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**ADVANCED NUTRITION MICRONUTRIENTS**

AIU EXAM:

**NUTRIENTS OF FLUID AND ELECTROLYTE BALANCE**

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## Introduction:

The topic of this chapter is Nutrients and Fluids Involved in Electrolyte Balance. I chose this assignment and this topic because, as a Nutritionist, recently I have been reading a great deal of information about the benefits of micronutrients and their intersection between nutrition and mental and physical health. After reading *The Mineral Fix* by Dr. James Dinicolantio and Siim Land, I became increasingly fascinated by the many ways in which micronutrients interact with and affect each other and the ways in which this impacts our body functions, from sleep to mood, gut health to hydration, prevention and recovery from illness, metabolism, etc.

This chapter speaks to many topics that are relevant to my own health as well as the health of my clients in my Fitness and Nutrition business, such as the importance and function of electrolytes, how they work, and how they can help protect from illness and disease when consumed in appropriate quantities. It begins with explaining how and where fluids are stored in our bodies and the ways in which our body uses electrolytes to function. It discusses the best fluids to consume and considerations for the many ways in which our body uses, balances, and loses fluid. The chapter also discusses several factors and variables involved in ensuring appropriate levels of hydration and electrolyte balance, such as age, sex, health status, weight, fat and muscle mass, duration and intensity of exercise, and the environment in which exercise takes place. It provides helpful examples of athletes and individuals who had inadequate hydration levels, the risk and results, and considerations for avoiding these risks. This chapter defines and discusses various health conditions that can result from over or under consuming electrolytes and the symptoms of each condition.

## Chapter 9 questions:

### 1. Which of the following is a characteristic of potassium?

- a. It is the major positively charged electrolyte in the extracellular fluid.
- b. It can be found in fresh fruits and vegetables.
- c. It is a critical component of the mineral complex of bone.
- d. It is the major negatively charged electrolyte in the extracellular fluid.

### 2. Which of the following people probably has the greatest percentage of body fluid?

- a. A female adult who is slightly overweight and vomits nightly after eating dinner

- b. An elderly male of average weight who has low blood pressure
- c. An overweight football player who has just completed a practice session in high heat
- d. A healthy infant of average weight

**3. Plasma is one example of**

- a. extracellular fluid.
- b. intracellular fluid.
- c. tissue fluid.
- d. metabolic water.

**4. Which of the following is true of the cell membrane?**

- a. It is freely permeable to water and many solutes.
- b. It is freely permeable only to water.
- c. It is freely permeable only to water and fats.
- d. It is freely permeable only to water and proteins.

**5. Which of the following lifestyle changes has been shown to reduce hypertension in all people with high blood pressure?**

- a. Consuming a low-sodium diet
- b. Normalizing body weight
- c. Getting at least 8 hours of sleep nightly
- d. Consuming one to two glasses of red wine daily

**6. True or false?** Drinking lots of water throughout a marathon will prevent fluid imbalances.

**7. True or false?** A decreased concentration of electrolytes in our blood stimulates the

thirst mechanism.

8. True or false? Hyponatremia is commonly caused by a rapid intake of plain water.

9. True or false? Absence of thirst is a reliable indicator of adequate hydration.

10. True or false? Conditions that increase fluid loss include constipation, blood transfusions, and high humidity.

**11. Explain why severe diarrhea in a young child can lead to death from heart failure.**

Responsible for over 500,000 estimated deaths in 2017, diarrheal illness is the second leading cause of child mortality among children younger than five years of age worldwide (GBD, 2017). The biggest complication related to diarrhea is dehydration, especially with young children and those with a weakened immune system. Moderate or severe dehydration puts stress on the heart and lungs (Hopkins Medicine, 2022). Normally, only about 150 to 200 ml of water is lost each day in the feces, however, when someone suffers from a severe case of diarrhea, water loss through fecal matter can increase to as much as several liters per day (p.332). This happens when body attempts to maintain a delicate balance of intra and extracellular electrolytes. When a child experiences severe diarrhea, they lose a great deal of intestinal and extracellular fluid, which causes the extracellular electrolyte concentration to become very high (which the body doesn't like). Resultantly, a large amount of intracellular fluid leaves the cells in attempt to balance this extracellular fluid loss (p. 329). Fluid leaving the cells = dehydration. This imbalance in fluid and electrolytes can cause an irregular heart rate, which can turn fatal.

Extreme diarrhea can also cause hypokalemia which is a condition in which blood sodium levels are dangerously low. Severe cases of hypokalemia can result in fatal changes in heart rate (p. 340).

Importantly, children with acute diarrhea and malnutrition are at increased risk for developing fluid overload and heart failure during *rehydration* (Harris et al, 2021). In these severe cases, it is important to rehydrate following medical best practices.

**12. After winning a cross-country relay race, you and your teammates celebrate with a trip to the local tavern for a few beers. That evening, you feel shaky and**

**disoriented, and you have a “pins and needles” feeling in your hands and feet. What could be going on that is contributing to these feelings?**

There are a number of confounding factors that could be contributing to these feelings. The first factor to consider is whether I drank enough fluid before, during, and after my race. As we know, exercise increases fluid lost through sweat and respiration, so it's likely that I lost more fluids than I anticipated and am experiencing dehydration. If I'm a 160lb adult, I could have lost between 4.8-8L of water during my exercise, which would explain the symptoms of disorientation and tingling extremities (p.344). In addition, if the race took place in a hot environment or if it involved vigorous exercise over an extended period of time, and I had not consumed adequate fluid, that could lead to dizziness, light-headedness, and disorientation (p.345). We also know that alcohol is a diuretic, thus it has likely increased urine output, further exacerbating dehydration (p.332).

**13. For lunch today, your choices include (a) chicken soup, a ham sandwich, and a can of tomato juice; or (b) potato salad, a tuna-fish sandwich, and a bottle of mineral water. You have hockey practice in mid-afternoon. Which lunch should you choose, and why?**

Assuming I am healthy individual with no underlying medical conditions that would impact what I should eat, I would choose option (b). While option (a) would likely be fine in combination with adequate hydration, the meal is very high in sodium in comparison to other electrolytes. Option B contains more of a balance of vitamins and minerals including sodium, potassium, chloride, and phosphorus. Choosing this option would also support a lower sodium (DASH) diet and may prevent or reduce hypertension and could potentially support a healthier bodyweight. If the bread is whole grain, it would also be a source of magnesium along with the fish. The carbohydrates in the potato would help provide an energy source and the protein in the fish would support muscle growth and repair after exercise.

**14. Your cousin, who is breastfeeding her 3-month-old daughter, confesses to you that she has resorted to taking over-the-counter weight-loss pills to help her lose the weight she gained during pregnancy. What concerns might this raise?**

Taking weight loss pills while breastfeeding an infant has implications for both mom and baby. We know that many OTC weight loss supplements consist of diuretic herbs or ingredients, so any resulting weight loss can be attributed to water loss rather than fat loss. Consumption of diuretic supplements can result in levels of fluid loss that can become dangerous (p. 332). To make matters worse, breastfeeding requires a substantial increase in fluid intake to compensate for the loss of fluid through nursing, so adding a diuretic to an individual who already needs to focus on increasing hydration can exacerbate fluid loss. Even if the weight loss pills only result in a small loss in body

water, symptoms such as excessive thirst and loss of appetite can occur. With more significant water loss, symptoms become increasingly dangerous and disruptive and can include sleepiness, nausea, flushed skin, problems with concentration, and even coma, cardiac arrest, and death (p. 343).

In addition to the mother, there are risks to the baby as well. Dehydration can lead to a reduction in breastmilk supply, thus affecting the amount of nutrients the baby receives (Jarlenski et al, 2014). Infants are at an even greater risk of dehydration due to the fact that they cannot tell us when they are thirsty, excrete urine at a higher rate, and have a larger ratio of body surface area to core. For these reasons, they respond more dramatically to heat, cold, and water loss (p. 343).

As mentioned above in question 11, moderate or severe dehydration in children can put stress on the heart and lungs, which can lead to heart failure.

**15. While visiting your grandmother over the holidays, you notice that she avoids drinking any beverage with her evening meal or in the hours prior to bedtime. You ask her about it, and she explains that she avoids fluids so that she won't have to get up and go to the bathroom during the night. "Though I still don't get a good night's sleep," she sighs. Many nights I wake up with cramps in my legs and have to get up and walk around anyway!" Is there a link here? If so, explain.**

There certainly could be a link between Grandma's muscle cramps and the fact that she avoids fluids for several hours preceding her bedtime. We know that elderly people can get dehydrated even when inactive, and their risk of becoming dehydrated is substantially higher than that of healthy young and middle-aged adults. This is due to the fact that the elderly have a lower total amount of water in the body and that their mechanism for thirst is less effective than a young person (p.343), therefore they may not realize how dehydrated they are.

Assuming Grandma only consumes water between 7am-5pm (approximately), it is very likely that she is not meeting her body's hydration needs. When electrolyte imbalances occur, it alters nervous system function, which in turn negatively affects muscle function. This can occur in the form of muscle cramps, which can last for seconds to minutes (p. 348). Sodium and potassium, in particular, work to maintain fluid balance and blood pressure, and assist with muscle contraction and relaxation (p. 340). If these are depleted, it could certainly have contributed to the muscle cramps.

### **Nutrition Debate:**

#### **Sports Beverage – Help or Hype?**

## 1. Are sports beverages smart choices for you? Why or why not?

When we think about sports drinks, we think about professional athletes guzzling from the infamous green Gatorade bottles from the sidelines of their respective sport. Indeed, sports drinks were originally developed for athletes, but have since been marketed as a performance enhancer for the general public. Sports drinks can be considered a “functional food”. As defined by the European Commission, functional food is “a food product that can only be considered functional if together with the basic nutritional impact it has beneficial effects on one or more function of the human organism thus either improving the general physical conditions or/and decreasing the risk of the evolution of disease” (Ozen et al, 2012). The issue most people have is in identifying whether these products are functional *for them*, *when* multi-million-dollar marketing campaigns continue to encourage the consumption of functional beverages, even when they are not needed (Heckman et al, 2010).

I think there is certainly a time and place for sports drinks, but there are number of factors to consider before deciding if it is a smart choice. It’s also important to note that there have been improvements to sports drinks since this text was originally published and there are many more products on the market now that may be more suitable to non-athletes. I will discuss this more below.

When considering whether a (traditional) sports drink is necessary, we need to consider several factors:

- 1) The intensity of the exercise session
- 2) The duration of the exercise session
- 3) The environment/weather/location
- 4) The individual

Studies have shown that electrolytes and glycogen stores may be depleted after 1 hour of intense exercise (Orru, 2018). We know that many professional and amateur athletes participate in intense training sessions that can be several hours long. It follows then that these athletes may indeed benefit from sports drinks as a means of restoring the electrolytes, carbs, and other nutrients that can be depleted during exercise via sweat, breathing, etc (Evans et al, 2017). In the context of intense training, sports drinks can also improve athletic performance and in prevent or assist with certain health conditions (Stachenfeld, 2014).

For me, personally, I do not feel that sports drinks are necessary. As an athlete myself (weightlifting), I engage in workouts 5-6 days per week and each workout consists of weight training for approximately one hour, followed by cardiovascular exercise such as walking, cycling, or using a stair climber machine for approximately 30-40 minutes. Though my workouts are quite long, they are generally only moderately intense, and I ensure to hydrate before, during, and after each workout. The purpose of a sports drink is to provide energy (carbohydrates) and some electrolytes, with the goal of helping an

individual exercise for longer and with less fatigue, and in my case, that is not necessary. That said, I do believe that maintaining electrolyte balance throughout my workouts and the remainder of the day is important for my overall health and wellness, so I ensure to consume electrolytes through my diet and/or through electrolyte powders, which I will discuss more below.

## **2. Why do you think sports drinks are so popular among inactive people?**

I believe that sports drinks are becoming increasingly popular among inactive people for the same reason that any product is appealing to anyone: marketing. Gatorade and other sports drinks are glamorized as exercise enhancers, with professional athletes endorsing their benefits, and advertisements showing very fit, strong, and beautiful fitness models and athletes in magazines, on tv, and on social media. It serves to leave the viewer thinking “wow, if I drink that beverage, I can look/perform like that too!” The concern is that the average consumer does not understand how, why, or if the product works, thus they simply assume if it works for an athlete, it will work for them. With nearly 75% of the American population being overweight or obese (Fryar et al, 2020), consumers are willing to try almost any product that promises a better body, improved health, or increased performance.

The issue with these beverages for the average population is their calorie count. Many traditional sports drinks contain a very high amount of sugar and therefore calories. For example, a bottle of Gatorade’s Frost Glacier Cherry contains 41 g (more than 10 tsps.) of sugar per serving. According to the text, fluids with a high calorie content do not serve to curb the appetite, so most people do not compensate for the extra calories they drink by eating less (p. 348), which could lead to a caloric surplus and consequent weight gain. Importantly, high calorie sweetened drinks like sports beverages replace more nutrient dense food and drink choices such as protein, fruits and vegetables which contain important vitamins and minerals.

In an interview with CBC Marketplace, Dr. Greg Wells, sports physiologist, states “The benefit of getting physically active – [which] improves your body composition, makes you healthier, makes you fitter and all that – that’s fantastic, but unfortunately, drinking sugary, salty drinks actually does the opposite to the average person.” (Griffith-Greene, 2014).

Dr. Wells goes on to say that while sports drinks are widely available, only a small minority of athletes would actually reap any benefits from them. “Eighty-five per cent of Canadians don’t get enough exercise to begin with, so they don’t need sports drinks. The remaining 15 per cent that actually do exercise, you probably have one or two per cent exercising really hard, really intensely enough to really need those sports drinks. In that group, probably a small subset of them are exercising long enough to need it.” (Griffith-Greene, 2014).



### **3. Should registered dietitians and other healthcare professionals discourage overweight clients from consuming sports beverages? Why or why not?**

In general, I feel that dietitians and other healthcare professionals should likely discourage sports drinks to *most* overweight patients (for reasons mentioned above); however, I don't think there is a one-size-fits-all approach and there may be exceptions.

Firstly, an individual being overweight does not preclude them from being an athlete. Indeed, many athletes such as wrestlers, weightlifters, football players, etc., would be considered overweight according to their BMI. Within their intense training and competition, they may be in the small minority of athletes who would benefit from consuming sports drinks. It would be prudent for the healthcare professional to consider the individual's overall health, the type, duration and intensity of their workouts, and the environment in which they exercise (heat, humidity, altitude, etc). For example, the textbook notes the football player named Korey Stringer who died as a result of heat stroke while playing football. Stringer, who was 6'4 and 330lbs, would have certainly fallen into the overweight category. Given the heat, humidity, tight fighting clothing, and dehydration, he likely could have benefitted from fluid breaks before, during, and after the game. Heat illnesses, according to the text, can be avoided by following established guidelines for fluid intake pre-, intra-, and post-workout (p. 345).

Secondly, sports drinks have seen many improvements in recent years. Many sports drinks now contain much lower amounts of sugar or even no sugar at all. Sugar-free sports drinks will not help with energy, of course; however, they may be an appropriate alternative for non-athletes who enjoy consuming them. Likewise, many people struggle to drink enough water in a day, and if low sugar or no sugar sports drinks can increase their fluid intake and prevent dehydration, again, this would be a situation where the benefits outweigh the risks and drinking the sports drinks may be advisable. It may also be beneficial during exercise in people who may have poor glycogen stores due to illness or in individuals who are unable to eat enough solid food prior to exercise (p. 354).

Another option would be for the healthcare professional to consider recommending an electrolyte drink rather than a sports drink. Electrolyte drinks are a newer product to the market, and most are sugar-free while containing a combination of electrolytes. These will provide many of the benefits of a sports drink (muscle contraction, avoiding cramping, maintaining body temperature, mental clarity, preventing mineral deficiency, etc), without the added calories of a sports drink. Electrolyte drinks are typically in powdered form and can be mixed with water. Like sports drinks, they come in many flavours and are easily portable.

## **Conclusion:**

The chapter offers insight into the ways in which our body uses and loses water so that we may apply this information to our own lives to ensure appropriate hydration and electrolyte balance. It addresses common myths and misconceptions about food and drink we may believe is healthy, but could actually be detrimental, such as too much or too little sodium. The chapter provides helpful information for consideration regarding the electrolyte contents in common food and drinks, as well as suggestions for a heart healthy diet. It also highlights the importance of maintaining electrolyte balance, which means we need to consume appropriate levels of hydration through the day and night, before, during, and after exercise. The chapter notes the ways in which our bodies can lose excessive amounts of fluid, such as through sweating, diarrhea, vomiting, and urination, especially during intense bouts of exercise, while at altitude, during illness, in infancy and elderly, and from consuming diuretics. With this information, we can be mindful to make food and drink choices that are appropriate for our health, our lifestyles and level of physical activity, and to address any risk factors.

Overall, this chapter offers valuable information for everyone from infants to the elderly, from inactive individuals to professional athletes, from the healthy to the ill, and demonstrates the importance of fluid balance for health and wellness.

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