Project SEAH

Stop Exercise Associated Hyponatremia: Hyponatremia Education in Marathon Runners

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Introduction

Once reserved for the elite athlete, endurance events, such as marathon and triathlon, have seen an immense increase in popularity since the late 1970’s. The surge in running began in 1979 over the success of the first “big city” marathon - the New York City Marathon, which ran through five boroughs of the Big Apple. In the years to follow, more cities would follow suit and gain bragging rights to host their own marathon. Over the twenty-five years the number of age-group competitors has skyrocketed. In 1979, the New York City Marathon hosted fewer than 2,000 runners. In 1980 the race grew to 10,000 runners and in 1990, it reached an astonishing 30,000 runner capacity (Noakes, 2012). In 2013, 50,266 runners completed the same marathon (New York Road Runners). Robert E. O’Conner, MD, PhD, notes that each year more than 400,000 athletes run in over 300 marathons (26.2 miles) in the United States (2006). As endurance sports continue to grow in popularity, so has the incidence of exercise-induced hyponatremia (EAH), a health-threatening sodium deficiency caused by the overconsumption of water that dilutes blood sodium concentration levels. In order to protect the health of marathon runners and instill the integrity of health through participation of endurance sports, it is important to educate entry-level marathon runners about the dangers of exercise-associated hyponatremia and promote the benefit of individual hydration status self-assessments for performance.

EAH is the most common medical complication in long-distance exercise that, if not treated, has serious implications, including fatality. Between 1984 and 1998, the number of EAH cases rose from under 100 to over 1,200 incidences, peaking again in the year 2000 with eight fatalities (Noakes, 2012). After 2000, reported incidences continued to increase. Those most
notably at risk are considered age-group endurance athletes (novice competitors) as marked by longer finishing times, which places the athlete at greater risk for hyponatremia (O’Conner, 2006).

Exercise-associated hyponatremia results from dehydration and salt depletion with an over consumption of fluid (water) intake during prolonged workouts and marked by both mild to ominous symptoms, including: vomiting, malaise, light-headedness, dizziness, fatigue, altered mental states, headache, incoordination, seizures, and coma that may develop into cerebral edema. EAS is further marked post-exercise serum sodium levels below 135 mEq/L. Symptoms are most notably present in levels lower than 125 mEq/L (Hew-Butler, Verbalis, & Noakes, 2006).

Review of Literature

“Updated Fluid Recommendation: Position Statement from the International Marathon Medical Directors Association (IMMDA)” discusses controversies regarding optimal fluid guidelines for athletes engaging in different sports. The position statement promotes understanding that assessment of fluid intake occurs in a “dynamic environment” and that specific individual needs for hydration must be assessed. In an effort to reduce dehydration, sport organizations, such as the American College of Sport Medicine, have recommended replacing 100% of fluid loss, rather than “pay attention to thirst”. This, however, places the athlete at risk for water intoxication. Recommendations to not exceed greater than a 2% loss in body weight also stress the promotion of fluid consumption, while using pre- and post- exercise body weight can be used as a determining guide for hydration status. However, what body weight fails to account for is energy consumption through food, not plasma osmolarity. The goal of this paper is
to promote the understanding and need for individual hydration and fluid analysis (Hew-Butler, Noakes & Verbalis, 2006).

The article “Drinking Too Much,” published in Ultra Cycling magazine by Lulu Weschler, is an informative tool for athletes and coaches about the deleterious effects of overconsumption of liquids, including water and sports drinks, as part of training routine and during an endurance event. Weschler firmly acknowledges, “overhydration does not equal good hydration” (2007). The body is finely tuned to maintain a homeostatic environment, one in which all systems and cells are evenly balanced; when excess water is consumed during an endurance event, the athlete is at risk of creating an imbalanced system for cells. This can especially pose a problem in the brain, as it is noted that the skull creates an environment where expansion from inflammation is limited. Cells that accept water and become hypotonic may exert pressure on the brain, causing cell lysis and a cascade of neurological problems (Weschler, 2007). When an athlete understands the risks and warning signs of hyponatremia, and is able to accurately listen to their body’s needs, they significantly reduce the potential harm and damage that could evolve. While training or racing, athletes can notice signs of weight gain, feeling bloated, puffiness at sock line or other areas where clothing has compression on limbs, and noticing dull headache. With these signs, hyponatremia may be present. Further, it is possible for an athlete to self-regulate thirst by simply noting whether or not they are thirsty. Weschler recommends listening to one’s own body for signs of thirst, rather than blindly following such advice as “drink[ing] until urine runs clear” (2007).

“Hyponatremia among runners in the Boston Marathon” was a study done by Almond, Bindstadt, Fortescue, Greenes, Mannix, Shin, Wypij in 2005 that provides quantitative data as to the prevalence of the condition of hyponatremia in a long-distance running event. Using
participants from the 2002 Boston Marathon, researchers gathered volunteers to provide information on hydration and urination habits, draw blood, and record pre- and post-race weights. Post-race information was collected from 64% of the initial volunteer group and they found that 13% of this group had hyponatremia, and 0.6% had a critical form of hyponatremia (Almond, et al., 2005). After the data was gathered, it was found that those competitors who had hyponatremia had positive correlation with post-race weight gain, a long race time of over four hours, and body mass index (BMI) extremes. Throughout the article, various factors were considered to explain risk or incidence of hyponatremia, but by far the largest correlation was weight gain due to excessive liquid intake (Almond et. al., 2005). The article’s emphasis was that the “strongest single predictor of hyponatremia was considerable weight gain during the race” (Almond et. al., 2005). An important non-distinction was made between consumption of water versus consumption of electrolyte sport beverage, as each can cause hyponatremia because even in a sports drink, osmolality is still lower concentration than that of blood plasma, thus creating an imbalanced internal environment. The prevalence of athletes completing a race with low serum sodium concentrations points to the fact that excessive consumption of liquids during a race can be harmful.

“Exercise-Associated Hyponatremia” provides another insightful look at the frequency of hyponatremia among endurance events including a bit of history of fluid intake among athletic events. Rosner and Kirven note the increasing popularity of marathons, triathlons, and other endurance events has created an influx of inexperienced participants who may have less knowledge about the physiological aspects of their training and racing routines (Rosner & Kirven, 2007). They found that hyponatremia is positively correlated with less marathons run, relaxed training pace, and longer finish times; when it takes longer for them to complete a race,
they are losing more electrolytes in sweat and drinking more water during this time as well (2007). An incidence of consuming excessive water post-race also contributes to the condition of hyponatremia. Particularly interesting is the consideration that hyponatremia is an iatrogenic condition, one which is preventable harm resulting from advice from a medical professional. General recommendations to endurance athletes include drinking only according to thirst, and try to get a general idea of hourly sweat losses to avoid consuming more liquid than this amount.

Written in the Journal of the Royal Society of Medicine, “Exercise-associated hyponatremia after a marathon: case series” discusses the complications associated with correcting hyponatremia too rapidly. The main objectives of this paper is to review treatment and response of runners presented at St. Thomas Hospital with EAS following the 2003 London Marathon. Although, treatment for exercise-induced hyponatremia must be acted upon quickly, the rate at which treatment is administered may perpetuate risk for hyponatremic encephalopathy. While fluid restriction with use of a 0.9% saline solution and hypertonic saline is practiced, a concurrent 2006 Consensus Conference advised 100 mL of a 3% saline be repeated hourly (Goudie, Kerins, Terris, & Tunstall-Pedoe, 2006). In the evaluation of 2003 London Marathon, 14 runners with EAS were presented to St. Thomas Hospital. Their finish times ranged from sub-three to sub six hours. The commonality between these runners was a delay between finish time and the time patients were presented to the hospital. It was noted that some patients who cross the finish line were described with having an “apparently normal state only to become confused later,” some of which experienced seizures. A 0.9% saline was used as the first response choice. In those runners whose symptoms did not improve or deteriorated, a 1.8% hypertonic solution was administered. It was concluded that the reason that an isotonic 0.9% saline solution may not be effective is due to the possible ongoing absorption of hypotonic
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fluids and ongoing sodium losses (Goudie et al., 2006). For this reason, the serum correction rate is still controversial.

Michael Moritz, MD, and Juan Carlos Ayus, MD, were the first to report on the successful use of hypertonic saline solutions in the treatment of patients that presented with EAS, more specifically, hyponatremic encephalopathy (a condition that causes pulmonary edema). In their paper, “Exercise-associated hyponatremia: why are athletes still dying?” the two physicians acknowledge that while use of their therapeutic approach is successfully being reproduced, that unless universal application is administered unnecessary deaths will continue to occur. In supporting their position, they refer to the fourteen runners presented with EAH following the 2003 London Marathon, that the treatment administered to these patients did not follow the use of a 1.8% saline solution but a 3% solution instead. They noted that the runners’ health failed to improve and/or worsened as a result. To gain universal adoption, Moritz and Ayus recommend that marathon organizers equipping medical staff on recognizing the symptoms of EAH, measure serum sodium levels on side, and treat immediately with a 100L-bolus of a 3% solution. While one article states the importance of the rate of serum saline therapy, another article condemns the application of its practice and sites that there should be a universal approach.

**Project Design Roadmap and Overview**

Project SEAH is at present a San Francisco Bay Area based education intervention for the adult marathoner. Due to the nature in popularity of marathon running and its growth in entrants, it is foreseeable that Project SEAH be implemented nationwide. This grassroots project kicks its program off at Sports Basement in San Francisco, a community-driven discount sporting goods shop frequented by runners, triathletes, yoga enthusiasts, skiers, and other sport-minded individuals. The Sports Basement has become a community gathering location for clinics,
demonstrations, and lectures and is often the start location for many run training events, offering access and exposure to adult runners training for marathons.

Project SEAH education is a 12-week program with three interventions occurring every four weeks. During the course of the program, marathon participants receive weekly online check-ins to assess and evaluate education application as it applies to the signs and symptoms of EAH and its prevention. The first intervention program will take place the week of April 2, 2014 with a sixty-minute education event offered to adults training for summer marathons.

Prior to the first meeting, runners will partake in a pre-assessment survey to gather information about runner experience, current fluid intake, knowledge of EAH, and any previous history of dehydration or related symptoms associated to EAH. Post assessments encompass the effectiveness and application of information provided. On location (runner training location) intervention includes monitoring fluid intake, assessing individual sweat rate and fluid needs. Environmental factors, such as temperature, humidity, and wind, will also be noted in each assessment.

**Needs Assessment and Problem Statement**

As endurance athletic events become increasingly popular, an influx of novice participants is entering races with little more training than having physically prepared for a race. It is possible that these new athletes, unaware of the range of injury they are exposing themselves to, may have little knowledge on proper hydration during racing (Rosner & Kirvern, 2007). Lack of education on this subject directly puts participants at risk for overhydration, as many entry-level age group racers strive to consume fluids according to old-school standards in order to avoid dehydration. As discussed in the paper, the greatest risk associated with over consumption of fluids is the risk of exercise-associated hyponatremia.
Short-term effects of hyponatremia are also warning signs for the athlete to properly replenish electrolytes. The Gatorade Sports Science Institute provides common signs and symptoms for someone who is hyponatremic including feeling bloated, noticing swollen extremities, nausea, vomiting, throbbing headache, dizziness, severe fatigue, lack of coordination, restlessness, confusion, and seizure. If severe and left untreated, hyponatremia can lead to death (Murray & Eichner, 2003).

Because of the seriousness of complications that can result from EAH and due to the lack of education amongst novice athletes pertaining to EAH, forming an education program around about EAH may save lives. In reducing these incidences, the immediate benefit is reduction of injury to athlete, allowing them to train and race more successfully. Encouraging awareness and implementation of an EAH program benefits event directors and the race culture. It offers improved athlete support, volunteer training surrounding awareness and risk factors, and leads to greater integrity with the sport while reducing a social stigma associated to the risk factors of running.

Goals, Objectives, and Evaluation Method

Due to the necessity to protect marathon runners, the overall goal is to reduce the frequency of hyponatremia among this faction of endurance athletes. The two main goals of this nutrition program are to educate athletes on the condition of hyponatremia and to train them to self-asses in order to deter exercise-associated hyponatremia. Education will provide athletes with a baseline of knowledge about EAH, the importance of fluid and electrolyte balance within the body, as well as the causes, and signs and symptoms of hyponatremia EAH.

An education program can take place almost anywhere, using tools and resources that will make clear the main points of hyponatremia. Trained educators will provide information on
the importance of electrolyte balance within the body, and how homeostatic balance can shift through over (or under) hydrated. In order to properly educate, assessing participants to see what their current awareness is of hydration during endurance events to give them information that is relevant to their training practices can be useful. Using a survey or questionnaire about current practices and beliefs about hydration can provide the educator with information about their audience so they can best meet their needs.

After education has been provided and the students understand why hyponatremia is an important consideration, it will be possible to help them incorporate relevant hydration routines into their training program. To start off, athletes can be given methods of assessing fluid loss after a workout session. This can be as easy as weighing oneself before and after exercise to determine the difference in weight. If they weigh more, then they have likely consumed too much water. Another very effective method of assessing electrolyte balance in the body is to use urine test strips to assess specific gravity, along with concentrations of electrolytes. Providing information and training for athletes on how to use these tools can improve individual assessment of hydration status during a race, helping make the participant more aware of their needs.

Final evaluation for participants may be done using an assessment survey and questionnaire comparing old habits to new. Asking the participants to demonstrate their ability to know signs and symptoms and to use urinalysis test strips. Overall, this class will empower the athlete and help them to progress in their race.

**Identifying Financial Needs Required for Grant Proposal**

Project SEAH implements itself locally, but foresees growing globally. Annual costs to run Project SEAH presently range between $125,000 to $290,000. The start-up needs associated
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with building this non-for profit organization include a San Francisco office space and supplies (computers, printers, projectors, software, desks, chairs, etc.). Additional assessment tools include bio-impedance scales and urine specific-gravity test kits.

To reach populations within the Bay Area training for marathons as well as through the State of California, a SEAH Truck will provide on site pre, during, and post screening to marathon runners during training and racing. The truck will be branded with a unique design that people recognize. Not only will the truck provide assessments, but also marathon runners will have access to education pamphlets and hydration products (that contain a 4% glucose solution). On site clinics and assessments will provide SEAH Care Kits. These kits include sample sodium replacement products, sun block, as well as education material on preventing EAH. The budget also includes costs for staffing and training volunteers that promote SEAH.

Summary

Exercise-associated hyponatremia was first described by Timothy Noakes, PhD, as “water intoxication”. Noakes explains in his book “Waterlogged” that up until the late 1970’s, marathoners were discouraged from drinking fluids for fear that it may slow them down (Noakes, 2012). To drink during an ultra-distance race was marked as a sign of weakness. Jackie Mekler, prominent 1960’s long-distance runner describes the mentality of running an ultra marathon without any fluid was regarded as the “most ultimate aim of most runners, and a test of their fitness” (Noakes, 2003, p. xii). Evidence had not yet shown that refraining from drinking was potentially dangerous resulting in illness or death.

With steady rise in runner participation at marathons came a rise in accounts of dehydration. Sport medicine organizations instructed runners to drink before feeling thirsty to prevent dehydration (Noakes, 2012). Cues from the sports drink market also promoted the
importance of hydrating to avoid heat stroke and/or dehydration. As a result, the pendulum swung in the opposite direction and runners began over-hydrating thus contributing to the prevalence of EAH. Despite the knowledge to educate runners about the signs and symptoms of EAH, as well as the studies that cite serum saline dose strengths once a runner has been presented with EAH, marathon runners are still at risk.

Through an education-based, intervention focus on empowering adult marathon runners to utilize practices for assessing individual sweat rate, urine specific gravity, and fluid and energy intake, the goal of Project SEAH is to minimize the prevalence of exercise associated hyponatremia. The foreseeable future of Project SEAH begins locally, but acts globally by being the frontline resource to runners before training, during training, and on site at races.
References


