Dehydration in Outpatients: Assessments, Risks and Treatment Options

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Upon successful completion of this article, the pharmacist should be able to:

1. Describe the mechanisms of electrolyte and mineral imbalance that cause symptoms of dehydration.
2. Assess dehydration symptoms in outpatients as mild, moderate, or severe according to case-based representations.
3. Identify specific acute and chronic risk groups who require special counseling to prevent dehydration, and explain why these patients are at risk.
4. Compare available oral rehydration solutions with simple fluid replacement (such as water or juice) in terms of World Health Organization-recommended electrolyte and mineral composition.

Upon successful completion of this article, the pharmacy technician should be able to:

1. Identify the electrolytes and minerals involved in dehydration symptoms.
2. List the symptoms that result from mild to moderate dehydration.
3. Name three patient populations who have higher risks of dehydration (and explain why).
4. Explain why oral rehydration solutions are preferred for hydration therapy versus simple fluids like water.

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Hydration, or the body's fluid level, affects well-being and physical health as well as recovery from body stressors. Although health professionals frequently consider hydration needs in relation to diseases like cholera, which are prevalent in non-industrialized countries, dehydration is a common complication in many U.S. populations also, causing symptoms through electrolyte imbalance. Acute and chronic reasons for dehydration should be considered in key populations, including (but not limited to) athletes, infants, and the elderly. In these and general outpatient populations, pharmacists aware of symptoms that signal electrolyte and fluid imbalances can address hydration needs appropriately to prevent severe consequences. When mild to moderate dehydration is detected, oral rehydration solutions may be the first products recommended to restore adequate fluid volume and an electrolyte and mineral balance.

INTRODUCTION

Maintenance of the body's fluid content is one of the body's most basic functions, but is also highly specific. The volume of fluid in the blood vessels must remain constant to support safe and efficient actions in the organ, muscle, and even cellular levels. The mechanism of homeostasis, or steady-state balance, that maintains adequate hydration for the body, therefore, is sensitive and complex; fluid regulation relies on proper activity in the nervous, renal, and gastrointestinal systems, as well as hormonal influences from the pituitary and adrenal glands. Water's crucial roles in the body include temperature regulation, composition of bodily secretions, transportation of oxygen, waste removal, lubrication of joints, and more. Overall, 50 percent to 65 percent of a person's total body weight is water. Although it is an often overlooked clinical measure, hydration status can reflect acute bodily stress and uncontrolled chronic disease, and an imbalance in hydration can easily cause acute adverse effects and irreversible long-term damage. A fluid deficit (hypovolemia, or dehydration) occurs in outpatients across a wide range of ages and conditions and is observed more often than excess (hypervolemia, or overhydration).

The hydration status maintained at a steady state, called euvolemia, refers to the measured amount of total fluid volume throughout the body. Gastrointestinal (GI) fluid loss is one of the most renowned causes of hypovolemia and dehydration worldwide, predominantly as a result of documented historical and ongoing third-world cholera outbreaks. GI-related fluid loss can be especially difficult to treat, because fluids often are lost again through vomiting or diarrhea immediately upon replacement. However, dehydration from other, non-GI causes remain prevalent, even in industrialized countries. Patients and health professionals often are surprised to learn that dehydration is a concern in the 21st century, even in the United States. Because of this low awareness, dehydration symptoms can be difficult to identify, and thus treat, especially in outpatients.

Fluid and Electrolyte Balance Basics

The body's fluid is dispersed unevenly through the blood, intracellular spaces, and extracellular fluid spaces that are comprised of plasma, lymph, and interstitial spaces. For example, a 150-pound man has approximately 40 L of total body water with approximately 25 L found inside cells, approximately 7 L in interstitial spaces, and approximately 10 percent of the total (almost 4 L), in blood. Additionally, fluid comprises different proportions of our body weight: blood is 80 percent fluid, muscle is 70 percent fluid, and fat is only up to 25 percent fluid.

The homeostatic system that maintains fluid volume acts without conscious effort. Water is absorbed primarily through the digestive tract to contribute to the total body volume. The kidneys adjust urine output in response to small variations of the intake-output balance to maintain euvolemia. The constant fluid balance involves maintenance not only of blood volume but also of the appropriate concentration of electrolytes: the minerals dissolved in the blood that promote proper cell and organ function. Sodium, potassium, magnesium, and chloride are just a few of these important electrolytes.

Sodium, present in the blood and the extracellular fluid, regulates total body water and extracellular fluid concentrations, muscle excitability, nerve function, and cell permeability. Chloride maintains the acid-base balance, contributes to gastric juices, and helps maintain osmotic pressure. Potassium is found mainly intracellularly, and it regulates intracellular water content and cell activity, particularly in muscle cells. In addition, appropriate potassium concentrations in the blood are essential for proper cardiac muscle activity.

Although electrolytes play an important role in maintaining euvolemia, a fluid imbalance can affect the concentration of these vital minerals, too. Both over-hydration and dehydration can change the concentration of these vital minerals and lead to signs and symptoms of organ damage. For example, the central nervous system is particularly sensitive to changes in total body sodium levels, and symptoms of high or low sodium are thirst and neurologic changes, such as confusion. In the presence of hypovolemia (particularly when caused by insufficient intake to replenish fluid loss), hypernatremia can develop, because the total body water volume is depleted relative to the total body sodium content. Reasons for hypovolemia that can lead to high sodium include GI disorders, skin burns, renal disease, and loop diuretics (which inhibit sodium reasbsorption in the nephrons to increase water clearance). Hydration therapy to restore the lost electrolytes and fluid is essential to restore the balance of both.

Dehydration Defined

Dehydration is defined simply as the deficiency in the body fluids and its essential minerals, when loss is greater than intake. Typically, loss is constant every day and is accounted for as urine and feces (1-2 L and <1 L, respectively) and sweat or skin evaporation and respiration (0-1 L). Fluid leaves the

extracellular fluid spaces first and is replaced with normal intake—usually 1-3 L of drinks and up to two liters of food (especially fruits and vegetables) daily. Loss can increase dramatically with exercise, sweat, illness, and more. Dehydration and its symptoms result when loss increases or when intake is reduced, to upset the balance.

Common Causal Factors and Risks

Causes of dehydration range from the overlooked mundane to surprisingly complex reasons. In some areas of the country or in patients unable to care for themselves, water access may be limited. Some reasons for dehydration despite normal intake include extra skin loss through burn damage or sweat; GI loss through diarrhea and vomiting, including excess GI fluid loss as a result of laxative abuse; and genitourinary loss as a result of chronic disease, diuretic products, or additional causes of osmosis in the kidneys.

Common provokers of these losses in any patient include heat or fever (increases sweat to cool the body down), increased activity or high altitudes (increases respiratory loss), medications that increase diuresis (such as caffeine, herbs, antipsychotic agents, or diuretics), and acute illness or chronic diseases. Some chronic diseases associated with poor hydration control are diabetes mellitus, diabetes insipidus, Addison's disease, and chronic kidney disease.

Occasionally, reduced intake alone can lead to dehydration. Underlying clinical causes can override the natural thirst mechanism, which usually triggers increased intake to maintain homeostasis. Elderly patients are most likely to experience a diminished thirst mechanism with increasing age, but some populations cannot achieve adequate intake even with a sufficient thirst trigger. For example, women during pregnancy—apart from nausea and vomiting—experience a shift in body fluids and an increased fluid requirement that can remain unaddressed. Likewise, elderly patients with dementia or any patient unable to maintain personal care are at risk of malnourishment, including dehydration. Finally, patients of any age may voluntarily reduce their fluid intake because of oral or respiratory irritations, such as canker sores or viral infections.

Some patients warrant extra hydration assessment because of predisposed risk factors related to body size and fluid storage. Fat holds less water than muscle, so obese patients carry more weight in proportion to their total body water content than lean patients. In women, the average smaller total body water content than men results in part because of size differences and in part because women carry more of their weight as fat tissue, which holds less water. When these two populations lose the same volume of water as patients who are leaner or have larger bone and muscle build, they will lose a greater *percentage* of their total body water and will not have as much fluid stored in intracellular spaces to replenish the fluid lost from blood vessels in early dehydration. In elderly patients, the body water content naturally lowers with increasing age, so these patients also have a poorer ability to replenish early fluid loss.

Symptoms

The "homeostatic range" of this highly balanced fluid system is extremely narrow: a net fluid loss of only 1.5 percent is enough to trigger the first symptoms of dehydration, as the body moves fluid from cells into the blood to keep the blood volume constant and maintain blood pressure. The body's first defense against this loss is thirst—with a goal of replenishing that small loss before additional symptoms develop.

However, symptoms of dehydration can develop quickly. For example, during acute gastrointestinal illness, fluid intake simply cannot match the copious losses. Sometimes, adequate intake is prevented by extreme nausea and vomiting. Conversely, mild dehydration symptoms can develop and linger for weeks or longer when they result from chronic causes, such as pregnancy or underlying malnutrition. Either way, symptoms of dehydration progress along a predictable path, and these symptoms, rather than laboratory electrolyte values, form the basis of a preliminary outpatient diagnosis.

Basic symptoms, in addition to thirst, that are indicative of mild dehydration are fatigue, irritability, reduced alertness, lower urine output, constipation, and headache. The onset of these early symptoms begins with fluid loss of just 1.5-2 percent. Because symptoms can be nonspecific and difficult to isolate and associated with fluid volume, two of the key symptoms used to identify dehydration at this stage are low urine content and dark urine.

As dehydration progresses from mild to moderate, with 3-4 percent loss, worse symptoms develop and more water is moved from cells and extracellular spaces to the blood. Symptoms at this stage progress to reduced skin elasticity, dry mouth, dizziness, muscle weakness, and cramps. Without treatment, moderate dehydration and electrolyte imbalance can lead to increased heart rate, palpitations, lack of sweat, and hypotension. As dehydration continues, tissues dry out, shrivel, and malfunction.

In moderate dehydration, electrolyte concentrations are also altered beyond their homeostatic ranges. Typically, untreated excess fluid loss leads to a lower blood volume. The result is increased electrolyte concentrations, a state known as hyperosmolarity. Hypernatremia in particular can be used to assess a dehydrated state.

Hypernatremia is defined as serum sodium level >145 mEq/L and reflects a total body water deficit relative to sodium content, usually because of inadequate fluid intake or excess loss. Although hypernatremia often reflects moderate or worse dehydration, thirst remains a key initial symptom.

Untreated, dehydration can progress to severe stages, at just 5-6 percent loss. Patients experience hypotension, increased heart and respiratory rates, and fever, progressing to delirium, confusion, seizures, and eventually shock.

Damage to organs, especially the brain, occur during severe dehydration and can be irreversible. Hypernatremia with dehydration can manifest as neurologic symptoms when water leaves brain cells and leads to a hyperosmolar central nervous system setting. In fact, confusion can be the best indicator of severe dehydration.

Although dehydration at mild and even some moderate stages can be reversed with basic water intake for rehydration, symptoms are unlikely to reverse on their own without treatment or with basic outpatient care. Treatment with controlled fluid replacement and identification of the underlying cause are keys to avoiding recurrence. Severe dehydration almost always requires hospitalization and IV fluids to correct volume and mineral imbalances safely. More often, independent pharmacists have the opportunity to intervene in the care of patients who have mild to moderate symptoms—those that bring the patient to the pharmacy but that the patient might not associate with fluid intake or loss.

IDENTIFYING AT-RISK PATIENTS

Identifying patients with mild to moderate dehydration can be a challenge for a pharmacy team member. In addition to the general risk factors outlined earlier (such as elderly age, pregnancy, obesity), certain populations should be monitored closely because of their increased likelihood for hydration imbalance. Focusing on these special populations helps guide the pharmacist's assessment and treatment evaluations. Key groups who warrant extra fluid monitoring because of increased dehydration risks can be easily identified when they appear at the pharmacy by asking open-ended identifying questions. The following cases and discussions will highlight some of the most common examples of elderly, infant, athletic, and midlife populations at the greatest risk of hypovolemia and dehydration.

Elderly Populations

P.G., a 72-year-old patient at your pharmacy, is being treated for hypertension which is well-controlled on his current regimen. About five months ago, P.G. started Aricept for the prevention of Alzheimer's disease progression. His cognitive decline to date has been slight, and he always picks up his refills on time. P.G. lives independently; however, his daughter (a primary caregiver in the past) recently moved from his town to another state for work. When P.G. approaches the counter to pick up his refill and a multivitamin, you notice that his hands are dry and peeling, and that he is slow to respond to your conversation. Could P.G. be experiencing symptoms of dehydration? What are some questions you could ask to ascertain his risk?

Patients older than 65 years of age have multiple important risk factors for dehydration. Along with their overall lower total body volume, the reliability of their thirst mechanism naturally declines with increasing age, raising the risk of insufficient intake to match daily fluid loss. Over time, cumulative loss may progress to a chronic, underlying dehydrated state. Although water intake on a schedule can assuage this trend, elderly patients who live alone may be unable to recognize this fluid need when symptoms are only mild, or may avoid drinking if they have trouble swallowing. Good questions to ask and observations to make about elderly patients who approach you in the pharmacy include the following:

- Do you have a usual routine for meals and drinks?
- How often do you drink glasses of water or juice during the day?
- Does the patient's hair, lips, or skin look dry?
- Are they buying over-the-counter products to treat dry mouth?

Elderly patients who develop acute gastroenteritis also are less likely to increase self-care to maintain fluid balance. When older patients come to the pharmacy with gastric complaints, basic hydration status questions, such as the ones listed above, are warranted.

Elderly populations also experience higher rates of chronic diseases that affect fluid volume, as heart and kidney functions slowly become less efficient. For example, older patients with chronic kidney disease may develop dehydration and hypernatremia when the kidneys become unable to concentrate urine. Patients with chronic kidney disease also can experience an accumulation of urea in the kidneys, which osmotically pulls water out of the blood through diuresis. The typically higher medication burden in the elderly population also complicates dehydration concerns. Drug plasma levels in elderly patients may be affected by the hydration status, because drugs levels in the serum may become more concentrated in dehydrated patients whose kidneys are not sufficiently clearing drugs. Several narrow therapeutic index drugs are more common in elderly patients (such as warfarin, digoxin, or amiodarone). In addition to basic dehydration care for elderly patients, drug assessments to adjust doses during and after treatment for dehydration are warranted.

A less common cause of persistent underlying dehydration in elderly patients who live independently can be mild dementia, which can contribute to a lack of nutritional care and a low awareness of basic needs, including hunger and thirst. These patients often remain untreated until the condition causes morbidity that is severe enough to require hospitalization.

In fact, dehydration causes extensive morbidity in the elderly. Acute, transient, and reversible problems with attention, cognition, and consciousness occur in up to 10 percent or more of elderly hospital admissions. Up to 50 percent of elderly patients can experience delirium during a hospital stay. One of the major causes of this delirium—besides drug or infection—is unnoticed or undocumented dehydration. Initial symptoms specific to elderly patients with underlying malnourishment and related dehydration as inpatients or outpatients include lethargy, a quiet and withdrawn demeanor, or paradoxically hyperalert and agitated states, although this

mechanism of action remains unclear.

You ask P.G. about his daily diet and self-care routine. When questioned, P.G. admits to feeling tired and slow in the past few weeks. He denies hunger or thirst and says that he "eats when he is hungry." He wants a vitamin so that he gets nutrients without worrying about meals. He noticed that he rarely gets up to use the restroom anymore, and he has few visitors to his home. Although P.G. seems tired, he does not seem confused or agitated during the conversation; you suspect at least mild dehydration because of his dry skin, fatigue, and low urine output. In addition, P.G. is likely to have an impaired thirst mechanism and poor self-care, given his dementia and lack of a caregiver. You point out to P.G. the importance of regular fluid intake in staying healthy and avoiding cognitive decline. You suggest immediately increasing fluid intake on a schedule, starting and ending each day with a glass of water, and keeping water bottles available around the house for easy access. You also encourage P.G. to visit his physician to check his electrolytes and evaluate his hydration status more formally.

Very Young Patients

At the other end of the age spectrum, newborns and infants experience a high risk of dehydration symptoms and morbidity. Their total fluid volume-to-body area ratio is quite low compared with adults, and this population cannot share or voice their thirst or other initial symptoms.

The biggest risk of dehydration in this young population occurs when vomiting and diarrhea develop; causing an acute and drastic imbalance from water and electrolyte loss. In fact, in the United States, gastroenteritis remains the biggest cause of dehydration in pediatric patients. In the U.S. pediatric population alone, gastroenteritis caused electrolyte imbalances that led 1.5 million outpatients to seek treatment in 2009. In the same year, dehydration from gastroenteritis alone led to 200,000 hospitalizations and 300 deaths in the pediatric population.

Pediatric complications from dehydration are usually related to low blood sugar (hypoglycemia) and hypernatremia (serum sodium concentrations >145 mEq/L, just as in adults). Although serum sodium levels may be measured in children at risk for dehydration, outpatient evaluation to identify a child who is dehydrated often relies first on clinical questions and a physical examination.

Physical signs of mild dehydration in newborns and infants include an abnormal respiratory rate, changes in skin turgor, and skin scaling. However, a few outpatient questions directed at the caregiver also can rule out dehydration despite gastric illness:

- Is oral intake normal?
- Is there no diarrhea?
- Is there still urine output?
- Is there normal tear production during crying?

If the answers to any of these questions (especially the last two) are yes, dehydration is unlikely.

Mid-Life Risk Groups

H.B., age 44 years, is a new patient in your pharmacy. She has transferred medications for year-round environmental allergies and an antidepressant (SSRI); a prescription for oral contraceptives is on hold while she nurses her 4-month-old baby. She admits to frequent dieting and using over-the-counter weight loss pills before her pregnancy and is considering restarting them after she stops breastfeeding. She has a follow-up visit at her health clinic next month, because she had gestational diabetes. You take some time to counsel H.B. on her medications, weight loss, nursing, and diabetes. What hydration-related topics should you point out to her?

Between the very old and very young at-risk populations, certain adult patients who have particular health histories are also at a greater risk of developing dehydration. These key populations should be screened for dehydration symptoms especially when they appear in the pharmacy for other health complaints.

Pregnancy

During pregnancy, women's fluid volumes and distributions change dramatically; blood volume may increase as much as 50 percent. The fluid requirements to maintain homeostasis in themselves, and a growing fetus, increase throughout the pregnancy, and up to 25 percent of a woman's added weight during the last two trimesters can be attributed to fluid. In addition to these basic changes, many women experience bouts of prolonged nausea and vomiting during their first trimester, which increases the likelihood of dehydration. A small percentage of pregnant patients develop hyperemesis gravidarum (HG), a condition of uncontrollable vomiting associated with pregnancy. HG is an extreme form of the anticipated nausea and vomiting of pregnancy, and it can last beyond the first trimester. HG can lead to ketosis, weight loss of at least 5 percent of weight, and dehydration with associated electrolyte abnormalities.

Pregnant patients should be encouraged to drink at least 8-10 glasses of water daily to maintain adequate fluid intake. After delivery, nursing women should drink a glass of water with each meal and with each nursing session, at least.

Acute Trauma or Illness

Acute damage to the skin or any part of the GI tract and oral cavity can negatively affect fluid volume as well. Acute skin trauma that occurs with second- or third-degree burns, or burns that affect a large body-surface area, remove the body's natural protective defense against moistures loss. As a result, more evaporative loss than usual, in addition to the blood loss associated with the damaged skin, quickly leads to dehydration.

Similarly, acute illness or damage in the mouth or throat makes patients of any age less likely to eat or drink to maintain intake. Examples include a sore throat from bacterial and viral infections, cold sores and canker sores that limit food intake, and acid reflux damage that limits food intake. These patients should be educated about the importance of scheduled fluid intake during acute illness to counter dehydration risks.

Chronic Diseases

Diabetes

Blood glucose has a unique role in the mechanism of dehydration. Osmotic pressure leads to diuresis of fluids which follow glucose out of the blood and intracellular space into the kidneys. In uncontrolled or undiagnosed diabetes, excess glucose (typically > 180 mg/dL) is cleared by renal excretion. Polyuria is often a symptom of undiagnosed diabetes mellitus and poses the greatest risk of dehydration, when extremely high glucose concentrations may develop without being addressed. Diabetes-related dehydration is one of the most common causes of hypernatremia in adults; the fluid movement into the kidneys and high urine output dehydrates intracellular fluid compartments and leaves the total body water hyperosmolar (with a high sodium-to-water ratio in the serum). An added risk occurs when serum sodium levels do not accurately reflect hypernatremia, because water moving from intracellular fluid to the blood also floods the extracellular spaces.

Patients already diagnosed with diabetes or insulin insensitivity should pay extra attention to changes in thirst or urination, because increases in these two markers are signs that blood glucose concentrations might be high, causing early symptoms of dehydration.

Mental Illness

Adults with mental illnesses who are not stabilized on a treatment program may refuse food, water, or medication when hospitalized for their conditions. As outpatients, adults with bipolar, depressive, and manic conditions may be less likely to maintain their basic needs, and those with obsessive disorders may be unable to perform adequate self-care tasks in a timely manner. In some cases, patients with mental illnesses may not be able to recognize basic triggers, such as the thirst mechanism. For patients who are diagnosed with mental illnesses, evaluation of their daily routine should include a focus on their food and water intake, at least.

Nutritional Choices

Alcoholism

Social drinking and alcoholism, in addition to or as a primary mental health condition, have the propensity to induce dehydration. Although the volume of fluid intake might be adequate for euvolemia or even excessive from alcoholic drinks, alcohol inhibits antidiuretic hormone, leading to increased diuresis and urination, worsening fluid loss. In addition, alcoholic fluid intake does not provide the necessary electrolytes required to maintain homeostasis. Dehydration associated with binge drinking of alcohol may be compounded by nausea and vomiting that occurs when toxic levels of alcohol irritate the gastric lining.

Dieting

Adults with chronic conditions are more susceptible to hydration imbalance. However, even healthy patients who diet increase their risk of fluid problems. In particular, low-carb diets are associated with dehydration, because fluids are stored and carried into the body together with carbohydrates. When carbohydrate intake is restricted, fluid intake also suffers. Therefore, moderate amounts of carbohydrate intake can increase absorbed water amounts and prevent dehydration during dieting.

Medications and Supplements

Finally, numerous drugs, supplements, and herbs can induce dehydration either intentionally or as an adverse effect. These products often are initiated during midlife to treat or prevent common conditions such as weight gain, high blood pressure, or allergies. For example, OTC weight loss pills may contain stimulants that increase urine output. The risk of medication misuse leading to dehydration is especially high because patients are likely to self-medicate for long time periods with these nonprescription products. Particular attention should be made during counseling to question the patient about the use of OTC drugs or herbal supplements for dieting, allergies, and more.

Prescribed medications also may contribute to dehydration and its symptoms by increasing urine output intentionally or unintentionally. Diuretics (for example, loop diuretics such as furosemide) and antihypertensive drugs that combine diuretics with other agents to reduce blood pressure or control symptoms of congestive heart failure can remove too much fluid over a prolonged treatment period. Some antipsychotic agents also contribute to dehydration by increasing urine output as a side effect of their intended use. When patients are otherwise healthy, the risk of fluid imbalance is easily overlooked. However, the long duration of treatment for cardiac conditions and psychotic disorders increases the risk of an underlying fluid imbalance. Prescription or OTC antihistamines may mask early symptoms of dehydration (such as thirst) because of their primary mechanism of action, which inhibits gastric secretions, saliva, and sweat.

Chemotherapy treatments also increase the likelihood of dehydration, both from excess loss and inadequate intake. Patients can experience nausea and vomiting side effects that establish mild dehydration; the loss can be compounded by poor fluid intake because of chemotherapy-associated

diminished appetite, mouth sores, and mucocutaneous fungal infections like thrush.

A number of dietary supplement products contain caffeine or other stimulant chemicals, such as taurine and ephedra. In addition to energy drinks, coffee, and sodas, diet and energy pills are common sources of caffeine-related chemicals that might be stocked in your pharmacy. These products contribute to dehydration by increasing urine output. Similarly, herbal products used for dieting or to reduce bloating typically rely on diuretic activity. Common examples to avoid are parsley, celery seed, watercress, and dandelion.

H.B. has numerous acute and chronic risks for underlying dehydration. In addition to her underlying risk for common overlapping symptoms, such as thirst, from chronic antihistamine use, H.B. is at risk for poorer self-care because of her history of depression. Her past dieting and OTC drug use are risk factors for dehydration that could become relevant again if she resumes either a low-carb diet or a stimulant weight-loss product. Her recent pregnancy and current nursing status both increase her fluid requirements as well. Finally, H.B.'s history of gestational diabetes puts her at risk for undiagnosed hyperglycemia and diabetes after her pregnancy, which can increase urine output and lead to dehydration.

You point out to H.B. the multiple reasons that her fluid volume could be low and explain that increasing fluid intake will improve her energy and weight loss (because thirst is often mistaken for hunger that leads to overeating), and it will protect her from dehydration if she does develop high blood sugar during her postpartum state. If H.B. affirms that she experiences thirst, low urine output, or other signs of dehydration now, you should recommend hydration therapy options and suggest that H.B. follow up about her hydration and electrolyte status at her upcoming clinic visit.

Athletes

E.J. is a 24-year-old university student whose family regularly uses your pharmacy. When E.J. is back at home on a school break, he stops in to ask about vitamins, while he is carrying a large sports drink bottle that has been refilled with a cola product. You are aware that E.J. was on his high school golf team, but you learn today that he has joined the university's cross country program as well. He is training for the upcoming relay meets and wants to increase his energy. Do you have concerns about E.J.'s hydration today or in the future? What suggestions can you give him as he increases his physical activity?

A sometimes surprising cause of symptoms from dehydration is exercise, because increased activity naturally increases fluid loss as a result of increased sweat, increased respiratory rate, and higher-than-usual energy loss. Therefore, athletes who are traditionally viewed as fit individuals are actually at a great risk for volume flux and improper fluid and electrolyte replacement to offset their greater losses.

The intensity, frequency, and duration of physical exercise all affect hydration status. Athletes performing short, intense workouts can rapidly develop moderate dehydration and hypernatremia. Increasing the intensity of workouts can rapidly increase carbohydrate metabolism, with its associated water loss. People who exercise multiple times per week also should be aware that fluid loss will accumulate during the week, thus greater fluid intake likewise should continue throughout the week to offset the extra loss.

Endurance athletes, such as cross-country runners, risk dehydration in another way, by slowly failing to maintain fluid intake during the prolonged activity. In these particular settings, athletes also can risk drinking too much water to compensate for their endurance sport without also replacing electrolytes, putting them at risk of hyponatremia, during which cells and brain tissue swell with extra water.

Pharmacists can counsel any athletic patient to increase fluid intake even more during outdoor physical activity on warm days, which carries additional risks of fluid loss because of hotter ambient and body temperatures.

E.J. is an apparently fit young adult, but he risks developing dehydration by not preparing adequately for his new exercise routines and meets, which are more intense than his past physical activity. You can suggest to E.J. that intense and endurance sports activities in particular require increasing fluid intake before, during, and after exercise to prevent dehydration and provide optimal energy. You also counsel E.J. that intense exercise outdoors increases fluid loss even more. When E.J. seems interested in learning more about how to stay hydrated as he prepares for, participates in, and ends his cross country meets, you also recommend replacing caffeinated and sugary cola products with water or with appropriate serving sizes of sports drinks that replenish electrolytes without the added stimulants and sugars.

HYDRATION TREATMENT

The treatment for dehydration sounds simple: rehydration. However, treatment options vary even within this basic premise. The goals of rehydration are to restore the circulating blood volume first, then to replace the interstitial fluid volume, and finally to maintain the fluid balance (euvolemia). During therapy, the rehydration treatment of choice should replace continuing losses during fever, ongoing diarrhea, or exercise. Ultimately, the patient should resume a normal diet.

One complicating factor during the restoration of euvolemia is the maintenance of isotonicity: the osmolarity of the water, or the proportion of its electrolyte contents. Isotonic body fluid contains 200 to 320 milliosmoles (mOsm) of electrolytes per kilogram of water. Any rehydration therapy should strive to rebalance electrolyte concentrations as well as total body volume.

Outpatient treatment options for mild to moderate dehydration can be broken down into three potential fluid cate-

gories: water, sports and energy drinks, and oral rehydration solutions (ORS). Although intravenous fluids to treat severe dehydration rely on precise measures of electrolyte osmolar quantities and proportions, outpatient treatment initially is less specific and does not involve laboratory measures of serum electrolytes. Instead, outpatient treatment and evaluation rely on physical signs of improvement.

Water

Water is considered the most basic fluid replacement, of course, but is sufficient only for very mild dehydration, because it does not contain electrolyte replacement. Water is the best option for the prevention of dehydration, though, and for the maintenance of euvolemia after other types of hydration therapy. Additional benefits of water are its lack of calories, sugars, or herbal stimulants (such as caffeine).

Indirect sources of water in the diet include broths, fruit and vegetable juices, and herbal teas. Although these products are predominantly water and do contribute to fluid intake goals, they contain many other ingredients in non-standardized quantities that can affect a patient's health. For example, broths and juices may contain high amounts of sodium or sugar, respectively, which can disrupt electrolyte levels or pull water into the urine; conversely, fluid replacement with clear sodas may not contain a sufficiently proportional amount of sodium. Caffeinated drinks of any kind also increase urination, making them a double-edged sword in the treatment of even mild dehydration. Moderate caffeine intake (defined as 200 to 300 mg or 2-4 cups of coffee or tea daily), though, is considered acceptable daily use for adults.

An example of a current recommendation for intake is, for most people, six glasses of fluid daily (6-8 ounces each) in addition to intake of foods that have high water volume content. Examples of these foods are watermelons, tomatoes, and lettuce. All food and drink in a day contribute to the total fluid intake, even when they also carry a detriment (like caffeine). It is important to remember that individual fluid needs vary slightly, so one patient's baseline may be more or less than six glasses of fluid daily. Thirst and hunger, which can be mistaken for thirst, is the primary way to base the decision to adjust intake above or below these basic recommendations. If any reasons for a higher risk of dehydration exist, though, a higher baseline should be considered. Generally, if the patient's urine remains light to colorless, hydration can be considered sufficient.

Sports and Energy Drinks

Sports drinks, such as Gatorade, are marketed to athletes, especially because of their need to replenish minerals, not just fluid volume. These products offer nutrients including, most commonly sodium, chloride, potassium, and useful calories. However, they are often high in sugar and may contain added sodium or caffeine without advertising these ingredients clearly. Also, their electrolyte content is often insufficient to meet the needs of endurance athletes. Although sports drinks can be used during fevers, vomiting, and diarrhea to replace electrolytes, they are not intended for this purpose, and their osmolar content is not formatted specifically to fit these needs. However, any dehydrated patient, especially when vomiting persists or when actual intake is lower than perceived, can consider sports drinks instead of water for fluid maintenance.

Sports drinks are probably most useful in healthy, hydrated individuals during high-intensity exercise, which burns calories and carbohydrates rapidly, especially if it lasts for more than one hour. The carbohydrate calories in these drinks can prevent hypoglycemia during an intense workout, and the added electrolytes can maintain healthy activity longer than just water. However, sports drink intake should be dosed more carefully than water intake. For example, sports drinks serving sizes should be checked before use and the optimal hourly intake during exercise should remain capped at 60 g of glucose. Also, patients should use sports drinks that do not contain caffeine and should note the sodium content, which may differ significantly between brands. Patients with hypertension, for example, should select a sports drink that contains lower sodium content. Conversely, endurance athletes, who risk over-hydration that induces hyponatremia, should be more attentive to the sodium content of their sports drink and of their total fluid intake during exercise. A general guideline for these athletes is to drink no more than 400 to 800 mL/h of sports drinks, a rate that can prevent dehydration without adversely lowering sodium levels.

Just as there are no basic daily intake guidelines that fit every person, there are no one-size-fits-all recommendations for exercising and fluid intake. In addition to checking urine color, patients can observe the American Council on Fitness guidelines for basic water intake during moderate to high intensity workouts:

- Drink up to 20 ounces of water 2-3 hours before exercising.
- Drink 8 ounces approximately 30 minutes before exercise, or during the warm-up period.
- Drink up to 10 ounces of water every 20 minutes of exercise.
- Drink 8 ounces of water within 30 minutes of completing exercise.

Energy drink products (large volume or 2-ounce shots), are distinct from sports drinks, both from advertising and food content perspectives. Energy drink products are not recommended to prevent or treat dehydration or to rehydrate after physical activity. These products are predominantly caffeine and related stimulants, such as guarana and taurine, that are intended to give the body a short-lived jolt. These are marketed to adults who are healthy and want a "pick me

up," not to those trying to stay hydrated. In addition to their stimulant ingredients, energy drinks often have high sugar levels and are considered particularly unsafe in pediatric and teenage populations.

Examples of Energy Drink Products
Amp
Monster
Red Bull
Rockstar
5-Hour Energy

Oral Rehydration Solutions: Optimal Fluid and Electrolyte Replacements

Depending on the extent of dehydration, replacement might need to address not just fluid deprivation but also electrolyte imbalances. At this stage, water and sports drinks are not sufficient outpatient treatment options. Instead, oral rehydration solutions (ORS) should be recommended according to approved labeling and expert guidelines.

Oral rehydration solutions act as a standardized replacement of water and essential electrolytes and are recommended for rehydration therapy by the WHO, the Centers for Disease Control and Prevention (CDC), and the American Academy of Pediatrics (AAP). ORS products are available worldwide, are simple to use, are affordable, and have little to no complications or drug interactions. In general, ORS can be initiated more quickly than IV therapies and can be re-administered as necessary at home or in any doctor's clinic. Even patients who receive ORS during a hospitalization or ER visit experience benefits of oral, versus intravenous, therapy: parents are more satisfied with care, care is non-invasive, ER stays are reduced, and prolonged hospital stays are avoided.

The WHO, CDC, and AAP recommend ORS for mild to moderate dehydration in children with any cause of gastroenteritis. There is no apparent difference in the efficacy of IV fluids or ORS for treatment of mild to moderate dehydration and electrolyte loss. In fact, ORS was established as equally effective as IV fluids in pediatric patients with gastroenteritis after four hours of therapy.

ORS History

ORS products were first developed in the 1960s, but the anecdotal use of minerals and water to replace fluids lost during GI illnesses has been noted for centuries. In the 1960s, clinicians observed that glucose increased the absorption of water from the intestines of patients with cholera-related diarrhea. During a cholera outbreak, patients who drank only water often lost the same amount of fluid through diarrhea (sometimes up to 1,000 mL/hour); hence treatment with water simply increased diarrheal volume but did nothing to restore blood or intracellular volume. With the administration of glucose with water, morbidity and mortality from acute diarrhea in children has been reduced drastically, from 5 million before effective rehydration to only 1.3 million after implementation of ORS. The oral rehydration salts advocated for the treatment of cholera-related diarrhea eventually has become used for numerous GI conditions, including rotavirus and traveler's diarrhea, globally.

Because of its success, low cost, and ease of use, ORS became a cornerstone of the antidiarrheal treatment plan in the 1970s, improving health across the globe. However, use of this simple treatment option still lags in the U.S. In 2003, the Food and Drug Administration deemed ORS an OTC product that is regulated as a food under the Food, Drug, and Cosmetic Act. Along with powdered packets, premixed liquid formulations, which are shelf stable, have become popular in the U.S.

The preferred products in the 1990s used dry packets that had osmolarity as high as 300 mOsm and sodium content as high as 90 mM/L. However, ORS products with such high osmolarity are unable to stop diarrhea and reduce fluid loss. Today's products, substantial revisions of the 1990s efforts, are called low-osmolarity formulas and average 245 mOsm/L, approximately 13.5 G/L glucose, and 75 mEq/L sodium. The new formulas minimize the risk of high stool output in children that occurred with earlier formulations, and they are associated with lower vomiting rates as a side effect.

ORS Mechanism of Action

The premise of ORS is osmosis of water with solutes (such as glucose). Glucose provided in the product with water increases the absorption of both water and sodium across the small intestine and into the body, thus increasing the volume of retained fluid more than water alone, even during ongoing diarrhea and vomiting, when water alone would pass directly through the intestines too quickly for absorption. An ORS product with a sodium/glucose ratio of 1:1 is sufficient to increase the absorption of electrolytes in the intestine, which then increases water absorption across the intestinal lumen into cells. A glucose concentration of just 50 mM increases jejunal sodium absorption 4-fold and water 6-fold; the same glucose concentration increases sodium and water absorption to 3-fold each in the ileum.

Ideal and Current ORS Features

Hyperosmolar glucose formulations (concentrated fluids with sodium and glucose) are still considered the best options for the most absorption of water, although the actual content of carbohydrates and sodium have been adjusted over time. The 2014 WHO-UNICEF recommended composition of ORS contains 75 mM glucose, 75 mM sodium, and 10 mM citrate (often sodium but may be potassium in some brands), to make a 245 mOsm product. This osmolar concentration is recommended for both adult and pediatric patients.

Ideally, ORS doses maintain a carbohydrate/sodium ratio of 1:1 and contain 20 mEq of potassium. Most ORS products use a carbohydrate that absorbs and carries the water and minerals. Although glucose forms are traditionally the primary carbohydrate source, rice starches are common in some marketed products, and other starch additives (such as from corn) have been used in experimental ORS products. The goal of these starch-based products is to improve the colonic absorptive capacity without increasing the glucose content. Marketed rice-based products may be certified as gluten free, for patients with severe gluten sensitivity or celiac disease.

ORS Doses

Unlike water or sports drinks, ORS products are designed to replace specific quantities of electrolytes plus a standardized carbohydrate quantity. However, though WHO defines specific osmolar concentrations for the use of ORS in the treatment of cholera, particularly in third-world countries, ORS products for use in the U.S. are typically dosed by fluid volume according to age, level of dehydration, and response to therapy. Most available dosage recommendations focus on children with an acute GI illness; general recommendations exist for older patients as well.

For acute mild to moderate dehydration in children or adults, WHO recommends the following quantities of ORS within the first four hours of the onset of dehydration, by age:

- 2-4 year olds: 800 to 1,200 mL
- 5-14 year olds: 1,200 to 2,200 mL
- Adults age 15 years and older: 2,200 to 4,000 mL to replace lost fluids. However, these doses can vary according to the level of diarrhea and its cause, which changes the sodium content in the stool.

The AAP suggests more specific guidelines for children during and just after acute vomiting or diarrhea from gastroenteritis:

- For mild dehydration, use 50 mL/kg over four hours, by spoon, cup, or oral syringe. This works out to a rate of 1 mL/kg every five minutes, as tolerated, and can be performed at home, resuming 30 minutes after any episode of vomiting. After four hours, if urine output is normal, maintenance and loss-replacement with ORT every two hours for up to the next 24 hours is acceptable.
- Treatment of moderate dehydration follows a similar pattern with higher volumes: ORT over four hours should begin at 100 mL/kg, and should be initiated with a health professional at first (such as clinic, office, or ER) before continuing treatment at home. Maintenance at home should still be given every two hours. However, if vomiting persists, with an estimated loss of 25 percent of the hourly administered ORT volume, then the treatment is considered unsuccessful, and the patient should be taken to the ER for consideration of severe dehydration and intravenous fluid treatment. After euvolemia is restored, pediatric patients are encouraged to resume eating, which can assuage diarrhea.

Although a highly specific dosing algorithm, developed by Holliday Segar, is available to calculate exact ORS quantities in children, it is more frequently used for inpatient hydration therapy and severe hydration. Outpatient ORS dosages may be simplified for patients as follows: for mild to moderate dehydration: give 1 ounce per hour in an infant, 2 ounces per hour in a toddler, and 3 ounces per hour in older kids. For ongoing loss, an estimate of 10 mL/kg for every loose stool, or 2 mL/kg for every episode of emesis, can be a simple dose for parents to follow.

With regular physical activity, athletes should observe the following guidelines from the American College of Sports Medicine and the American Dietetic Association:

- Replacement recommendations during sports include 0.5 to 0.7 g of sodium per L of fluid intake during a 2-3 hour activity, in part to replace sodium and in part to increase the urge to drink. Sodium requirements can increase over longer activity, to 0.7 to 1.2 grams/L.
- Fluid replacement should begin before exercise: at 2-4 hours before, individuals should drink 400 to 600 ml of water, which can lower the heart rate during exercise and delay or prevent dehydration during physical activity.
- During exercise, fluid replacement should reach up to 1 L of isotonic fluid every hour; to achieve this, individuals should maintain intake of 150 to 350 mL (6-12 ounces) three times per hour during activity.
- All recommended fluid intake should increase if exercise takes place outdoors on very hot days.

ORS Products

Commercial products today in the U.S. typically contain 50 mEq/L sodium (less than the 90 mEq/L recommended by WHO for cholera-specific loss but near the approximate loss of sodium that occurs during a rotavirus infection, for example). Also, these products usually contain approximately 25 g/L dextrose, to avoid hypoglycemia in infants, and 30 mEq/L of sodium bicarbonate to reduce vomiting and to correct a potential acidosis in the small total body water volume. The different available ORS products aim to provide tolerability (by taste, texture) and ideal efficacy in different delivery vehicles. Examples include Pedialyte, Ceralyte, Recover ORS, Normalyte, and H2ORS; variations are slight and often center on the form of carbohydrate used.

ORS Cautions

The negative characteristics of ORS products are few, but can be prohibitive. Poor taste is a significant reason that patients avoid these treatments, and limited selection or availability in the pharmacy also may be a problem. Also,

Table 1: Basic Composition of Common Hydration Therapy Options				
Product	**Carbohydrate**	**Sodium (mEq/L)**	**Osmolarity (mOsm/L)**	**Distinguishing Characteristics**
Water	0	0-10	0-18	Low cost, often readily available
Standard WHO formula	20 G/L glucose	90	310	Easy-to-store packets
Low-osmolarity WHO formula	13.5 G/L glucose	75	245	
Apple Juice	Fructose, glucose, sucrose	3	680	Pleasant taste, widely available in stores
Tea	0	0-10	18	Variety of flavors
CeraLyte 70	40 G/L rice starches	70	220-235	Advertised gluten free, easy-to-store single-use packets
DripDrop	33 G/L glucose	60	235	Easy-to-store packets, pleasant taste
Equalyte (Ross)	30 G/L dextrose, oligosaccharides	78.2	290	Ready-to-use
Gatorade	58 G/L fructose, sucrose AND glucose	20	330-380	Widely available in stores, variety of flavors
Pedialyte (Ross)	25 G/L glucose, dextrose, or fructose	45	250	Ready-to-use, low sugar formula
Powerade	High fructose corn syrup	~10	~400	Lower sodium, higher sugar content than some other sports drinks

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cost can be a deterrent to many patient populations, especially those most in need (patients who remain unvaccinated and develop rotavirus).

A small subset of patients should not use ORS without physician supervision. These patients most often have pre-existing chronic diseases:

- Congestive heart failure or other cause of fluid restrictions
- Impaired urine output, such as with kidney diseases and patients on dialysis
- Sodium sensitivity as a result of hypertension
- Severe dehydration (which requires immediate assessment and treatment with IV fluids) or age younger than 1 year (who should be referred to a pediatrician).

Although parenting websites might offer homemade rehydration solution recipes, clinicians should not recommend the use of these products, because preparation errors are high, and the electrolyte and sugar contents can be unreliable.

COUNSELING HIGHLIGHTS

Identifying and treating dehydration in an outpatient setting are valuable but challenging tasks, because symptoms can appear nondescript or unimportant, because patient populations at risk are so variable, and because dehydration is still considered a condition more prevalent in non-industrialized countries.

Because fluid status and balance are so important to overall good health, though, pharmacists should not hesitate to counsel any patient with an identified or even suspected cause of dehydration about healthful fluid and electrolyte intake. This outreach ensures that the recommendations for fluid intake reach every outpatient—from those whose dehydration is a side effect of an acute illness to those who

are experiencing increased urine output of chronic disease, age-related changes in body volume, or adverse effects of drugs or supplements.

ORS products are preferred by patients and providers over intravenous fluid treatment, but awareness of ORS availability, correct use, and its importance in mild to moderate dehydration still remains inadequate. Pharmacists can help by educating patients about when to use ORS, especially in lieu of water or sports drinks, by teaching patients to recognizing progressive symptoms of dehydration (such as dark urine or lack of sweat or tears) as they develop. Also, pharmacists can stock a variety of ORS products in the pharmacy to recommend to these patients during dehydration and as a preventive on-hand measure for high-risk groups.

Basic reminders for patients include the following:

- Drink water when you feel hunger, because that sensation is often mistaken for thirst.
- Remember to drink water before, during, and after a workout of any duration.
- Carry reusable water bottles throughout each day.

More specific recommendations are:

- To select decaf over caffeinated coffee
- To start and end each day with water
- To drink water at restaurants instead of sodas or teas or alcohol
- To follow a water intake schedule, in extreme cases of poor self-care.

Pharmacists also can advise patients to avoid energy drinks or sodium tablets (to retain water) at all times, because there are safer, more effective products. Finally, pharmacists must remember to stock oral rehydration solution products—a cheap, safe, and easy outpatient treatment alternative to intravenous fluids and hospitalization for rehydration in most patients of any age, for the establishment of electrolyte balance and hydrated status after dehydration from almost any cause. ■

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Editor's Note: For the list of references used in this article, please contact *America's Pharmacist* Managing Editor Chris Linville at 703-838-2680, or at chris.linville@ncpanet.org.

Continuing Education Quiz

Select the correct answer.

1. Hydration status involves
a. A constant flux of volume that is evenly distributed throughout the blood and extracellular spaces
b. A constant balance of volume intake and loss from excretions and insensible losses like perspiration
c. Regulation from only the neurologic system
d. Regulation predominantly from the cardiopulmonary system

2. The total body fluid volume ranges from __% to __ % of the body weight, but only __% of this is distributed into fat.
a. 50, 65; 25
b. 50, 65; 10
c. 55, 75; 10
d. 60, 80; 40

3. A regular patient in your pharmacy has developed a viral infection and has a sore throat; she comes to you for cough drop recommendations. In addition, you ask which questions to ascertain adequate fluid maintenance during her acute illness?
a. Have you been drinking one glass of water every 10 minutes?
b. Have you noticed whether your urine is clear to colorless or a darker color?
c. How often do you urinate each day?
d. Two of the above
e. All of the above

4. The patient admits to dark urine, low urine output, and dry skin in addition to the fatigue, headache, and thirst she associated with her cold. She denies confusion and dizziness and states that sweat and tears still occur. Which of the following could you recommend to her?
a. Increase fluid intake by drinking two more cups of coffee every morning.
b. Increase fluid intake by drinking a baseline of at least six glasses of fluid daily and increasing other sources of fluids (such as broths or decaffeinated teas) to replace lost fluid and prevent worse dehydration.
c. Immediately begin a course of oral rehydration solution, maintaining an intake of at least 500 mL each hour.
d. See her physician or visit the ER to be evaluated for severe dehydration.

5. As fluid loss accumulates and causes mild dehydration, liquid in the extracellular compartments are shifted into the ___ to maintain _____ and _____.
a. Blood; cellular volume, blood pressure
b. Cells; cellular volume, osmotic pressure
c. Blood; blood volume, blood pressure
d. Cells; blood volume, blood pressure

6. Sodium is an essential electrolyte for ___ function, but increased concentrations greater than ___ that develop during dehydration can cause ____.
a. Nerve and muscle; 145 mEq/L; neurologic changes
b. Cardiac contractions; 145 mEq/L; myocardial infarction
c. Kidney; 75 mEq/L; kidney stones
d. Skin; 75 mEq/L; scaling

7. Which of the following statements about dehydration risks is correct?
a. Obese patients are at lower risk than lean patients because they have extra body weight and, thus, volume.
b. Women are at lower risk than men because they have fewer chronic health conditions, such as diabetes, that complicate the body's ability to maintain euvolemia.
c. Women have a higher risk of dehydration during pregnancy, because their body volume shifts and fluid needs and gastrointestinal losses both can increase.
d. Infants who are bottle feeding during a rotavirus infection have higher dehydration risks than those who breast feed.

8. A patient comes to your pharmacy to buy bottles of a sports drink and salt pills and mentions his upcoming half-marathon. You overhear him at checkout and intervene with which of the following counseling points?
a. Marathon running is the safest type of exercise, because dehydration is less likely than with weight-bearing exercises performed indoors.
b. Salt pills actually are dangerous to use at any time, because they provide electrolytes without extra fluid to maintain the proper balance of both.
c. Sports drinks may be used to prevent dehydration, and the goal intake to prepare for exercise is no more than 60 grams of glucose per hour.
d. Both b and c
e. All of the above

9. How can undiagnosed diabetes lead to dehydration?
a. Increased glucose in the blood pushes water into the intracellular spaces to lower the serum water level.
b. Increased glucose in the cells pulls water into the intracellular spaces to lower the serum water level.
c. Increased glucose in the blood overflows into the pancreas and leads water there to accumulate.
d. Increased glucose in the blood enters the kidneys to be cleared and water in the blood follows the glucose by osmosis into the urine.

10. A regular patient who is obese by body-mass index measures and has hypertension and heart failure is taking an ACE-I and a loop diuretic. He visits your pharmacy for a diabetes-related blood sugar testing event, and his fasting glucose is 148 mg/dL. Which of the following describe his dehydration risks?
a. Obesity, because fat holds less water than muscle; medications that increase urine output; and hyperglycemia that pulls water into the urine
b. Obesity, because fat holds less water than muscle; medications that increase salt loss without affecting fluid volume; and hyperglycemia that pulls water into the cells instead of the serum
c. Obesity, because fat holds onto water more than muscle does; and medications that increase urine output
d. Medications that increase urine output; hyperglycemia that implies intake of sugary drinks that don't affect blood volume

11. A young mother approaches you to ask for cola syrup, because her 6-month-old child has had vomiting and diarrhea for the past five hours. How can you quickly assess the infant's hydration status?
a. Ask if the baby is still sweating.
b. Ask if the diarrhea volume is more than 500 mL.
c. Ask if the baby still has tears when she is crying.
d. All of the above

12. What do you recommend to this baby's mother?
a. Make a replacement hydration solution at home with cola syrup and ginger ale for sugar replacement.
b. Try giving the baby extra water in a bottle.
c. Give approximately 1 ounce per hour of Pedialyte, as an ORS option.
d. Contact a pediatrician, because her infant is younger than 1 year old.
e. Both C and D

13. Which of the following patients may be most unlikely to maintain euvolemia independently?
a. An adult patient with bipolar disorder who lives alone and has a history of stopping her medications.
b. A pregnant woman who makes it to all of her OB/GYN appointments.
c. An elderly patient living with his daughter and son-in-law as caregivers.
d. An elderly patient with congestive heart failure and chronic kidney disease.

14. Prevention of dehydration during exercise relies on
a. 4 L intake before and 2 L intake after, and no fluid intake during exercise.
b. 500 mL intake before and 500 mL during, but only carbohydrate-heavy foods after exercise.
c. Fluid avoidance before exercise to avoid nausea, and 500 mL each hour during and after exercise.
d. 8 ounces 30 minutes during warm-up times, up to 10 ounces every 20 minutes during exercise, and 8 ounces within 30 minutes after exercise.

15. What are two primary indicators to patients to increase fluid intake before dehydration begins to affect organ function?
a. Light urine and low urine output
b. Confusion and thirst
c. Thirst and low urine output
d. Dark urine and confusion

16. In addition to patients with GI illnesses, what groups might consider ORS use?
a. Chemotherapy-treated patients experiencing nausea, vomiting, and thrush.
b. Patients who train outdoors for a marathon who want to avoid sports drinks.
c. Patients who are pregnant and are experiencing prolonged hyperemesis.
d. All of the above.

17. By the 1960s, when the first standardized ORS products were developed, clinicians were aware that
a. Glucose added to water increases intestinal absorption of water (such as in cholera) better than water alone.
b. Glucose improves the flavor of the water, so people will drink more.
c. Glucose plus water is less likely to induce vomiting than water alone.
d. Glucose is safe for every patient.

18. ORS products currently available are hypermolar products that contain approximately
a. 90 mM sodium and 200 mOsm/L
b. 75 mM sodium and 245 mOsm/L
c. 40 mM sodium and 350 mOsm/L
d. 75 mM sodium and 350 mOsm/L

19. GI loss replacement guidelines by ___ suggest an ORS composition of ___ ___ and a dose replacement volume of ___ for patients age 2-4 years.
a. WHO/UNICEF; 75 mM sodium and 245 mOsm; 800 to 1,200 mL
b. CDC; 60 mM sodium every 2 hours
c. WHO/UNICEF; 40 mM sodium and 300 mOsm; 200 mL/h
d. CDC; 75 mM sodium every six hours

20. Rehydration product options include
a. A concentrated liquid that can be dissolved in larger volumes of water.
b. A powder that can be carried in its packet and used buccally or sublingually.
c. A lozenge for adult athletes to use instead of water during exercise.
d. A shelf-stable, unit-of-use liquid popsicle product that can be frozen to improve taste and compliance.