Acute Gastroenteritis

Deise Granado-Villar, MD, MPH,* Beatriz Cunill-De Sautu, MD,† Andrea Granados, MD§

Author Disclosure
Drs Granado-Villar, Cunill-De Sautu, and Granados have disclosed no financial relationships relevant to this article. This commentary does contain a discussion of an unapproved/investigative use of a commercial product/device.

Educational Gap

In managing acute diarrhea in children, clinicians need to be aware that management based on "bowel rest" is outdated, and instead reinstitution of an appropriate diet has been associated with decreased stool volume and duration of diarrhea. In general, drug therapy is not indicated in managing diarrhea in children, although zinc supplementation and probiotic use show promise.

Objectives

After reading this article, readers should be able to:

1. **Recognize the electrolyte changes associated with isotonic dehydration.**
2. **Effectively manage a child who has isotonic dehydration.**
3. **Understand the importance of early feedings on the nutritional status of a child who has gastroenteritis.**
4. **Fully understand that antidiarrheal agents are not indicated nor recommended in the treatment of acute gastroenteritis in children.**
5. **Recognize the role of vomiting in the clinical presentation of acute gastroenteritis.**

Introduction

Acute gastroenteritis is an extremely common illness among infants and children worldwide. According to the Centers for Disease Control and Prevention (CDC), acute diarrhea among children in the United States accounts for more than 1.5 million outpatient visits, 200,000 hospitalizations, and approximately 300 deaths per year. In developing countries, diarrhea is a common cause of mortality among children younger than age 5 years, with an estimated 2 million deaths each year. American children younger than 5 years have an average of two episodes of gastroenteritis per year, leading to 2 million to 3 million office visits and 10% of all pediatric hospital admissions. Furthermore, approximately one third of all hospitalizations for diarrhea in children younger than 5 years are due to rotavirus, with an associated direct cost of $250 million annually. (1)(2)

Definitions

Diarrhea is defined as the passage of three or more loose or watery stools per day (or more frequent passage of stool than is normal for the individual). Stool patterns may vary among children; thus, it is important to note that diarrhea should represent a change from the norm. Frequent passage of formed stools is not diarrhea, nor is the passing of "pasty" stools by breastfed young infants. (2)(3)

There are three clinical classifications of diarrheal conditions:

- Acute diarrhea, lasting several hours or days
- Acute bloody diarrhea or dysentery
- Persistent diarrhea, lasting 14 days or longer

Abbreviations

CDC: Centers for Disease Control and Prevention
IV: intravenous
K+: potassium
Na+: sodium
NG: nasogastric
ORS: oral rehydration solution
WHO: World Health Organization

*Chief Medical Officer, Senior Vice President for Medical & Academic Affairs, Miami Children's Hospital; Clinical Associate Professor of Pediatrics, Affiliate Dean for Miami Children's Hospital, Herbert Wertheim College of Medicine, Florida International University.
†Director, Pediatric Residency Program, Miami Children's Hospital; Clinical Assistant Professor of Pediatrics, Herbert Wertheim College of Medicine, Florida International University.
§Chief Resident, Miami Children's Hospital; currently Pediatric Endocrinology Fellow, University of Michigan.

Clinical Presentation

The clinical manifestations of acute gastroenteritis can include diarrhea, vomiting, fever, anorexia, and abdominal cramps. Vomiting followed by diarrhea may be the initial presentation in children, or vice versa. However, when emesis is the only presenting sign, the clinician must contemplate other diagnostic possibilities, such as diabetes, metabolic disorders, urinary tract infections, meningitis, gastrointestinal obstruction, and ingestion. The characteristics of the emesis, such as color, intensity, and frequency, as well as relationship to feedings, often lead to the most likely diagnoses. (1)(2)(4)

A complete history and physical examination always must be performed. The clinician should inquire about the duration of illness; the number of episodes of vomiting and diarrhea per day; urine output; the presence of blood in the stool; accompanying symptoms such as fever, abdominal pain, and urinary complaints; and recent fluid and food intake. Recent medications and the child's immunization history also should be reviewed. The physical examination should focus on identifying signs of dehydration such as level of alertness, presence of sunken eyes, dry mucous membranes, and skin turgor. (1)(3)

Viruses are the cause of the majority of cases of acute gastroenteritis in children worldwide. Viral infections usually are characterized by low-grade fever and watery diarrhea without blood. Bacterial infections may result in infiltration of the mucosal lining of the small and large intestines, which in turn causes inflammation. Children thus are more likely to present with high fever and the presence of blood and white blood cells in the stool. Table 1 lists the common causal pathogens of acute gastroenteritis in children. (2)

Table 1. Causes of Acute Gastroenteritis in Children (2)

Viruses
Rotaviruses
Noroviruses (Norwalk-like viruses)
Enteric adenoviruses
Caliciviruses
Astroviruses
Enteroviruses
Bacteria
Campylobacter jejuni
Nontyphoid *Salmonella* spp
Enteropathogenic *Escherichia coli*
Shigella spp
Yersinia enterocolitica
Shiga toxin producing *E coli*
Salmonella typhi and *S paratyphi*
Vibrio cholerae
Protozoa
Cryptosporidium
Giardia lamblia
Entamoeba histolytica
Helminths
Strongyloides stercoralis

Assessment of Dehydration

Dehydration related to acute gastroenteritis is a major concern in pediatric patients. Therefore, clinicians in primary care offices, emergency departments, and hospital settings must assess the circulatory volume status as part of the initial evaluation of children presenting with acute gastroenteritis. This assessment is essential in guiding the decision making regarding therapy and patient disposition.

In 1996, the CDC published recommendations on the assessment of dehydration, which were subsequently endorsed by the American Academy of Pediatrics (AAP). These guidelines classified patients into three groups based on their estimated fluid deficit: mild dehydration (3%–5% fluid deficit), moderate dehydration (6%–9% fluid deficit), and severe dehydration (>10% fluid deficit or shock). These classifications are similar to those delineated by the World Health Organization (WHO) in 1995, which also divided patients into three groups: no signs of dehydration (<3%–5%), some signs of dehydration (5%–10%), and severe dehydration (>10%).

The authors of studies have evaluated the correlation of clinical signs of dehydration with posttreatment weight gain and have demonstrated that the first signs of dehydration might not be evident until 3% to 4% dehydration. Furthermore, more obvious clinical signs of dehydration become apparent at 5% dehydration, and indications of severe dehydration become evident when the fluid loss reaches 9% to 10%. As a result, the CDC revised its recommendations in 2003 and combined the mild and moderate dehydration categories, acknowledging that the signs of dehydration might be apparent over a relatively wide range of fluid loss (Table 2). The ultimate goal of this assessment is to identify which patients can be sent home safely, which should remain under observation, and which are candidates for immediate, aggressive therapy. (1)

Laboratory Evaluation

Serum electrolytes are not indicated routinely in patients who have acute gastroenteritis. Authors of several studies have evaluated the utility of laboratory tests in assessing the degree of dehydration, and the evidence reveals that

Table 2. **Symptoms Associated With Dehydration (1)**

Symptom	Minimal or No Dehydration (<3% Loss of Body Weight)	Mild to Moderate Dehydration (3%–9% Loss of Body Weight)	Severe Dehydration (>9% Loss of Body Weight)
Mental status	Well; alert	Normal, fatigued or restless, irritable	Apathetic, lethargic, unconscious
Thirst	Drinks normally; might refuse liquids	Thirsty; eager to drink	Drinks poorly; unable to drink
Heart rate	Normal	Normal to increased	Tachycardia, with bradycardia in most severe cases
Quality of pulses	Normal	Normal to decreased	Weak, thready, impalpable
Breathing	Normal	Normal; fast	Deep
Eyes	Normal	Slightly sunken	Deeply sunken
Tears	Present	Decreased	Absent
Mouth and tongue	Moist	Dry	Parched
Skin fold	Instant recoil	Recoil in <2 seconds	Recoil in >2 seconds
Capillary refill	Normal	Prolonged	Prolonged; minimal
Extremities	Warm	Cool	Cold; mottled; cyanotic
Urine output	Normal to decreased	Decreased	Minimal

such studies are imprecise and may distract clinicians from focusing on signs and symptoms that have proven diagnostic utility. Commonly obtained laboratory tests, such as blood urea nitrogen and bicarbonate concentrations, generally are helpful only when the results are markedly abnormal. Thus, these laboratory tests should not be considered definitive predictors of dehydration. (1)(5)(6)(7) Additionally, current evidence demonstrates that urinary indices, including specific gravity and the presence of ketones, also are not useful diagnostic tests for identifying the presence of dehydration. (8)(9) Therefore, measurement of electrolytes should be reserved for patients afflicted with severe dehydration who require intravenous (IV) fluid therapy upon initial clinical assessment and for those in whom hypernatremic dehydration is suspected (ie, ingestion of hypertonic solutions). (1)

Stool studies should be considered during outbreaks, especially in child care settings, schools, and hospitals, where there is a public health concern that mandates the identification of a pathogen and the identification of the source of disease. Other special circumstances that warrant the collection of stool samples for identification of enteric pathogens include the evaluation of children who have dysentery, a history of recent foreign travel, and managing young or immunocompromised children who present with high fever. (2)

The Evolution of Oral Rehydration Solutions

The introduction of oral rehydration solutions (ORSs) has decreased significantly the morbidity and mortality associated with acute gastroenteritis worldwide. (1) ORS is the cornerstone of therapy in managing uncomplicated cases of diarrhea.

ORSs began to evolve in the 1940s, as an initiative of Daniel Darrow at Yale and Harold Harrison at Baltimore City Hospital. Darrow performed studies in children who had acute diarrhea and identified the need for appropriate replacement of sodium (Na+), potassium (K+), and alkali to correct the metabolic acidosis. Subsequently, Harrison added glucose to a balanced electrolyte solution and established that such a solution could be used successfully for rehydration. In 1953, Chatterjee first demonstrated that ORSs could rehydrate patients who have cholera and avoid the need for IV fluids.

Studies evaluating the mechanism of intestinal solute transport have revealed that the absorption of water in the gastrointestinal tract is a passive process that depends on the osmotic gradient created by the transcellular transport of electrolytes and nutrients. Although there are alternate mechanisms that contribute to the absorption of Na+ in the enterocyte, it is the coupled transport of Na+ and glucose at the intestinal brush border that is responsible for the success of ORSs.

Sodium-solute-coupled cotransport is an energy-dependent process. The Na+ gradient within the cell is maintained by the Na+–K+ adenosine triphosphatase pump on the basolateral membrane of the enterocyte. Subsequent research has revealed that other solutes, such as amino acids, also were absorbed by active transport mechanisms involving Na+ ion coupling.

Clinical studies of ORSs in patients who have cholera in the Philippines and India have confirmed that oral

replacement of water and electrolytes produced a sufficient osmotic gradient to rehydrate patients successfully, even in severe diarrheal disease. Solutions of lower osmolarity that maintain the 1:1 glucose to Na+ ratio function optimally as oral solutions for diarrhea management. Subsequent clinical studies have confirmed the dramatic effect that ORSs had on decreasing mortality in acute diarrheal disease; consequently, the WHO and the AAP have endorsed the implementation ORSs worldwide. (4)

Management

Most cases of acute gastroenteritis in children are self-limiting and do not require the use of medications. An initial critical step in the management of acute gastroenteritis usually begins at home with early fluid replacement. Families should be instructed to begin feeding a commercially available ORS product as soon as the diarrhea develops. Although producing a homemade solution with appropriate concentrations of glucose and Na+ is possible, serious errors can result in attempting to use a homemade solution. Thus, standard commercial oral rehydration preparations should be recommended where they are readily available. (4)

ORS is recommended by the WHO and the AAP as "the preferred treatment of fluid and electrolyte losses caused by diarrhea in children with mild to moderate dehydration." The basis of this endorsement is meta-analysis comparing ORSs with traditional IV rehydration. The evidence supports low overall treatment failures with ORSs (3.6%), defined as the need to revert to IV therapy, without an increased incidence of iatrogenic hyponatremia or hypernatremia. (10) Other advantages of ORS include its lower cost, the elimination of the need for intravascular line placement, and the involvement of the parents in providing oral fluid replacement in the home environment when tolerated.

Common household beverages such as fruit juices, sports drinks, tea, and soft drinks should be avoided in the management of acute gastroenteritis. Many of these beverages have a high osmolality due to their high sugar content and contain little Na+ and K+; consequently, use of these fluids may worsen the patient's condition by increasing the stool output and increasing the risk of hyponatremia. Table 3 provides a comparison of the carbohydrate load and electrolyte composition of

Table 3. Composition of Commercial Oral Rehydration Solutions (ORS) and Commonly Consumed Beverages

Solution	Carbohydrate (gm/L)	Sodium (mmol/L)	Potassium (mmol/L)	Chloride (mmol/L)	Base* (mmol/L)	Osmolarity (mOsm/L)
ORS						
World Health Organization (WHO) (2002)	13.5	75	20	65	30	245
WHO (1975)	20	90	20	80	30	311
European Society of Paediatric Gastroenterology, Hepatology and Nutrition	16	60	20	60	30	240
Enfalyte®†	30	50	25	45	34	200
Pedialyte®§	25	45	20	35	30	250
Rehydralyte®¶	25	75	20	65	30	305
CeraLyte®**	40	50–90	20	NA††	30	220
Commonly used beverages (not appropriate for diarrhea treatment)						
Apple juice§§	120	0.4	44	45	N/A	730
Coca-Cola®¶¶ Classic	112	1.6	N/A	N/A	13.4	650

*Actual or potential bicarbonate (e.g., lactate, citrate, or acetate).
†Mead-Johnson Laboratories, Princeton, New Jersey. Additional information is available at http://www.meadjohnson.com/products/cons-infant/enfalyte.html.
§Ross Laboratories (Abbott Laboratories), Columbus, Ohio. Data regarding Flavored and Freezer Pop Pedialyte are identical. Additional information is available at http://www.pedialyte.com.
¶Ross Laboratories (Abbott Laboratories), Columbus, Ohio. Additional information is available at http://rpdcon40.ross.com/pn/PediatricProducts.NSF/web_Ross.com_XML_PediatricNutrition/96A5745B1183947385256A80007546E5?OpenDocument.
**Cera Products, L.L.C., Jessup, Maryland. Additional information is available at http://www.ceralyte.com/index.htm.
††Not applicable.
§§Meeting U.S. Department of Agriculture minimum requirements.
¶¶Coca-Cola Corporation, Atlanta, Georgia. Figures do not include electrolytes that might be present in local water used for bottling. Base=phosphate.
Source: Centers for Disease Control and Prevention. Managing acute gastroenteritis among children: oral rehydration, maintenance, and nutritional therapy. *MMWR* 2003;52(No. RR-16):1–16.

Table 4. **Summary of Treatment Based on the Degree of Dehydration (1)**

Degree of Dehydration	Rehydration Therapy	Replacement of Losses	Nutrition
Minimal or no dehydration	Not applicable	<10 kg body weight: 60–120 mL ORS for each diarrheal stool or vomiting episode >10 kg body weight: 120–240 mL ORS for each diarrheal stool or vomiting episode	Continue breastfeeding, or resume age-appropriate normal diet after initial hydration, including adequate caloric intake for maintenance
Mild to moderate dehydration	ORS, 50–100 mL/kg body weight over 3–4 hours	Same	Same
Severe dehydration	Lactated Ringer solution or normal saline in 20 mL/kg body weight intravenously until perfusion and mental status improve; then administer 100 mL/kg body weight ORS over 4 hours or 5% dextrose in ½ normal saline intravenously at twice maintenance fluid rates	Same; if unable to drink, administer through NG tube or administer 5% dextrose in ¼ normal saline with 20 mEq/L potassium chloride intravenously	Same

commercial ORSs with the content of commonly offered household drinks deemed inappropriate for oral rehydration therapy. (4)

Treatment of acute gastroenteritis should include two phases of therapy: rehydration and maintenance. In the rehydration phase, fluid should be replaced rapidly in a 3- to 4-hour period. In the maintenance phase, calories, in addition to fluids, are administered.

Rapid re-alimentation should follow rapid rehydration, having the goal of returning the patient quickly to an age-appropriate, unrestricted diet. During both phases, persistent fluid losses from vomiting and diarrhea should be replaced continuously. Table 4 summarizes the recommended rehydration and fluid loss replacement therapies based on the degree of dehydration. (1)

For more than 15 years, physicians have recognized the importance of early introduction of an age-appropriate diet, compared with the outdated practice of "bowel rest." Reinstitution of an appropriate diet has been associated with decreased stool volume and duration of diarrhea.

Breastfeeding should be continued during both the rehydration and maintenance phases. The diet should be advanced as tolerated to compensate for lost caloric intake during the acute illness. Lactose restriction ordinarily is not indicated, although such restriction might be helpful in cases of diarrhea in malnourished children or among children who have a severe enteropathy. In general, changes to a lactose-free formula should be made only if the stool output significantly increases on a milk-based diet. (1)(3)(4)

Minimal or No Dehydration

The ultimate goal for patients who have minimal or no dehydration is to provide adequate fluid intake while continuing an age-appropriate diet. Nutrition should not be restricted. (4) Patients who have diarrhea must have increased fluid intake to compensate for losses and cover maintenance needs; the use of ORSs containing at least 45 mEq Na+/L is preferable to other fluids for preventing and treating dehydration. In principle, 1 mL of fluid should be administered for each gram of stool output. In the hospital setting, soiled diapers can be weighed (without urine), and the estimated dry weight of the diaper can be subtracted. At home, 10 mL of fluid can be administered per kilogram body weight for each watery stool or 2 mL per kilogram for each episode of emesis. As an alternative, children weighing less than 10 kg should be administered 60 to 120 mL (2–4 ounces) of ORS for each episode of vomiting or diarrheal stool, and those weighing more than 10 kg should be fed 120 to 240 mL (4–8 ounces). (1)

Mild to Moderate Dehydration

Children who have mild to moderate dehydration should have their estimated fluid deficit replaced rapidly. Fifty to 100 mL of ORS per kilogram body weight should be administered over a period of 2 to 4 hours to replace the fluid deficit, with additional ORS administered to replace ongoing losses. By using a teaspoon, syringe, or medicine

dropper, small volumes of fluid should be offered initially and increased gradually as tolerated. If a child appears to want more than the estimated amount of ORS, more can be offered. Nasogastric (NG) feeding allows continuous administration of ORS at a slow, steady rate for patients who have persistent vomiting or oral ulcerations. Clinical trials support using NG feedings as a well-tolerated, more cost-effective method associated with fewer complications when compared with IV hydration. This method is particularly useful in the emergency department, where hospital admissions can be avoided if oral rehydration efforts are successful. In addition, a meta-analysis of randomized controlled trials comparing ORS versus IV rehydration in dehydrated children demonstrated shorter hospital stays and improved parental satisfaction with oral rehydration. (1)(4)

Hydration status should be evaluated on a regular basis in the clinical setting to objectively assess the response to therapy and to evaluate the correction of the dehydration. Upon return to the home setting, caregivers must be provided with and must understand fully the instructions containing specific indications prompting their return for re-evaluation and further medical care. (1)

Severe Dehydration

Severe dehydration is characterized by a state of hypovolemic shock requiring rapid treatment. Initial management includes placement of an IV or intraosseous line and rapid administration of 20 mL/kg of an isotonic crystalloid (eg, lactated Ringer solution, 0.9% sodium chloride). Hypotonic solutions should not be used for acute parenteral rehydration. The patient should be observed closely and monitored on a regular and frequent basis. Serum electrolytes, bicarbonate, urea nitrogen, creatinine, and glucose levels should be obtained, although commencing rehydration therapy without these results is safe. A poor response to the initial, immediate treatment should raise the suspicion of an alternative diagnosis, including septic shock as well as neurologic or metabolic disorders. Therapy may be switched to an oral or NG route as soon as hemodynamic stability is accomplished and the patient's level of consciousness is restored. (1)(4)

Indications for Admission

The majority of children who experience acute gastroenteritis can be managed on an outpatient basis.

The decision to admit patients who have acute gastroenteritis must take into account risk factors predisposing to unfavorable outcomes, such as prematurity, young maternal age, lack of immediate and follow-up access to a health-care facility, and other socio-economic stressors. Clinical indications for the management of acute gastroenteritis in a hospital setting are described in the following scenarios (1):

- Intractable emesis, poor ORS tolerance, or ORS refusal.
- Severe dehydration defined as loss of more than 9% body weight.
- Young age (<1 year old), irritability, lethargy, or an uncertain diagnosis that may require close observation.
- Underlying illness that may complicate the course of the disease.
- ORS treatment failure, including worsening of diarrhea and dehydration despite appropriate administration of ORS.
- Concerns regarding adequate care at home by caretakers.

Limitations of ORS Therapy

There are several clinical settings in which oral rehydration therapy is contraindicated. These conditions include the care of children who have hemodynamic instability, altered mental status, and shock in which the use of ORSs can increase the risk of aspiration because of the loss of airway protective reflexes. Likewise, ORSs should not be used in cases of abdominal ileus until bowel sounds are present. In cases of suspected intestinal intussusception, which might present with diarrhea or dysentery, the need for radiologic studies and surgical evaluation may be warranted before considering the use of ORSs. (1)(10)

If the stool output exceeds 10 mL/kg body weight per hour, the rate of ORS treatment failure is higher. However, ORSs should continue to be offered because the majority of patients will respond well if adequate fluid replacement is administered. (1)

For children presenting with persistent emesis, physicians should instruct parents to offer small amounts of ORS; for example, 5 mL with a spoon or syringe every 5 minutes, with a gradual increase in the fluid amount consumed. This technique frequently results in successful fluid replacement and often a decrease in the frequency of vomiting as well. (1)(10)

Pharmacologic Therapy

Antimicrobial Agents

Antibiotics are not indicated in cases of uncomplicated or viral acute gastroenteritis and may actually cause harm. Antimicrobial agents may increase the risk of prolonged carrier stage and relapses in nontyphoid *Salmonella*

infections. Furthermore, treating gastroenteritis due to Shiga toxin producing *Escherichia coli* with antibiotics may increase the risk of hemolytic-uremic syndrome. The use of antibiotics is reserved for the treatment of acute enteritis complicated by septicemia and in cases of cholera, shigellosis, amebiasis, giardiasis, and enteric fever. (1)(2)(3)

Antidiarrheal Agents

Antidiarrheal drugs are not recommended for routine use because of the risk of their adverse effects. Antimotility agents, such as loperamide, are known to cause opiate-induced ileus, drowsiness, and nausea in children younger than age 3 years. Conversely, agents such as bismuth subsalicylate have demonstrated limited efficacy in treating acute gastroenteritis in children. Racecadotril, an enkephalinase inhibitor that decreases the intestinal secretion of water and electrolytes without effects on intestinal motility, has been studied in children in the inpatient setting with promising effects; however, the drug is not yet approved for use in the United States. Further well-designed prospective studies of its efficacy and safety are needed. (1)(2)(3)(10)

Antiemetic Agents

The desire to alleviate vomiting arises from the need to prevent further dehydration and to avoid the need for IV therapy and subsequent hospital admission. Ondansetron, a selective serotonergic 5HT3 receptor antagonist, has shown to be an effective antiemetic agent, decreasing the rate of admissions in patients treated with a single dose in the emergency department with few adverse effects reported. (11)(12)

Older generation antiemetics such as promethazine, a phenothiazine derivate with antihistamine and anticholinergic activity, have been found to be less effective in reducing emesis. Promethazine is approved by the Food and Drug Administration only for children older than age 2 years and is associated commonly with adverse effects such as sedation and extrapyramidal effects, which may interfere with the rehydration process.

Metoclopramide, a procainamide derivate that is a dopamine receptor antagonist, has been proven to be more effective than placebo, but the rate of extrapyramidal reactions reported in association with its use is up to 25% in children. The use of these medications is not recommended routinely by the AAP or the CDC. None of these drugs addresses the causes of diarrhea, and the use of pharmacotherapy may distract the general care physician away from the mainstay therapy: appropriate fluid and electrolyte replacement and early nutrition therapy. (1)(10)

Supplemental Zinc Therapy

Zinc is an essential micronutrient that protects cells from oxidative injury. In cases of acute or chronic diarrhea, there is a significant loss of zinc due to increased intestinal output. Some clinical trials done in developing countries in which the prevalence of zinc deficiency is high have revealed a potential benefit from zinc therapy in conjunction with ORS therapy. The theory postulates that zinc may improve the absorption of water and electrolytes, although the exact mechanism of action is not understood completely. Studies comparing zinc supplementation with placebo have revealed a reduction in stool frequency and shortening of the duration of diarrhea. The addition of zinc to ORSs is now recommended by the WHO and the United Nation's Children's Fund worldwide for the treatment of diarrheal diseases of children. (2)(13)

Functional Foods

Probiotics are live microorganisms in fermented foods that potentially benefit the host by promoting a balance in the intestinal flora. *Lactobacillus rhamnosus* GG, *Bifidobacterium lactis*, and *Streptococcus thermophilus* are the most common probiotic bacteria studied. Randomized controlled trials have particularly supported the efficacy of *L rhamnosus* GG in the treatment of acute infectious diarrhea, reducing the duration of the diarrhea by 1 day.

When analyzing the different causes of diarrhea, *Lactobacillus* was more effective in treating gastroenteritis caused by rotavirus, with a reduction in duration of diarrhea of 2 days. Probiotics seem to be more helpful when the therapy is started early in the presentation of illness in otherwise healthy patients who have viral gastroenteritis. Prebiotics, on the other hand, are oligosaccharides, rather than microorganisms, that stimulate the growth of intestinal flora. Randomized controlled trials studying prebiotics have failed to demonstrate a reduction in the duration of diarrhea in children; therefore, prebiotics are not recommended routinely. (14)

Summary

- Based on epidemiologic evidence, most episodes of acute gastroenteritis are self-limited, and laboratory investigations should be performed only if the results will influence the management and outcome of a specific patient.
- Based on strong evidence, an adequate history and physical examination allow the clinician to classify the acute diarrheal illness, assess the severity of dehydration, determine whether investigations are needed, and begin the appropriate management.

- Based on strong evidence, administration of ORSs is the preferred method for replacing fluid and electrolyte deficits resulting from intestinal tract losses in children who have acute gastroenteritis.
- Based on strong evidence, rapid reinstitution of an unrestricted age-appropriate diet should be introduced as part of the maintenance phase of treatment.
- Strong evidence suggests that pharmacologic therapy generally is not indicated in cases of acute gastroenteritis, and the use of drugs may complicate the natural course of the disease.

References

1. King CK, Glass R, Bresee JS, Duggan C; Centers for Disease Control and Prevention. Managing acute gastroenteritis among children: oral rehydration, maintenance, and nutritional therapy. *MMWR Recomm Rep.* 2003;52(RR-16):1–16
2. Elliott EJ. Acute gastroenteritis in children. *BMJ.* 2007;334 (7583):35–40
3. World Health Organization. The treatment of diarrhea: a manual for physicians and other senior health workers. Geneva, Switzerland: World Health Organization; 2005. Available at: http://www.who.int/maternal_child_adolescent/documents/9241593180/en/. Accessed February 29, 2012
4. Committee on Nutrition. Oral therapy for acute diarrhea. In: Kleinman RE, ed. *Pediatric Nutrition Handbook.* 6th ed. Elk Grove Village, IL: American Academy of Pediatrics; 2009:651–659
5. Porter SC, Fleisher GR, Kohane IS, Mandl KD. The value of parental report for diagnosis and management of dehydration in the emergency department. *Ann Emerg Med.* 2003;41(2):196–205
6. Gorelick MH, Shaw KN, Murphy KO. Validity and reliability of clinical signs in the diagnosis of dehydration in children. *Pediatrics.* 1997;99(5):E6
7. Steiner MJ, DeWalt DA, Byerley JS. Is this child dehydrated? *JAMA.* 2004;291(22):2746–2754
8. Nager AL, Wang VJ. Comparison of nasogastric and intravenous methods of rehydration in pediatric patients with acute dehydration. *Pediatrics.* 2002;109(4):566–572
9. Steiner MJ, Nager AL, Wang VJ. Urine specific gravity and other urinary indices: inaccurate tests for dehydration. *Pediatr Emerg Care.* 2007;23(5):298–303
10. American Academy of Pediatrics. Statement of Endorsement. Managing acute gastroenteritis among children: oral rehydration, maintenance, and nutritional therapy. Centers for Disease Control and Prevention. *Pediatrics.* 2004;114(2):507
11. Reeves JJ, Shannon MW, Fleisher GR. Ondansetron decreases vomiting associated with acute gastroenteritis: a randomized, controlled trial. *Pediatrics.* 2002;109(4):e62
12. Freedman SB, Adler M, Seshadri R, Powell EC. Oral ondansetron for gastroenteritis in a pediatric emergency department. *N Engl J Med.* 2006;354(16):1698–1705
13. Lukacik M, Thomas RL, Aranda JV. A meta-analysis of the effects of oral zinc in the treatment of acute and persistent diarrhea. *Pediatrics.* 2008;121(2):326–336
14. Thomas DW, Greer FR; American Academy of Pediatrics Committee on Nutrition; American Academy of Pediatrics Section on Gastroenterology, Hepatology, and Nutrition. Probiotics and prebiotics in pediatrics. *Pediatrics.* 2010;126(6):1217–1231

PIR Quiz

This quiz is available online at http://www.pedsinreview.aappublications.org. NOTE: Since January 2012, learners can take *Pediatrics in Review* quizzes and claim credit online *only*. No paper answer form will be printed in the journal.

New Minimum Performance Level Requirements

Per the 2010 revision of the American Medical Association (AMA) Physician's Recognition Award (PRA) and credit system, a minimum performance level must be established on enduring material and journal-based CME activities that are certified for *AMA PRA Category 1 Credit™*. In order to successfully complete 2012 *Pediatrics in Review* articles for *AMA PRA Category 1 Credit™*, learners must demonstrate a minimum performance level of 60% or higher on this assessment, which measures achievement of the educational purpose and/or objectives of this activity.

Starting with the 2012 issues of *Pediatrics in Review*, *AMA PRA Category 1 Credit™* may be claimed only if 60% or more of the questions are answered correctly. If you score less than 60% on the assessment, you will be given additional opportunities to answer questions until an overall 60% or greater score is achieved.

1. A previously healthy 3-year-old boy presents with a 1-day history of a fever up to 39°C accompanied by bloody diarrhea. The most likely explanation of his problem is an infection with

   A. Enteric adenovirus.
   B. *Giardia lamblia.*
   C. Norovirus.
   D. Rotavirus.
   E. *Shigella dysenteriae.*

2. A previously healthy 15-month-old girl vomited twice this morning. She has not vomited since but has now experienced three episodes of profuse watery diarrhea. She has been afebrile. On examination, she refuses fluids but is alert. The following are normal: bowel sounds, capillary refill, heart rate, and respiratory rate and effort. If the clinician draws a blood sample to check a basic metabolic panel, he would expect to find:

   A. A normal profile.
   B. Significantly elevated blood urea nitrogen.
   C. Significantly elevated serum potassium.
   D. Very low serum bicarbonate.
   E. Very low serum potassium.

3. Optimal *initial* management of the 15-month-old girl described above requires

   A. Ad lib sports drink with electrolytes.
   B. An intravenous bolus of normal saline.
   C. As much dilute apple juice as tolerated.
   D. Oral ondansetron every 4 hours.
   E. 6 ounces of commercial oral rehydration solution for each diarrheal stool.

4. This same patient does not vomit again; hence, small frequent feedings of oral rehydration solution are not required, although her watery diarrhea continues. Optimal nutritional management of the diarrhea now requires

   A. Avoidance of breastfeeding.
   B. Complete bowel rest.
   C. Limitation of protein intake.
   D. Resumption of an unrestricted regular diet as tolerated.
   E. Routine use of a special lactose-free formula.

5. Aside from appropriate fluids and nutrition, the BEST way one can shorten the course of diarrhea and promote recovery of this child is by giving her oral

   A. *Lactobacillus rhamnosus.*
   B. Loperamide.
   C. Metoclopramide.
   D. Ondansetron.
   E. Trimethoprim-sulfamethoxazole.

Acute Gastroenteritis

Deise Granado-Villar, Beatriz Cunill-De Sautu and Andrea Granados

Pediatrics in Review 2012;33;487
DOI: 10.1542/pir.33-11-487

Acute Gastroenteritis

Deise Granado-Villar, Beatriz Cunill-De Sautu and Andrea Granados

Pediatrics in Review 2012;33;487
DOI: 10.1542/pir.33-11-487