be made clinically with an appropriate history, palpable stool on abdominal exam, and/or large stool quantity on rectal exam. Plain film radiography may be helpful in obese children or those who have good history for constipation, but have scant stool in the rectal vault. Short-segment Hirschsprung’s disease should be considered in infants younger than 1 year of age, unless resulting from obvious trauma, should be suspect for nonaccidental injury. These infants should be referred to pediatric gastroenterology for further evaluation.

Gastroesophageal reflux is diagnosed with esophageal manometry and pH monitoring esophagitis with endoscopy with biopsy. Upper gastrointestinal contrast studies are not indicated in the evaluation of GERD. The diagnosis of cow’s milk protein allergy is largely clinical; however, elevated levels of serum IgE and peripheral eosinophilia are associated with allergic eosinophilic gastritis and enterocolitis. With dietary protein enterocolitis, serum levels of IgE are normal, but anemia is common and stools are positive for blood and leukocytes. Anemia is also common in dietary protein enteropathy and, when malabsorption is severe, hypoproteinemia is an associated finding. The diagnosis of cow’s milk protein allergy in the irritable infant with frankly bloody stool is not often straightforward, and the final diagnosis of milk allergy is made only after the exclusion of more serious conditions. The ED evaluation of these infants typically includes a CBC, electrolytes, coagulation studies, liver function studies with total protein and albumin, and stool studies for blood, leukocytes, and cultures. If the infants are very young or are ill-appearing, blood culture, catheterized urinalysis and culture, and lumbar puncture is indicated. Occasionally an infant will have colicky abdominal pain suggestive of intussusception, in which case abdominal ultrasound or contrast enema may be necessary as part of the evaluation.

Workup of a Groin Mass
Ultrasound is a valuable tool for the evaluation of groin mass in the neonate and infant when the clinical distinction between lymphadenopathy, femoral hernia, or groin hernia is unclear. Also, the differentiation between scrotal hernia and hydrocele may be problematic in the irritable, crying infant — ultrasound will quickly identify each condition. Clinical assessment of testicular torsion, incarcerated scrotal hernia, and epididymitis can be very difficult in the young infant and often requires an imaging study. Ultrasonography readily identifies scrotal hernias and hydroceles, and Doppler sonography has high specificity for inflammatory processes. Doppler sonography and radionucleotide imaging are equally specific for testicular torsion, though both modalities do have a small incidence of false negatives and false positives. However, demonstrating flow in the small testes of the neonate is sometimes technically difficult with ultrasound, and the adequacy of the exam is dependent on the comparison of flow of the affected testis with that of the normal testis. The choice of imaging study for testicular torsion is typically related to institutional preference and availability. Urology should be consulted emergently for testicular torsion, before any the imaging study.

Presumptive Musculoskeletal Etiology
The evaluations of fractures and dislocations, congenital abnormalities, bony manifestations of metabolic disease, and screening for infectious and oncologic disease begin with plain film radiography. Ultrasound is helpful for the detection of joint effusion and in the evaluation of the infant suspected of having developmental dysplasia of the hip. Bone scan will detect subtle fractures not appreciated on plain films and is useful in the evaluation of suspected osteomyelitis when the site is poorly localized; however, MRI is a better imaging modality when the site of infection is more clearly defined. Screening laboratory tests for renal disease and disorders of calcium that have bony manifestations include BUN, creatinine, calcium, magnesium, and phosphorus. Erythrocyte sedimentation rate and C-reactive protein are usually elevated with septic arthritis and osteomyelitis, while white blood count has low sensitivity and is therefore less useful. Fractures in infants less than 1 year of age, unless resulting from obvious trauma, should be suspect for nonaccidental injury. These infants should
be scrutinized for other signs of injury with a skeletal survey, hemoglobin and hematocrit, liver and pancreatic enzymes, and urinalysis. If these studies are negative, but the mechanism of injury is inconsistent with the fracture or the fracture is pathognomonic of child abuse, further testing, including bone scan and non-contrast-d head CT, is warranted. Any unusual fracture or suspect circumstances involving trauma in young infants should be reported to child protective services for investigation.

**The Jittery Infant**

Investigation of the jittery, irritable infant should begin with a bedside glucose, to evaluate for the presence of hypoglycemia, and also include screening for hematologic, metabolic, endocrine, and toxic conditions. Pertinent laboratory tests include hemoglobin, hematocrit, electrolytes (including calcium, magnesium, and phosphorus), BUN, creatinine, thyroid studies, and urine drug screen. In addition to routine laboratory testing, the infant with failure to thrive should have liver function studies with measurement of total protein and albumin, stool studies for fat, and urine screening for reducing substances. Serum ammonia and blood pH are helpful for the initial identification of inborn errors of metabolism.257

**Treatment**

**Neurologic Conditions Requiring Urgent Treatment**

Children suspected of having meningitis should have lumbar puncture (LP) and analysis of the CSF as quickly as possible after obtaining the history and performing a careful physical examination with particular attention to the neurologic exam. If the infant or child is neurologically intact and hemodynamically stable, administration of antibiotics need not occur prior to the LP and CSF analysis, given the LP is performed in a timely manner.61,272 The vast majority of meningitis in children is aseptic or viral, and administration of antibiotics prior to obtaining CSF for culture can confuse the diagnosis and subject the child to unnecessary prolongation of hospitalization and antibiotic therapy. Inability to capture an organism and perform antibiotic sensitivity could also contribute to an adverse outcome, if the organism is resistant to usual empiric antibiotics.272 Kanegaye et al reported CSF complete sterilization of meningococcus within 2 hours and the beginning of sterilization of pneumococcus within 4 hours of initiating antibiotic therapy.273 If the child is hemodynamically unstable or exhibiting signs of increased intracranial pressure, thereby precluding performance of the lumbar puncture, or if significant delay is anticipated, empiric antibiotics should then be administered. The choice of antibiotics is related to patient age. The neonate should be treated with antibiotics to cover for group B streptococci, *E. coli*, and other gram-negative organisms; *Listeria* is treated with ampicillin and gentamicin or cefotaxime. Neonates at risk for herpes encephalitis should also receive acyclovir empirically. Older infants and children are adequately covered with either ceftriaxone or cefotaxime, and the addition of vancomycin, pending culture and sensitivity, to cover possible penicillin-resistant pneumococcus.272 Use of corticosteroids in the treatment of bacterial meningitis has been debated for many years, but recent evidence suggests better outcomes in patients given dexamethasone before or concomitant with the first antibiotic dose.274,275 In the past, IV fluids have been restricted to 2/3 maintenance in children with bacterial meningitis, for fear of increasing the likelihood of the syndrome of inappropriate antidiuretic hormone (SIADH) and worsening of cerebral edema. However, many children with meningitis are hypovolemic, and recent studies have demonstrated no adverse effects with liberal fluid administration when compared to the increased mortality and morbidity associated with fluid restriction.61,252 Cerebral edema and increased intracranial pressure is a life-threatening complication of bacterial meningitis and is a clinical diagnosis, not a radiologic one, as brain CT can be normal despite obvious clinical signs of increased ICP.254 Clinical manifestations of increased ICP include altered mental status, bradycardia, hypertension, and an altered respiratory pattern. Papilledema is a late sign of increased ICP, and a normal fundoscopic exam does not exclude increased ICP; hypotension is a preterminal sign of increased ICP. Infants and children with clinical signs suggestive of increased ICP should undergo neuroprotective rapid sequence intubation for ventilation and airway protection. Hyperventilation should be avoided, with maintenance of PaCO₂ in the 30-35 mmHg range. The child should be sedated and paralyzed to facilitate ventilation and prevent valseva maneuvers that raise ICP. Maintaining optimum oxygenation and mean arterial pressure are necessary for adequate cerebral perfusion pressure and preventing secondary brain injury. Children who do not adequately respond to these measures may require administration of osmotic agents and/or pressors, which should be given with consultation and input from the pediatric intensivist.

**Cardiac Conditions Requiring Urgent Treatment**

Termination of supraventricular tachycardia (SVT) can occasionally be achieved in infants with application of ice to the face and with valseva maneuvers in older children. Hemodynamically unstable infants and children should have emergent synchronized cardioversion. The primary pharmacologic agent for the treatment of SVT in hemodynamically stable children is adenosine at an initial dose of 0.1 mg/kg rapid IV push; the dose may be doubled to a maximum dose of 12 milligrams. Children who do not convert with appropriate doses of adenosine require admission to the pediatric intensive care unit for administration of second-line drugs. Digoxin, propranolol, or procainamide are standard second-line drugs in the stable patient with adenosine refractory SVT. In addition, recent reports have shown amiodarone and the combination of flecainide and sotalol to be efficacious and safe for treatment of refractory SVT in infants and children; these agents should be given in consultation with pediatric cardiology or a pediatric intensivist.144,145 Children with myocarditis present with varying
degrees of myocardial dysfunction, and the ED treatment is related to specific symptoms. Myocarditis can present as congestive heart failure, atrial or ventricular arrhythmias, heart block, myocardial ischemia and infarct, or cardiogenic shock. Children with myocarditis may initially appear to have a more common pediatric illness, such as gastroenteritis, bronchiolitis, or sepsis, with the correct diagnosis becoming apparent only after failure to respond to therapy, or when cardiomegaly is recognized on the chest x-ray. Significant hypoxia and respiratory distress may necessitate intubation and mechanical ventilation. Treatment of heart failure should include La6 for fluid overload, dopamine or dobutamine for inotropic support, and nitroprusside or milrinone for afterload reduction, if the patient is not hypotensive.141 Digoxin should be avoided or given judiciously, because of the lowered threshold for toxicity in patients with myocarditis.141,148 The pediatric intensivist or cardiologist should be consulted early, with admission to the pediatric intensive care unit as soon as feasible.

Infants with coronary artery ischemia secondary to congenital anomalies can present with heart failure and/or symptoms of ischemia or myocardial infarction. As in myocarditis, the ED therapy should be tailored to the individual presenting symptoms. Heart failure should be treated with diuretics, inotropic agents, or afterload reducers, as needed. In addition, these patients often have significant coronary ischemia and will require nitroglycerin, as well as heparinization and tissue plasminogen activator (tPA) for emergent treatment of acute myocardial infarction.140 Definitive treatment is surgical correction. Therapy for coronary ischemia or myocardial infarction associated with Kawasaki disease is largely based on data from adult studies and includes heparinization, tPA, and platelet glycoprotein IIb/IIIa inhibitors (abciximab). There has been limited use of emergent coronary angioplasty and stents, both of which require a high level of expertise available in only a few academic institutions. Surgical treatment includes coronary artery bypass and heart transplantation. Infants and children with coronary artery ischemia, either from congenital anomalies or as a result of Kawasaki disease, should be transferred quickly to facilities with pediatric cardiothoracic surgical capability.

**Treatment of Urgent Abdominal, Genitourinary, and Musculoskeletal Conditions**

ED treatment of infants and children with abdominal obstruction, peritonitis, acute scrotum, and traumatic, inflammatory, or metabolic musculoskeletal conditions is

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**Eight Pitfalls To Avoid**

1. **“He didn’t have a fever; I didn’t realize he had a serious infection.”**  
   Neonates can have SBI without fever, and urinary tract infection can be present in older infants without fever. Irritability and excessive crying can be the only symptom of serious illness in neonates and young infants.

2. **“The parents were intelligent and affluent and would never harm their child.”**  
   Child abuse occurs in all socioeconomic and ethnic groups.

3. **“He only vomited 2-3 times, and the abdominal exam was normal. How could he have malrotation?”**  
   Young infants, especially neonates, can present early with malrotation and not have bilious emesis initially. The abdominal exam is also often benign early in the course, and the bowel can twist and untwist, as well. Physicians should have a high index of suspicion for malrotation in neonates with vomiting.

4. **“She only cried when I picked her up, I didn’t think about a fracture.”**  
   Paradoxical irritability (crying with movement) is indicative of pain, common with increased ICP and musculoskeletal and soft tissue trauma or inflammatory conditions.

5. **“Of course his heart rate was high; he was crying.”**  
   Vital signs should be reassessed frequently in crying infants, in order to identify persistent abnormalities or changes. Tachycardia out of proportion to external stimuli or persistent tachycardia should prompt evaluation for underlying cardiac disease, shock, or dehydration.

6. **“She only had subjective fever.”**  
   Parents correctly identify the presence, but not the degree, of fever approximately 50% of the time. This is extremely important for infants younger than 60 days, who can appear relatively well even with serious disease. Parents should be given the benefit of the doubt, and neonates and young infants should be observed without antipyretics and evaluated appropriately.

7. **“His white count was normal, he was hungry, and had only mild generalized abdominal tenderness. I didn’t think about appendicitis.”**  
   Infants and young children often have nonspecific presentations with appendicitis, unless they have peritoneal signs. It is also not uncommon for them to be hungry early in the course of the disease. Only 50% of young children will have localized tenderness in the right lower quadrant.

8. **“She was just a small baby; she didn’t look malnourished.”**  
   The clinical appearance may be deceiving with failure to thrive. Weight and height should be plotted on appropriate growth charts to accurately assess for FTT in the absence of frank malnutrition. ▲
basically supportive, while definitive diagnostic evaluation occurs. This consists of monitoring vital functions, administering IV fluids for resuscitation and maintenance, pain control, and empiric antibiotics, as appropriate. Consultation with appropriate subspecialty consultants should occur early, and decisions regarding specific therapies and diagnostic testing made in conjunction with their recommendations.

**Treatment of Acute Chest Syndrome and Vasocclusive Crisis**

Nearly all children with Acute Chest Syndrome (ACS) will have some degree of hypoxia, and supplemental oxygen should be given to maintain the oxygen saturation greater than 90 percent. Fluid management should be individualized to the cardiopulmonary status and, in infants and children without significant myocardial dysfunction, total IV and oral fluids should be near 1.5 times maintenance requirements. Pain control is ideally provided by patient-controlled analgesia infusions in doses that are sufficient to prevent respiratory splinting, but avoid hypoventilation. Antibiotics — a cephalosporin and erythromycin or macrolide — should be given empirically and continued until fever has been absent 24 hours. Many patients with ACS have reactive airway disease, demonstrated by clinical wheezing. Increased work of breathing or decreased peak flow should be treated with bronchodilators. Patients who do not respond to the above measures require blood transfusion.

The most important aspect of treatment of vasocclusive crisis associated with sickle cell disease is adequate pain control, with the route of administration determined by the severity of the patient’s pain. The mainstay of pain therapy for moderate to severe pain is morphine. Meperidine (Demerol®) should be avoided, due to the high incidence of side effects associated with repeated dosing. Administration of IV and oral fluids should not exceed 1 to 1.5 times maintenance, unless there is significant hypovolemia. Overzealous use of IV fluids can exacerbate or worsen the pulmonary complications of sickle cell disease.

**Treatment of Common, Nonurgent Conditions**

Common causes of excessive crying in young infants that can be treated in the ED with subsequent discharge include otitis media (OM), corneal foreign body or abrasion, thrush, pharyngitis, nasal congestion, uncomplicated hair tourniquet, fecal impaction, simple rashes, and insect bites. Infant crying should abate soon after removal of the offending stimulus or adequate pain control; if crying persists, further evaluation and/or observation should occur. Infants with historical and physical findings suggestive of non-life-threatening drug exposure, ie, nicotine or OTC drug exposure via breast milk transmission, may benefit from an observation period in the ED and may be discharged if the crying resolves, to follow up with the primary care physician within a few hours. Neonates with findings consistent with drug withdrawal syndromes and infants with exposure to toxic substances should be admitted for longer observation periods.

Treatment of otitis media is somewhat dependent upon the infant’s age and past history. Traditional treatment of the neonate with otitis has been septic workup and admission for IV antibiotics pending culture results, due to the possibility of concomitant serious bacterial infection (SBI). The management of the infant 29-56 days of age with OM is somewhat controversial; if the infant is febrile or otherwise ill-appearing, a septic workup should be performed, and the infant should be admitted and given IV antibiotics. The management of the afebrile infant in this age group varies based on the comfort of the practitioner and the ability to secure timely follow-up. The incidence of bacteremia and meningitis in the well-appearing infant older than 25 days with a temperature under 38.6°C is 0.4%. Pathogens causing OM in neonates and very young infants have long been assumed to be the same as those associated with more serious infections, such as bacteriaemia and UTI; however, a study by Turner of 137 infants ranging in age from 0-60 days with OM who had tympanocentesis and culture of middle ear effusion revealed organisms similar to those detected in older children with otitis. Thirty percent of the infants in Turner’s study were afebrile, and none had a SBI. Many private pediatricians treat afebrile infants with OM in the 29-90-day-old group with outpatient antibiotics. Choice and duration of therapy for OM is also related to age and past history of OM. First-line therapy in very young infants should be high-dose amoxicillin (80-90 mg/kg/day) to provide adequate coverage for susceptible and intermediate resistant pneumococci. The excessive crying of the infant with OM is presumed to be due to earache, and adequate pain control should result in fairly rapid resolution of the crying. Instillation of benzocaine eardrops (Auralgan®) into the affected ear typically will relieve earache in less than 10 minutes; contraindication for the use of Auralgan is a perforated tympanic membrane. If crying does not resolve with the use of Auralgan or adequate doses of acetaminophen, the infant should be evaluated further to rule out more serious disease.

Crying also quickly resolves with corneal foreign bodies and/or abrasions upon instillation of topical ophthalmic anesthetics. The clinical appreciation of corneal foreign bodies or abrasion is difficult, and resolution of crying with instillation of a topical anesthetic serves as a diagnostic as well as a therapeutic modality. Treatment of corneal abrasions in infants and children is the application of antibiotic ophthalmic ointment, adequate pain control, and follow-up in 24-36 hours.

Thrush, stomatitis, or pharyngitis can cause crying secondary to pain as well as irritability associated with the inability to feed, which may result in dehydration, further exacerbating irritability. Recommended treatment of thrush is the application of Mycostatin® solution; however, some infants may have candida recalcitrant to usual dosage, especially infants with history of prematurity and neonatal intensive care admissions during which they received therapy for candida. Higher doses with more
frequent applications of Mycostatin solution may be more efficacious, or the use of fluconazole may be necessary for eradication.112-113 Treatment should also occur for concomitant diaper rash and for the nipples of the breastfeeding mother. Topical application of a Benadryl®-Maalox® suspension or “Magic Mouthwash” (Benadryl, nystatin, hydrocortisone) often affords adequate pain relief for the infant with stomatitis or pharyngitis. Lidocaine suspension and narcotics should be avoided in infants and young children, due to the potential for lidocaine and opiate toxicity.

Neonates and young infants are obligate nose breathers and can have significant upper airway obstruction associated with upper respiratory infections. Respiratory distress interferes with the suck-swallow process and hampers the ability to feed. Irritability and crying may result from the nasal obstruction and the hunger that accompanies the inability to feed adequately. Frequent nasal suctioning with a bulb syringe and saline nose drops is usually all that is necessary for the relief of nasal congestion. Smaller, more frequent feedings may also be better tolerated by infants who tire easily during feedings when they have increased work of breathing. Antihistamines and decongestants should be avoided in infants, because of frequent adverse side effects.159

Abdominal pain associated with constipation is usually due to fecal impaction. Rectal disimpaction must occur for initial relief of discomfort and before institution of maintenance therapy for constipation. Glycerin suppositories or gentle digital disimpaction should be used in infants. Enemas should be avoided in infants less than 2 years of age, due to the potential for structural trauma associated with upper respiratory infections. Respiratory distress interferes with the suck-swallow process and hampers the ability to feed. Irritability and crying may result from the nasal obstruction and the hunger that accompanies the inability to feed adequately. Frequent nasal suctioning with a bulb syringe and saline nose drops is usually all that is necessary for the relief of nasal congestion. Smaller, more frequent feedings may also be better tolerated by infants who tire easily during feedings when they have increased work of breathing. Antihistamines and decongestants should be avoided in infants, because of frequent adverse side effects.159

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Infants with spitting up secondary to GERD and who are growing normally, gaining weight appropriately, and do not have symptoms suggestive of esophagitis require no treatment, other than parental reassurance. Thickening the formula with the addition of rice cereal may decrease the frequency of spitting, and placing the infant in the prone position has been shown to decrease reflux during sleep.182 Formula changes do not decrease symptoms of GERD and should be discouraged. Infants with suspected esophagitis characterized by crying associated with feeding, which may or may not be accompanied by grimacing, kicking, and arching, and who are having poor feeding and weight gain may benefit from a trial of ranitidine (Zantac®) or famotidine (Pepcid®). Omeprazole (Prilosec®), the only proton pump inhibitor (PPI) currently prescribed for children, should be reserved for severe cases of esophagitis refractory to histamine-2 receptor antagonists.152

Infants with GERD and failure to thrive or those with severe symptoms of esophagitis not responsive to initial therapy should be referred to pediatric gastroenterology for endoscopy and esophageal pH monitoring.

Infants with allergic eosinophilic gastritis, allergic eosinophilic gastroenterocolitis, and most infants with dietary protein proctitis typically respond well to protein elimination from the diet and the use of hydrolyzed infant formulas, such as Alimentum® or Nutramigen®. Occasionally some infants with dietary protein proctitis are sensitive to hydrolyzed formulas and require the use of amino acid-derived formulas (EleCare®, Neocate®).160 Formula changes for well-appearing and thriving infants are rarely necessary during the ED visit and, if considered, should be done so in consultation with the primary care physician. Infants with dietary protein enterocolitis or dietary protein enteropathy must have the offending antigens eliminated from the diet for symptom resolution. Infants with failure to thrive, chronic diarrhea, anemia, and protein-losing enteropathy may require hospitalization and short-term IV fluid administration; all will need evaluation by pediatric gastroenterology.

Infants less than 60 days of age with urinary tract infection should undergo full septic workup, receive IV antibiotics, and be admitted, due to the potential for bacteremia and meningitis in this age group.195,196 The incidence of bacteremia and meningitis associated with UTI declines with age, and recent studies suggest the prevalence of bacterial meningitis in 60–90-day-old infants who have UTI is no greater than that of similar infants without UTI.195,205,206 There is an association of aseptic meningitis and young infants with febrile UTI, which can cause confusion resulting in unnecessary hospitalization and prolonged parenteral antibiotics in infants who have received antibiotics prior to CSF analysis.195,206 Febrile and/or ill-appearing infants 60-90 days of age with presumptive UTI should undergo septic workup prior to the administration of antibiotics; however, an argument can be made that afebrile, well-ap-
purring infants in this age group do not require lumbar puncture and, after cultures of the blood and urine are obtained, can be discharged on appropriate antibiotics to follow up with their primary care physician in 12-24 hours. Older infants seldom require more than an adequate culture of the urine, but evaluation should be more extensive for ill-appearing or high-risk patients. Choice of outpatient antibiotics includes cefixime (Suprax®), amoxicillin/clavulanate (Augmentin®), and cephalexin (Keflex®).

Balanitis and balanoposthitis almost always occur in uncircumcised patients. Balanitis, infection of the glans penis and prepuce, is commonly caused by Candida and can be managed with topical mycostatin ointment only. Balanoposthitis involves not only the glans but the penile shaft, and typically the pathogenesis is that of initial candidiasis with secondary bacterial cellulitis involving the body of the penis. Treatment of balanoposthitis is topical application of mycostatin ointment and an oral antibiotic that provides coverage for Staph aureus and group A streptococcus. Rarely do these children need hospitalization unless there is extensive cellulitis, difficulty with urination, or ill appearance.

The goals of therapy for atopic dermatitis (AD) are to eliminate environmental allergens, limit the extent of skin involvement, and relieve the discomfort. Basic treatment involves liberal use of emollients, such as eucerin cream and antihistamines, for relief of pruritis. Antihistamines should be given during the daytime hours in doses that do not cause excessive sedation and should always be used at night, since children with AD have significant sleep disturbances. Topical steroids have been the primary adjunctive therapy for atopic dermatitis; however, with long-term or overzealous application, the child can experience serious adverse effects. Topical steroids should only be used for the short-term treatment of flare-ups and oral steroids should be avoided, due to severe rebound of the AD symptoms on withdrawal. Pimecrolimus (Elidel®) is a proinflammatory cytokine inhibitor and available as a 1% cream for the treatment of inflammatory skin disease. It is a nonsteroid and does not cause skin atrophy, the most common side effect of topical steroid preparations. Pimecrolimus has been shown to be a safe and effective agent for the long-term treatment of AD in young infants and children.

Children with extensive atopic dermatitis are at risk for secondary bacterial infection with Staph aureus or group A streptococcus. These infections are usually of an impetiginous nature and respond to antibiotics commonly used, such as an oral cephalosporin; however, if the infection is recalcitrant or manifests as superficial abscess(es) or extensive cellulitis, community-acquired methicillin-resistant staph aureus (CA-MRSA) should be suspected, especially if the incidence of CA-MRSA is greater than 5-10% in the community.

Diaper dermatitis commonly causes irritability and crying in infants, due to pain and discomfort. Infants with minimal inflammatory changes rarely require more than a barrier cream, such as zinc oxide or petrolatum jelly; however, these infants do not typically present with associated excessive crying. The infants with significant pain are those with moderate to severe dermatitis with extensive skin involvement, maceration, erosions, and ulceration. Candidal colonization occurs in 40-77% of infants with moderate to severe diaper dermatitis and, in addition to the application of a barrier cream, should also be treated with topical antifungal cream. Although not approved for use in diaper dermatitis, miconazole (Lotrimin®) has been shown to be a safe and effective treatment in young infants.

Infants and children with presumed brown recluse spider bites who do not exhibit systemic symptoms can be followed as outpatients. The size of the resulting lesion and the amount of necrosis varies, depending on the reaction to the toxins injected by the spider. Multiple treatments have been studied and tried, including antibiotics, corticosteroids, dapsone, hyperbaric oxygen, and early surgical excision of the bite — none proved effective. Local wound care and supportive treatment with analgesics is the only recommended treatment. Large necrotic wounds may require delayed surgical intervention, along with antibiotics for secondary infections.

With the increase in community-acquired MRSA in low-risk children during recent years, the management of superficial abscesses and cellulitis has changed. Prevalence varies from region to region; the incidence in this author’s institution is presently about 50% (unpublished data). All abscesses should be cultured when incised and drained; antibiotics are unnecessary for simple, superficial abscesses after appropriate incision and drainage. Children should have close follow-up of clinical course and culture results. Most CA-MRSA is generally susceptible to clindamycin, trimethoprim-sulfamethoxazole, gentamicin, ciprofloxacin, and vancomycin. There has also been a significant increase in musculoskeletal and HEENT infections caused by CA-MRSA; a higher level of vigilance is necessary for CA-MRSA infections, and cultures should be obtained routinely whenever possible.

Removal of constricting bands of hair or thread (tourniquet syndrome) from fingers and toes can usually be accomplished in the ED. Removal of bands from the genitalia may be more problematic, and appropriate consultation with gynecology and urology should guide the treatment. Emergent surgical consultation and decompression and debridement in the operating room should occur, if there is either cyanosis or signs of necrosis of the digit. Any surgical exploration of the finger or toe in the ED should be preceded by either digital block or sedation in the very young infant whose digit is so small as to preclude injection of local anesthetic. If the encircling band is visible, it may be possible to divide it with an 11-scapel blade, but one must be certain to have completely severed all constricting bands. More often the constricting band is embedded in folds of edematous tissue and is not visible, but merely suspected by the general appearance of the
digit. In this instance, it may be necessary to incise the skin on either side of the digit to ensure tissue decompression and division of the band. Longitudinal incisions should be made at right angles to the constriction and placed midway on both sides of the digit to avoid damage to the neurovascular bundles.190 If one is not comfortable with this procedure, treatment should be deferred to pediatric or general surgery. Infants with constricting bands involving multiple digits, multiple loops and knots, and those whose caretakers delayed seeking medical treatment should have a child abuse evaluation and be reported to CPS.

Special Circumstances

Colic
The diagnosis of colic is one of definition and exclusion. The definition is recurrent episodes of excessive crying in an otherwise healthy infant less than 5 months of age, in whom serious disease has been excluded, either by specific evaluation, or by the passage of time without the occurrence of other symptomatology or sequelae. It is highly unlikely that a 4- to 5-month-old infant with a history of recurrent episodes of crying who is feeding well, growing, and developing neurologically and socially has an occult, serious organic condition. These infants do not typically present to the ED, unless there are new or complicating symptoms. The crying infant of much greater concern is one who is younger and/or experiencing the first, or perhaps second, episode of acute, excessive crying.

The etiology of colic is unknown — it is thought by some to be a variant of normal patterns of crying, and clearly some instances are parental misconceptions regarding what constitutes normal infant crying. Colic is often thought to be caused by abdominal pain by parents and health care workers alike, due to associated activity of some infants during crying characterized by flexing of the legs, tensing the abdomen, clenching the fists, and flushing. Also, the character of the crying is often described as more shrill and high-pitched than at other times; however, acoustic analysis of infants with colic is consistent with only increased stress arousal.18-21 Due to this misconception that colic is a manifestation of abdominal pain, it has long been and continues to be regarded by many as a gastrointestinal disorder. A common explanation is excessive intragastrointestinal air load or gas. Infants with colic are known to have excessive flatus and, as a consequence, the gas has been labeled as the cause of the colic. Multiple studies have failed to show conclusive evidence of excessive colonic gas production in infants with colic.29,270 A study by Duro et al recently showed an association of increased crying and carbohydrate malabsorption of fruit juice containing sorbitol, but the study numbers (n=30) were small, and the assessment of crying was determined by a parental questionnaire, which relies on parental perception of their infant’s crying.271 Also, several studies have tested the efficacy of simethicone (Mylicon®) for the treatment of colic and found no difference between simethicone and placebo.272 Milk protein allergy is often blamed for colic, which may result in multiple formula changes without alleviation of symptoms. The diagnosis of milk protein allergy should not be made without objective clinical and laboratory findings. Several studies have addressed formula changes with soy formula, casein hydrolysate, whey hydrolysate, and low-lactose milk, all of which have shown inconclusive or insufficient evidence to support empiric formula change, based on the presence of excessive crying alone.7,29,270 Increased intestinal motility with abdominal cramping has been implicated as a cause of colic, and clinical trials using the anticholinergic drug dicyclomine hydrochloride (Bentyl®) showed significant reduction of colic symptoms, but the use of dicyclomine has been associated with significant respiratory depression and apnea and is contraindicated in infants and young children.7,270 Further evidence that increased intestinal motility may contribute to the pathogenesis of colic is based on measurements of motilin, a gut hormone involved in the regulation of gut motility. Basal motilin levels are raised in infants with colic, independent of their diet, and levels are higher at birth in infants who later develop colic.29,270 Certain herbal teas (chamomile, fennel, licorice, and balm-mint) are thought to have anti-spasmodic activity, but there has been limited study of their efficacy, and fennel was recently reported to have mutagenic effects on bacteria and a carcinogenic effect in mice.7,270 A small subset of infants with colic will have GERD, with excessive crying as the only manifestation; given the absence of common symptoms of GERD, only esophageal pH monitoring will identify these infants.153,154,270 There has been limited success with behavioral modification of parents’ response to infant crying and with focused parental counseling.7 The only real “treatment” we have to offer to the parent of the infant with colic is a comprehensive evaluation to reasonably rule out organic pathology, and reassurance that colic rarely lasts beyond the first 4 to 5 months.

Controversies/Cutting Edge

There are few controversies in the management of a persistently crying infant. An evaluation aimed at identifying the most likely etiology of the crying is typically indicated. There have been no recent developments that could be considered “cutting edge” in the workup of acute crying.

Disposition

There are no evidenced-based guidelines for the disposition of the infant who has an episode of acute, excessive crying that spontaneously resolves while in the ED. The only data available are from Poole’s study, which showed that infants who ceased crying prior to arrival or early in the evaluation were unlikely to have serious disease.5 I find that a short observation period during which the infant feeds is reassuring, both to the parents and myself. The parent or caregiver should receive specific instructions regarding the signs and symptoms that should prompt immediate return to the ED. Follow-up should occur with the primary care physician in 12-18 hours, and discussion
with the PMD prior to the infant’s discharge would be optimal.

Infants who stop crying after the initial history and physical examination or during the subsequent evaluation are more problematic. Again, some direction can be taken from Poole’s study, which suggests a period of observation in the ED that is helpful in sorting out the infant who may have an “unrecognized” condition. How long one should observe these infants is unclear. Experience with other categories of children for whom observation is necessary for signs of recurring or worsening symptoms, such as asthma, febrile seizures, or subjective neonatal fever, has shown that a minimum of 2 hours of close observation is necessary prior to discharge. Discussion with the primary care physician should occur prior to discharge, with follow-up arranged within 8-12 hours. Parents should also be comfortable with the discharge plans and be given specific instructions regarding follow-up and/or return to the ED.

Poole was more specific regarding the infant for whom the history and physical examination is normal, but who continues to have excessive or inconsolable crying—these infants were more likely to have a serious condition. Observation should continue in the ED with repeat examinations, which may provide additional information in directing the evaluation. Infants who continue to have excessive crying require admission for extensive observation and evaluation.

Summary
1. There is a subset of infants who present with acute, excessive, unexplained crying and have serious disease. A comprehensive history and expanded physical examination will identify most of these infants.
2. Infants who have common, benign conditions identified by history or physical examination can be observed or treated in the ED and discharged to follow up.
3. Infants with historical or physical findings suggestive of serious disease should be evaluated as needed to establish or rule out the diagnosis, in conjunction with appropriate subspecialty consultation.
4. Infants who have a noncontributory history and physical examination, but who continue to have excessive crying, should be observed in the ED with repeated assessments. Continued crying of unknown etiology requires extensive evaluation and admission.
5. Urinary tract infection is often occult in infants and can present with excessive crying as the only symptom.
6. Colic is a diagnosis of exclusion and should be avoided in the ED setting, unless there is a history of multiple, recurrent episodes of crying in an otherwise healthy, thriving infant. These infants should undergo a comprehensive history and expanded physical examination to rule out unrecognized conditions.

Whatever Happened to Oscar?
The ED social worker convinced the parents to allow for further investigation of Oscar’s crying. The catheterized urinalysis was consistent with a urinary tract infection. A septic workup was completed, and Oscar was admitted for 48 hours of IV antibiotics pending culture results. His parents were thankful and appreciative for our diligence, and Oscar recovered uneventfully to return to the ED another day. ▲

References
Evidence-based medicine requires a critical appraisal of the literature based upon study methodology and number of subjects. Not all references are equally robust. The findings of a large, prospective, randomized, and blinded trial should carry more weight than a case report.

To help the reader judge the strength of each reference, pertinent information about the study, such as the type of study and the number of patients in the study, will be included in bold type following the reference, where available. In addition, the most informative references cited in the paper, as determined by the authors, will be noted by an asterisk (*) next to the number of the reference.


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20. For children with sickle cell disease, acute chest syndrome most commonly presents with which of the following?
   a. fever, chest pain, infiltrate on chest x-ray
   b. lower extremity swelling, foul breath, alopecia
   c. periods of apnea, cough, rhinorrhea
   d. unilateral chest rash, oral lesions, episodic crying

21. Which of the following is the most common cause of intestinal obstruction in infants?
   a. intussusception
   b. malrotation with midgut volvulus
   c. Meckel’s diverticulum
   d. pyloric stenosis

22. Which of the following is the preferred method of treatment for intussusception?
   a. enema reduction
   b. expectant observation
   c. laparoscopic reduction
   d. whole bowel irrigation

23. Which of the following is the most common cause of death for infants less than one year of age?
   a. abusive head injury
   b. acute lymphocytic leukemia
   c. maternal Rh incompatibility
   d. pyloric stenosis

24. For infants, which of the following is the most common cause of crying with feeding?
   a. excessively hot formula
   b. gingivostomatitis
   c. intussusception
   d. rough maternal nipples

25. Which of the following is least likely to cause acute, unexplained, excessive crying?
   a. corneal abrasions
   b. gingivostomatitis
   c. nonaccidental trauma
   d. teething

26. The manifestations of which inborn error of metabolism are most likely to be mistaken for nonaccidental trauma?
   a. glutaric aciduria type I
   b. maple syrup urine disease
   c. phenylketonuria
   d. propionic academia

27. An older infant presents with fever, meningismus, crying, and poor feeding. The results of a lumbar puncture are normal. Which of the following tests should be performed next?
   a. ammonia level for inborn error of metabolism
   b. CT scan of the neck for retropharyngeal abscess
   c. Fluorescein staining for corneal abrasions
   d. pH probe for gastroesophageal reflux
   e. sweat test for cystic fibrosis

28. Sustained sinus tachycardia that is unresponsive to intravenous crystalloid administration and is associated with hepatomegaly is most consistent with which of the following diagnoses?
   a. intussusception
   b. myocarditis
   c. pyloric stenosis
   d. pyogenic granuloma

29. A 2-month-old with a prior history of crying, abdominal distension, and constipation presents with the acute onset of worsening abdominal distention, fever, and explosive, bloody diarrhea. Which of the following is the most likely diagnosis?
   a. acute appendicitis
   b. ALCAPA
   c. Encopresis
   d. Hirschprung’s disease
   e. Kawasaki disease

30. Which of the following infantile causes of crying is most likely to be associated with failure to thrive (FTT)?
   a. bacterial meningitis
   b. corneal abrasion
   c. cow’s milk allergy
   d. perforated appendicitis

31. Which of the following is the most common cause of pancreatitis in young children?
   a. blunt trauma
   b. congenital agenesis of the pancreas
   c. fetal alcohol syndrome
   d. primary biliary atresia

32. A child with frequent crying and bowing of the long bones most likely has which of the following?
   a. ALCAPA
   b. Hirschprungs disease
   c. Kawasaki disease
   d. lumbago
   e. rickets
33. Which of the following is most likely to be the earliest physical manifestation of sickle cell disease?
   a. blindness  
   b. dactylitis  
   c. myocarditis  
   d. pancreatitis  
   e. priapism

34. Which of the following is increasingly being identified as a cause of cutaneous infections in infants and young children?
   a. Community-acquired methicillin-resistant *Staphylococcus aureus*  
   b. *Haemophilus influenza* type b  
   c. invasive *Streptococcus pneumoniae*  
   d. *Pseudomonas aeruginosa*

35. A child with atopic dermatitis and increased crying is most likely experiencing which of the following?
   a. congenital syphilis  
   b. fear  
   c. nonaccidental trauma  
   d. pruritis

36. In neonates, the crying associated with maternal opiate abuse is most commonly described by which of the following adjectives?
   a. high-pitched  
   b. muffled  
   c. paroxysmal  
   d. whimpering

37. Which of the following best describes paradoxical irritability?
   a. crying that occurs when the infant encounters a smiling face  
   b. crying that occurs when soothing classical music is played  
   c. crying that occurs when an infant is picked up and gently rocked  
   d. crying that comes in bursts that frighten the parents

38. Pseudoparalysis of an infant’s lower extremity is most suggestive of which of the following conditions?
   a. congenital torticollis  
   b. idiopathic neuropraxia  
   c. nonaccidental tibia fracture  
   d. SCIWORA  
   e. Viral encephalitis

39. The “squeeze the wheeze” technique is most appropriately used to elicit which of the following?
   a. a deep breath  
   b. endotracheal tube air leak  
   c. higher pulse oximetry readings  
   d. repetitive coughing

40. Vertebral discitis is most commonly associated with which of the following symptoms in infants?
   a. faint maculopapular rash on the back  
   b. flaccid paralysis and shock  
   c. high fever and urinary retention  
   d. paradoxical irritability and truncal immobility

41. Cheilosis is a term used most appropriately to describe which of the following?
   a. allergic esophageal erosions  
   b. crying when rocked or held  
   c. empty rectal vault and a history of constipation  
   d. head size > 95th percentile  
   e. radiating fissures of the lips

42. A 2-week-old infant is brought to the ED because of a newly discovered immobile “lump” overlying the left clavicle. Which of the following is the most likely diagnosis?
   a. branchial cleft cyst  
   b. clavicle fracture  
   c. congenital torticollis  
   d. migrating thymoma  
   e. neonatal onset lymphoma

43. The “rachitic rosary” most appropriately refers to which of the following?
   a. chest wall findings associated with rickets  
   b. facial findings of severe neonatal acne  
   c. physical exam findings in hypocalcemia  
   d. subcutaneous nodules from a spider bite

44. A crying infant has an indurated, erythematous area circumferentially surrounding the umbilicus. Which of the following is the most appropriate treatment?
   a. expectant observation and reassurance  
   b. oral cephalexin and 24-hour follow-up  
   c. pediatric surgical consultation  
   d. topical mupirocin and wound care

45. The most appropriate treatment for a young child with acute chest syndrome includes which of the following?
   a. anticoagulation with heparin  
   b. aspirin and intravenous immunoglobulin  
   c. immediate orotracheal intubation  
   d. intravenous antibiotics and analgesia  
   e. prompt open lung biopsy

46. Which of the following most appropriately differentiates balanitis from balanoposthitis?
   a. balanitis is frequently fatal  
   b. balanitis typically involves a bacterial superinfection  
   c. balanoposthitis involves the penile shaft  
   d. balanoposthitis is manually reducible
47. Which of the following is the most appropriate treatment for dietary protein enterocolitis?
   a. frequent oral diphenhydramine
   b. intravenous antibiotics for one week
   c. multidose oral neomycin until symptoms resolve
   d. removal of the offending protein from the diet

48. Which electrolyte abnormality is suggested by an ipsilateral facial grimace elicited by tapping the cheek just below the zygoma?
   a. hypocalcemia
   b. hypochloremia
c. hypokalemia
d. hyponatremia
e. hypophosphatemia

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Each action in the clinical pathways section of Pediatric Emergency Medicine Practice receives a score based on the following definitions.

Class I
• Always acceptable, safe
• Definitely useful
• Proven in both efficacy and effectiveness

Level of Evidence:
• One or more large prospective studies are present (with rare exceptions)
• High-quality meta-analyses
• Study results consistently positive and compelling

Indeterminate
• Continuing area of research
• No recommendations until further research

Class II
• Safe, acceptable
• Probably useful

Level of Evidence:
• Generally higher levels of evidence
• Non-randomized or retrospective studies; historic, cohort, or case-control studies
• Less robust RCTs
• Results consistently positive

Class III
• May be acceptable
• Possibly useful
• Considered optional or alternative treatments

Level of Evidence:
• Generally lower or intermediate levels of evidence

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