Electrolyte Replacement Solutions

Technical Document

Developed by INDI/SNIG for the Irish Sports Council

2014
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Pubmed (Medline), SPORTDiscus, Google Scholar and Cochrane library were searched for all human studies published in peer reviewed journals. The terms searched were “electrolyte replacement solutions” AND “fluid” AND “exercise” up to November 2009 (original) and updated to March 2014. The majority of literature retrieved for this review was similar to that in the “Sports Drinks” technical document. Studies included in this review adhered to the following criteria:

Inclusion criteria
- Human studies published in English
- Healthy subjects
- Original investigations or reviews assessing the use of electrolyte replacement solutions and exercise
- Reviews and position statements on electrolyte consumption and exercise

Exclusion Criteria
- The use of electrolyte replacement solutions in diseased populations
- Literature assessing the prevalence of nutritional supplement use among athletes

Introduction

Electrolyte replacement solutions (ERS) are oral rehydration agents that are traditionally used for the treatment of diarrhoea-induced dehydration. ERS such as Dioralyte contain glucose, sodium chloride, potassium chloride and disodium hydrogen citrate, and when mixed with water provide a means of rapidly replacing water and electrolytes. Though ERS are commonly used in clinical settings, for example rehydration after illness such as diarrhoea, they have been more recently used by athletes to assist with hydration before, during and after exercise. This allows for replacement of electrolytes (mainly sodium and potassium) lost through sweat (Australian Institute of Sport, 2011). During hard exercise, high sweat rates limit the rise in core temperature (Maughan and Shirreffs 2012). For a review of fluid requirements for exercise, please refer to The American College of Sports Medicine’s position stand for exercise and fluid replacement (Sawka et al. 2007).

Electrolyte losses through sweat depend on the total sweat loss and sweat electrolyte concentrations. Sweat electrolyte concentrations according to the most recent exercise and fluid replacement position statement can be seen in Table 1. Sweat concentrations
vary depending on genetic predisposition, diet, sweating rate, and heat acclimatization (Sawka et al. 2007).

Table 1: Sweat Electrolyte Composition

<table>
<thead>
<tr>
<th>Electrolyte</th>
<th>Average loss (mEq · L⁻¹)</th>
<th>Range (mEq · L⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>35</td>
<td>10-70</td>
</tr>
<tr>
<td>Potassium</td>
<td>5</td>
<td>3-15</td>
</tr>
<tr>
<td>Calcium</td>
<td>1</td>
<td>0.3-2</td>
</tr>
<tr>
<td>Magnesium</td>
<td>0.8</td>
<td>0.2-1.5</td>
</tr>
<tr>
<td>Chloride</td>
<td>30</td>
<td>5-60</td>
</tr>
</tbody>
</table>

*Source:* Sawka et al. 2007

Sports drinks are the most common method for replacing electrolytes before, during and after sport. For detailed information regarding the use of sports drinks, please refer to the “Sports Drinks technical document” in this series.

The sodium content of fluids provided after exercise-induced dehydration plays a significant factor in the restoration of body water loss, especially plasma volume and extracellular fluid (Nose et al. 1988, Wemple et al. 1997, Shirreffs and Sawka 2011). Deficits in total body water (hypohydration) will stress the thermoregulatory and cardiovascular systems and effect exercise performance (Shirreffs and Sawka 2011). Merson et al. (2008) demonstrated that urine output was inversely related to sodium intake. Therefore the addition of 40 and 50 mmol/l of sodium to a rehydration beverage can reduce subsequent urine output i.e. enable the body to retain more fluid. The other major electrolytes potassium (K), magnesium (Mg) and calcium (Ca) are in abundant supply in fresh fruit and fruit juices (Maughan and Shirreffs 2012). However, no recent evidence has emerged that any electrolyte, other than sodium has any significant role in hydration either before, during or after exercise (Shirreffs and Sawka 2011).

Hyponatraemia (low plasma sodium concentrations) can occur when inadequate sodium is ingested during or after exercise (net sodium loss), but is more likely to occur when fluid is consumed in excess of sweat losses i.e. a net fluid gain (Montain, 2008, Australian Institute of Sport, 2011).

It has been clearly demonstrated in many studies that ingestion of plain water to restore significant dehydration can lead to a fall in plasma osmolality and sodium concentration, which in turn will suppress the thirst mechanism and stimulate urine output (Valentine, 2007, Shirreffs et al. 2004). It is therefore advisable for athletes competing in extended physical activity to consume fluids that contain adequate electrolytes. As sodium is the primary cation for extracellular fluid, sodium losses must be replaced to replenish the extracellular fluid and thus the total body water (Shirreffs and Sawka 2011).
The athletic benefits of electrolyte replacement solutions

ERS should be considered by athletes for the following situations:
- Rapid rehydration after weigh-in in making-weight sports where dehydration has been used as a strategy to make a specific weight category
- Ultra-endurance sports where sweat losses are significant, e.g. Ironman triathlon
- Initial days of hot weather training before an athlete has acclimatized, as acclimatization improves the athletes ability to reabsorb sodium and chloride
- When electrolyte-containing beverages such as sports drinks are not available and dehydration is inevitable
- Athletes who are heavy sweaters or salty sweaters
- When rapid rehydration is required between training or competition completed in close succession

ERS guidelines for use during exercise

Specific guidelines for the consumption of ERS have not yet been defined due to the significant variation between individuals for fluid and electrolyte losses during exercise. It is recommended that consuming fluids with sodium (20-50mEq·L\(^{-1}\)) or salted snacks or sodium-containing foods before exercise will help retain consumed fluids (Sawka et al. 2007). The Institute of Medicine provides general guidelines for the composition of sports drinks, which may assist with preventing dehydration during prolonged exercise. They recommend sports drinks contain 20-30 mEq·L\(^{-1}\) of sodium, 2-5 mEq·L\(^{-1}\) of Potassium and 5-10% carbohydrate (The Institute of Medicine, 1994).

Concerns with electrolyte replacement solutions use
- Excessive water consumption during exercise is the main cause of hyponatraemia and ERS during exercise will not necessarily prevent this
- Reliance on ERS can be expensive. The addition of salt to pre- or post - training/competition snacks/meals in conjunction with adequate fluid consumption should be trialed as a hydration strategy. Waking hydration status can be monitored by assessing upon waking urine sample for urine specific gravity, while fluid balance during exercise can be monitored by weighing the athlete (and their drinks) before and after exercise (Australian Institute of Sport, 2007,2011).
- Altering the sodium content of sports drinks or using high sodium content ERS, may decrease voluntary fluid intake. When using these products, the practitioner should assess palatability of the beverage.
**Summary**

ERS provide a valuable option for rapid rehydration for athletes in many situations. Currently there are no specific guidelines in regards to electrolyte replacement supplementation, and future recommendations will need to be applied individually due to the large variation in sweat loss and composition between athletes. It is known that both fluid and electrolyte losses need to be replaced otherwise an athlete will remain dehydrated following exercise. However, to achieve and maintain euhydration and avoid diuresis rapid rehydration strategies should factor in drink temperature, drinking pattern and gastric emptying, and hydration strategies individualized for each athlete (Shirreffs and Sawka 2011).
References


