# Hydration 101

**version 1.0**

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# Humans are not created equal…there are some big differences in our individual make up

**Our hydration '101' provides a spectrum of scientifically proven arguments - 'real facts' - and helps you dissipate some of the myths surrounding sports and hydration**

*Average is all well and good, but not everyone is created equally. This is especially true with hydration. Everyone varies dramatically with what daily activities they do, where they live and work, what sports and leisure activities they undertake and in what ambient conditions, how long for and at what level. Put these variables along with the fact that human sweat electrolyte loss varies over 9-fold then how can a 'one-size-fits-all' strategy possibly satisfy everyone's requirements*

**Use Hydration 101 to understand your individual physiology and help you perform better**

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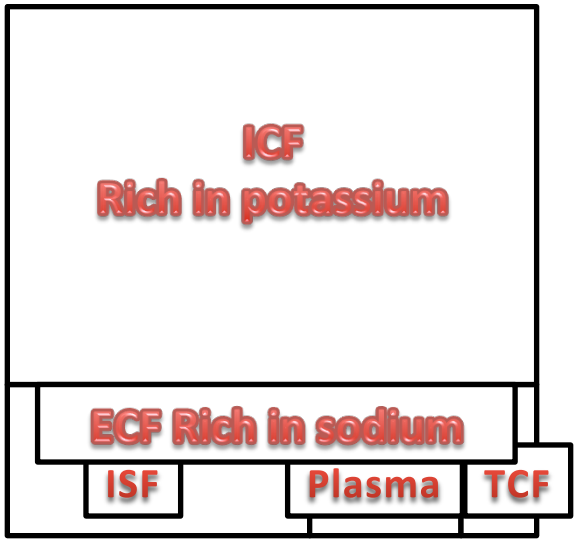
# For all of us water is a big part of us and is essential for life

The body is made of **60-75% water equating to approximately 40kg in a healthy 70kg man**. Some parts of the body have more water than others. For example, the brain contains 95% water, the lungs 85% water and blood 82%

This body water is stored in 2 major compartments – ICF and ECF:




⅔ or approximately 28 litres is **Intra-cellular Fluid (ICF)**

⅓ or approximately 15 litres is **Extra-cellular Fluid (ECF)**
This is then split into a further 3 compartments:

- Interstitial Fluid (ISF) - 10 litres
- Plasma - 4 litres
- Trans-Cellular Fluid (TCF) - 1 litre

Hall, John E. (2011). *Guyton and Hall Textbook of Medical Physiology*

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On a continual basis water in our bodies is gained and lost in a variety of ways…and we are not in control of our losses!

## Water Gains

Your body gains water mainly from food and ingested water. Water ingested is absorbed mainly via in the jejunum (small gut) and some from the large gut (colon). As food is metabolized it releases water by a process called oxidation

- 1000g of carbohydrate releases 600ml
- 1000g of fat releases > 1000mls
- 1000g protein releases 410mls

## Water Losses

'Insensible losses' are water losses via urine, feces and sweat. The most dramatic losses as conditions alter are via sweat

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# Uncontrolled losses ('insensible') vary substantially with small changes in temperature

| Fluid loss from different areas of the body | Normal weather no exercise. 20°C | Warm Weather no exercise. 29°C | Warm weather + exercise. 29°C |
|---|---|---|---|
| Skin | 350ml | 350ml | 350ml |
| Breathing | 250ml | 350ml | 650ml |
| Urine | 1400ml | 1200ml | 500ml |
| Feaces | 100ml | 100ml | 100ml |
| Sweat | 100ml | 1400ml | 5000ml |
| **Total fluid loss in 1 day** | **2300ml (2.3 L)** | **3300ml (3.3 L)** | **6600ml (6.6 L))** |

*Guyton and Hall Textbook of Medical Physiology*

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# Although losses vary widely some standards exist in recommended water intake…

**Your body turns over 5-10% of your body water every day**. The exact amount varies dramatically depending upon diet, activity level, environment, your health status and your individual metabolism. **In some cases this is as high as 6 liters per day**

Recommendations from authorities vary but all emphasise the need to adjust according to the variables

UK National Health Service:

*".....we should drink about 1.2 litres of fluid every day to stop us getting dehydrated..... in hotter climates, the body needs more water than this....."*

World Health Organization:

*".....the 'absolute minimum' quantity of water to sustain hydration remains elusive, as this is dependent on climate, activity level and diet"*

*Sawka et al. Human water needs. Nutrition Reviews 2005;63:S30-S39*
*http://www.nhs.uk/Livewell/Goodfood/Pages/water-drinks.aspx (accessed December 2011)*
*Howard et al. Domestic water quantity, service level and health. World Health Organization: Geneva 2003*

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# Recommended consumption does account for some specific conditions…

National Academies, Institute of Medicine, Food and Nutrition Board recommendations on the Dietary Reference Intakes for Electrolytes and Water

| | Average conditions | Manual labour in high temperatures | Total needs in pregnancy/lactation |
|---|---|---|---|
| **Female adults** | 2.2 litres | 4.5 litres | 4.8 litres (pregnancy)<br>5.5 litres (lactation) |
| **Male adults** | 2.9 litres | 4.5 litres | - |

WHO recommendations for daily requirements of drinking water

| | | Total water intake per day (including water contained in food and other beverages)* | Water obtained from drinks per day (representing approx. 81% of total water intake) |
|---|---|---|---|
| **Adults (19-50 years)** | **Men** | 3.7 litres | 3 litres |
| | **Women** | 2.7 litres | 2.2 litres |

*Dietary Reference Intakes for Water, Potassium, Sodium, Chloride and Sulfate (2004) Institute of Medicine of the National Academies*
*Howard et al. Domestic water quantity, service level and health. World Health Organization: Geneva 2003*

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# Athletes are not covered by the general guidelines and generally do not drink enough!

## Are Athletes typically well hydrated? - In a nutshell – NO!

Current evidence suggests that many athletes start a training session or competitive game hypo hydrated

In 2009, a study evaluating pre-practice hydration status of 263 National Collegiate Athletic Association (NCAA) Division I athletes **showed that 53% were hypo hydrated**. A separate study the same year found that approximately 50% of NBA basketball players evaluated prior to match play were hypo hydrated

In a further study, even at elite professional level football and with free access to sports drinks and water only 45% of sweat losses were met

*Volpe et al. Estimation of prepractice hydration status of NCCA Division I athletes. J Athl Train. 2009;44:624-9*
*Stover et al. Consistently high urine specific gravity in adolescent American football players and the impact of an acute drinking strategy. Int J Sports Med. 2006;27:330–335*
*Shirreffs et al. The sweating response of elite professional soccer players to training in the heat. Int J Sports Med. 2005;26:90-5*

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# It seems that despite a general understanding of the need for hydration there is rather less knowledge of what this entails

A study in 2005 looking at knowledge, attitude and behaviours of athletes showed that while most understood the need for general hydration, **there was lack of knowledge regarding principles and use of sports drinks**

Skilled and endurance athletes generally faired better in the evaluation

*Nichols PE, et al. Knowledge, attitudes, and behaviors regarding hydration and fluid replacement of collegiate athletes. . Int J Sport Nutr Exerc Metab. 2005; 15:515-27*

# Sweat Losses

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# Sweat volume loss is particularly relevant to athletes, typically higher than understood and between individuals has a wide variation

Maximal sweating rates vary from as much as 1.5 l/hr in healthy unacclimatized man to as much as 3 l/hr in acclimitized soldiers. In certain sports in hot and humid conditions the losses can be quite dramatic

One of the highest documented sweat rates in sports is that of Alberto Salazar. During the 1984 Olympics Marathon he lost an average of 3.7 l/hr in sweat.

Losses may also vary considerably between sports. When assessing sweat rates between runners and football players in identical conditions, a group from West Chester University, USA demonstrated that daily sweat losses of footballers was over 9 litres compared to 3 litres that runners lost

**Sweat is not only water but also just as importantly valuable electrolytes which may be quite difficult to replace**

Sweat volumes losses are generally much more than appreciated by most
In some players and athletes the losses run to over 9 litres in 24 hrs

*Wilmore JH, Costill DL. Physiology of Sport and Exercise 2nd ed., p323, Human Kinetics Publishers, Champaign, IL, 1999*
*Wenger, C.B. 1988 Human heat acclimatization. Pp. 153–197 in Human Performance Physiology and Environmental Medicine at Terrestrial Extremes. Indianapolis, Ind.: Benchmark Press*
*Godek et al. Sweat rate and fluid turnover in American football players compared with runners in a hot and humid environment. Br J Sports Med. 2005;39:205-11*
*Armstrong et al. 1986 Preparing Alberto Salazar for the heat of the 1984 Olympic Marathon. Physician Sportsmed.*
*14(3):73–81.*

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# Though sweat loss is mainly water, it also contains essential minerals, usually **called Electrolytes**, these too are lost

- While sweat is predominately water, it also contains valuable electrolytes (also referred sometimes to as minerals)

- Electrolytes are essential for conduction of electrical energy between and within cells and for maintaining  each cellular membrane electrical integrity

- Since sweat is derived from extra-cellular fluid (ECF), it contains large amounts of sodium.  Other important electrolytes in sweat but in much lower concentrations are potassium, magnesium and calcium

- The loss and replacement of sweat electrolytes in healthy athletes is a finely balanced act between individual loses, existing body stores and the relative importance of each electrolyte loss in the active athlete

- An elegant way of looking at the importance of each electrolyte is to look at the number of litres you would need to lose to be depleted

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# Of these four key Electrolytes contained in lost sweat **only Sodium** can typically be depleted through sweat loss alone

| Electrolyte | Typical daily intake (mg) | Typical absorption efficiency | Typical sweat losses per litre | Loss in litres of sweat to be deficient | Deficiency possible by sweating? |
|---|---|---|---|---|---|
| *Sodium | 4000 | >90% | 230-1700 | 4 | Yes |
| Potassium | 2700 | >90% | 150 | 16 | No |
| Calcium | 500 | 30% | 28 | 5 | Possible |
| Magnesium | 300 | 10-70% | 8.3-14.2 | 15 | No |

***Sweating 2 l/hr in a hot race would mean that in as little as 2 hours you would deplete your daily intake of sodium. Considering that there are no useable reserves of sodium in the body this would need to replaced as you exercise**

*Nutrition for Sports, Dr Arnie Baker, 2nd edition, Sweat Mineral Losses, p22, ebook on [www.arniebakercycling.com](http://www.arniebakercycling.com)*

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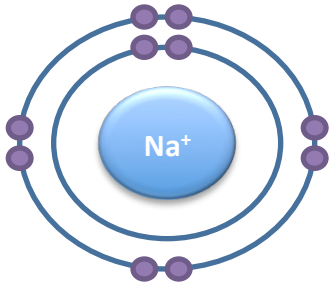
**Sodium** is not only the most likely to be lost it is also the most likely to be required during training & racing




- This positively charged electrolyte is found primarily OUTSIDE the cell

- It is crucial for maintaining the electrical integrity of the body cell and is the electrolyte priority for muscle contraction and nerve conduction

- Sodium is also essential for transport of water in the body. Your body cannot excrete and move free water-instead it moves with sodium

- Blood sodium loss and gains are tightly regulated by the kidney with drives from the brain to increase salt intake or drink more water as necessary

- Normal blood levels are maintained between 135-145 mmol/l

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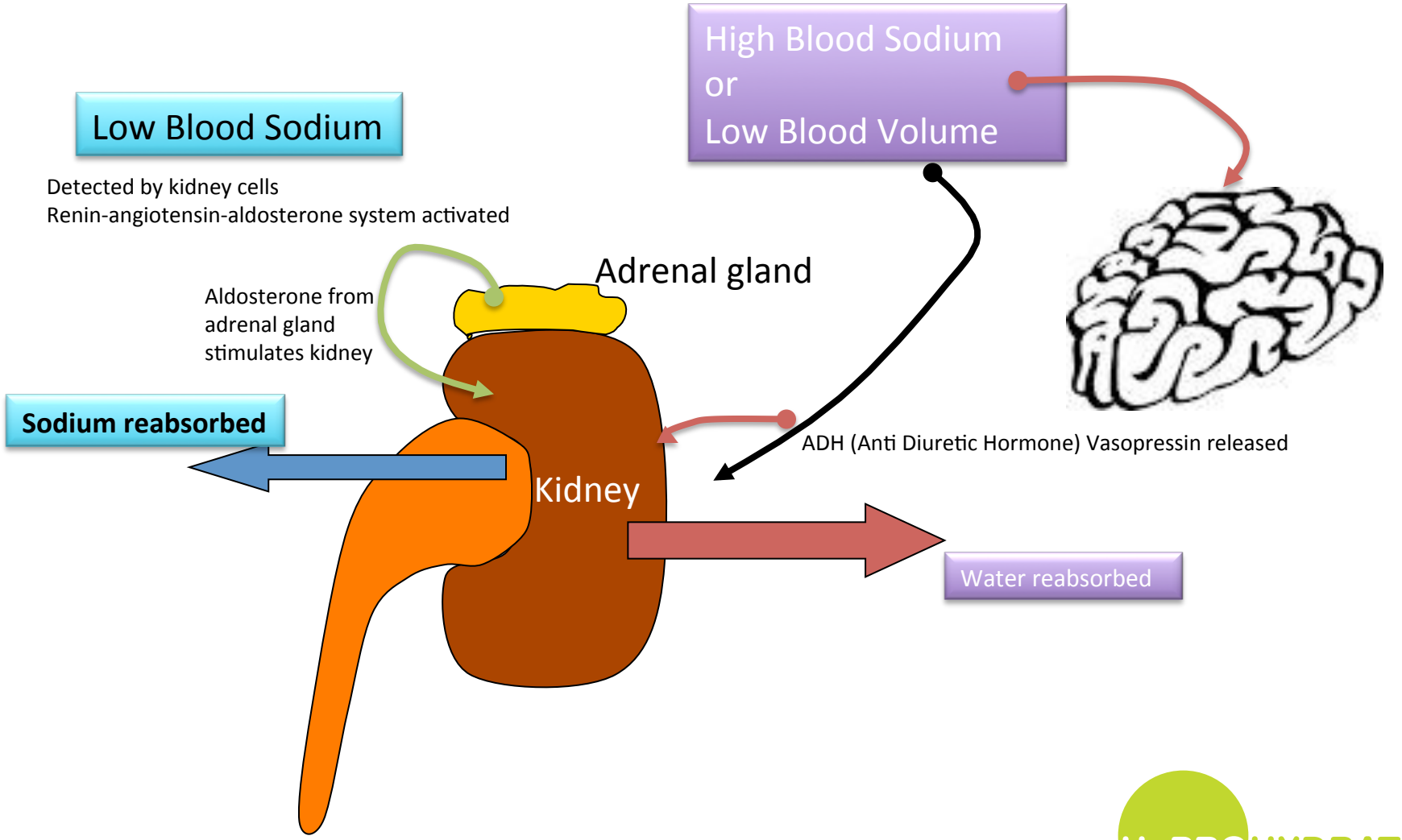
# The body does have mechanisms to regulate sodium however reserves are small and the effective performance band is narrow

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Given **sodium losses**, small reserves and narrow band of operation it is relatively easy for athletes to become **sodium depleted**

- Low blood sodium in sports is mostly due to the dilutional effects of drinking water or low concentration sports drinks in excess of sweat and urine sodium losses

- This condition is also known as **Exercise Associated Hyponatremia (EAH)** – first described by Noakes in 1985

- With Hyponatremia the athlete experiences weakness, nausea, muscle fatigue and cramping. As sodium levels drop even further and water moves into the brain there may be agitation, seizures and occasionally death

- Risk factors for EAH include long 4 hr+ races, slow running pace, female gender, low body weight, pre-race excessive water intake, over-drinking >1.5 l/hr during racing and abundance of drinks during the event

*Noakes et al. Water intoxication: A possible complication during endurance exercise. Med Sci Sports Exerc 17: 370–375, 1985*
*Rosner et al. Exercise-Associated Hyponatremia. Clin J Am Soc Nephrol 2: 151–161, 2007*

# What about other electrolytes…**Potassium?**

- Potassium is a positively charged electrolyte found INSIDE of cells

- Along with sodium it regulates the electrical integrity of the cell membrane and is therefore important in nerve conduction

- It also helps transport glucose into the cell so is crucial for energy generation
- Blood levels of potassium are regulated between 4.5-5.5 mmol/l

- Low blood potassium (hypokalaemia) is usually due to diarrhoea, fasting and taking certain drugs such as diuretics long-term

- In sports hypokalaemia is rare. Certain ultra-endurance athletes who generally have a poor solid food diet may be prone to hypokalaemia leading to nausea, muscle fatigue and weakness

- Potassium supplements should always be taken with caution and on the advice of a doctor

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# What about other Electrolytes…**Calcium?**

- Calcium is intimately involved in muscle contraction and relaxation, nerve conduction, hormonal secretion and blood clotting

- Your body has vast supplies stored in the bones which are tapped into when needed

- Generally in a well nourished athlete eating a normal diet with dairy products (normally fortified with Vitamin D to help calcium absorption) calcium deficiency during racing is rare

- Low calcium can lead to poor muscle contraction and cramping

- Dietary sources are generally better than supplements. Equally important are weight-bearing exercises. Swimmers and cyclists suffer the same bone calcium loss as sedentary normal humans so remember to fit in weight-bearing exercises into your regime

*Taaffe et al. Differential effects of swimming versus weight-bearing activity on bone mineral status of eumenorrheic athletes. J Bone Miner Res. 1995 Apr; 10(4):586-93*

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# What about other Electrolytes…**Magnesium?**

- Magnesium is necessary in every cell for enzyme reactions as well as muscle contraction and energy production

- Prolonged exercise and training with poor diet can lead to depletion although this is rare to surface in an acute setting

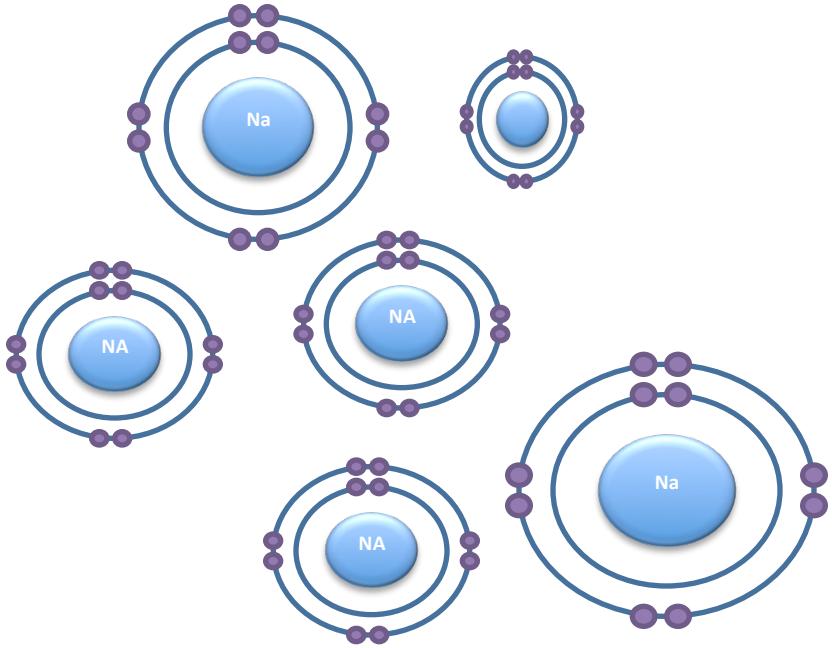
- Magnesium deficiency can lead to dizziness, fatigue and depression

- There is no evidence that magnesium supplementation in people with normal blood levels offers any benefit in sports performance

- Weight-lifters and wrestlers tend to be magnesium deficient and may benefit from oral supplementation

*Nielsen et al. Update on the relationship between magnesium and exercise. Magnes Res. 2006;19:180-9*

# Sweat Sodium Losses



# Total Sodium lost through sweat is a question of volume and concentration…and **concentration varies widely** between individuals!

There is much published literature showing a large variation in sodium levels lost in human sweat. In athletes, normal adults and manual labourers using patch testing and chemically induced sweat a range of 12-110 mmol/l has been described

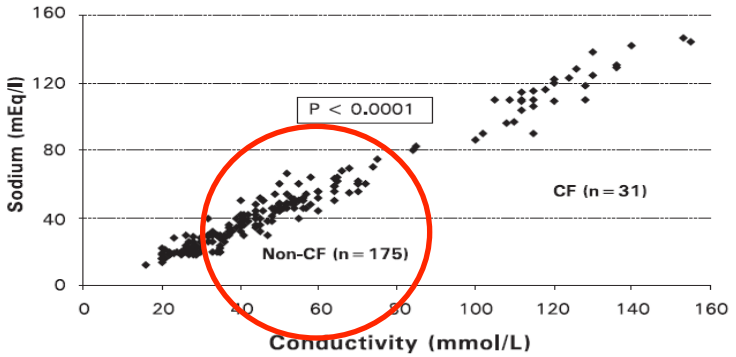
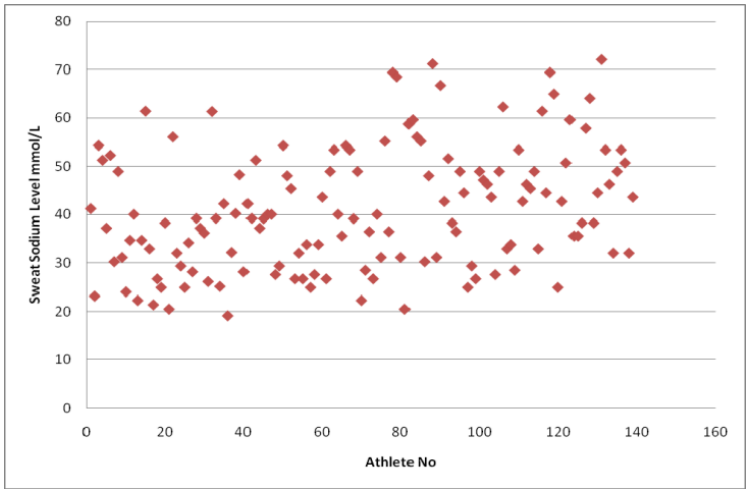



**Figure 1 -** Comparison between conductivity and sodium concentration in the same sweat sample in patients with and without cystic fibrosis

Precision Hydration's own tests in elite athletes ranging from national squads and elite international athletes has reflected this large variation




*Bates et al. Sweat rate and sodium loss during work in the heat. J Occup Med Toxicol. 2008;29;3:4*
*Godek et al. Sweat rates, sweat sodium concentrations, and sodium losses in 3 groups of professional football players. J Athl Train. 2010;45:364-71*
*Riedi et al. Comparison of conductivity with sodium determination in the same sweat sample. J Pediatr (Rio J). 2000;76:443-6*

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# When you combine the dynamics of volume and concentration net losses can vary at least **13 fold** between individuals

- When you consider the large variation in sweat rates AND sweat sodium levels in humans and athletes, the resulting net sodium losses are potentially massive

- Several groups have looked at sodium losses during identical training sessions in squads with interesting results. One dramatic finding was an observational field study by Sandra Godek in 2010 who looked at 44 professional football players. **In 4.5hrs of training the sodium losses of the players ranged 13-fold from 2.3 to 30 grams**

- This large variation has been shown in other sports such as Premier League football, basketball and ice hockey. Furthermore a lower ambient temperature or shorter but high bursts of intense activity as with ice-hockey and basketball also results in high sodium imbalances

*Godek et al. Sweat rates, sweat sodium concentrations, and sodium losses in 3 groups of professional football players. J Athl Train. 2010;45:364-71*
*Maughan et al.Water balance and salt losses in competitive football. Int J Sport Nutr Exerc Metab. 2007; 17:583-94*
*Logan-Sprenger et al. Estimated fluid and sodium balance and drink preferences in elite male junior players during an ice hockey game. Appl Physiol Nutr Metab. 2011;36:145-52*

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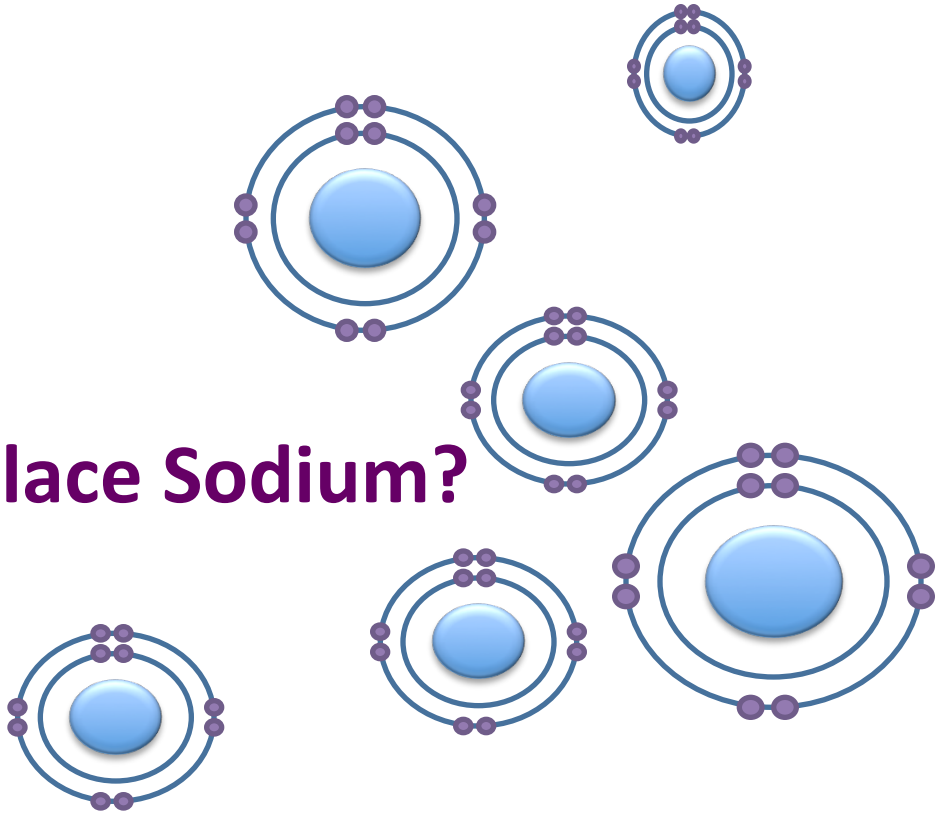
# But Why Bother to Replace Sodium?



# Because good evidence clearly suggests sodium management is necessary for active people to function at their best

1. Most athletes/players (even professionals) will **start training or match-play poorly hydrated**
2. The athletes/players will invariably lose sweat while training or match-play, some more than others
3. The sweat volume lost will vary depending upon environmental conditions
4. The electrolyte lost more than others is sodium with depletion possible within a few hours of training or racing
5. Sodium also happens to be the priority electrolyte in muscle contraction and nerve conduction
6. How much sodium is lost is a product of volume and sweat sodium levels
7. **Sweat sodium levels in athletes/players vary 9-fold** therefore net sodium losses are potentially massive between athletes/players even under identical conditions
8. Inadequate replacement will lead to **early fatigue, weakness, nausea, muscle fatigue and cramping**. With severe depletion there will be irritation, seizures and occasionally death

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There are always some naysayers however views of all the key credible experts support the evidence…

***"...the great individual variability in sweat and electrolyte losses of players in the same training session or match dictates that individual monitoring to determine individual water and electrolyte requirements should be an essential part of a player's nutritional strategy."***

Sherriffs *et al*. Journal of Sports Science, 2000

***"...need to individualise hydration strategies."***

Casa *et al*, 2000. National Athletic Trainers' Association position statement

***"....athletes should assess their hydration status and develop a personalized hydration strategy.... Sweat salt losses can be determined by collection and analysis of sweat samples. ....."***

Prof R Maughan. Scand J Med Sci Sports. 2010

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# But will replacing my Sodium levels increase my performance?..

**Good question! This is still a very new field with daily growing evidence base. This is the evidence so far.....**

Strong evidence for performance gains seen following sodium supplementation comes from a study published in 2005 by Coles and Luetkemeier. This study evaluated 14 cyclists performing a 15 min time trial. The cyclists were randomized to a sodium-free drink or a pre-exercise 164 mmol/L (3700 mg/l) sodium drink. Each cyclist undertook a 45-min session in a climate chamber at 70% maximal workload followed by a 15 min performance time trial. The cyclists who were pre-loaded with sodium showed a **significant improvement of around 7.8% performance gain compared to those that ingested the sodium-free drink**

Randomized crossover trials performed by Precision Hydration in controlled climate chamber conditions following a similar protocol to the study by Coles and Luetkemeier have demonstrated similar performance gains. In the Precision hydration trials the dose of sodium was customised to the sweat sodium analysis result and delivered *ad libitum* for 72 hrs prior to the trial. The dose varied from 500mg to 1500 mg (22 to 65 mmol/l respectively) which was much lower than the 3700 mg/l described by Coles. The overall performance gain in terms of power output in the 6 athletes tested **was 7.3% with the highest gains seen in the high sodium excretors (over 65 mmol/l in sweat) equating to 19.8%**.

*Luetkemeier et al. Dietary sodium and plasma volume levels with exercise. Sports Med. 1997;23:279-86*
*Precision Hydration Aug 2011 Trials, Porsche Human Performance (unpublished data)*

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# There is no doubt that not replacing lost Sodium will harm your performance

More evidence for sodium pre-loading in increasing performance comes from New Zealand in a study that compared the effect of a high and low sodium drink (164 vs. 20 mmol/l) on endurance-trained athletes running to exhaustion. **The sodium supplementation group showed improved hydration, lower heart rates and perceived exertion and greater times to exhaustion**

These findings have been replicated in the Precision Hydration trials where appropriate sodium supplementation depending on sweat sodium analysis resulted in lower heart rates and core body temperature while pushing on average a 4.4% higher power output. This increase was also seen while maintaining the same blood lactate levels and rates of perceived exertion

There is evidence that appropriate sodium supplementation also increases mental/ cognitive performance. The published evidence comes from work sponsored by Gatorade and has also been seen in Precision Hydration trials where **hand-eye coordination, reflexes and the ability to process complex mental tasks (Colour-Stroop test) were all improved with appropriate sodium supplementation**

*Sims et al. Sodium Loading Aids Fluid Balance and Reduces Physiological Strain of Trained Men Exercising in the Heat. Med. Sci. Sports Exerc., Vol. 39, No. 1, pp. 123–130, 2007*
*Pahnke et al. Sodium supplementation maintains serum sodium concentration and improves cognitive function in endurance athletes during exercise. Medicine and Science in Sport and Exercise. Vol 40; 5 supplement to May 2008, S86*
*Precision Hydration Aug 2011 Trials, Porsche Human Performance (unpublished data)*

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# Though not everyone agrees…there is as might be expected some contrary opinion and evidence... BUT

**But not everyone agrees with sodium supplementation and performance gains.....**

One of the first studies to look at sodium supplementation in elite sport was during the 2001 South Africa Ironman race where 145 volunteers were randomised to either a placebo or sodium supplementation with a 244 mg tablet. No difference in finishing time, serum sodium concentration before and after the race, or weight before and during the race.

*Looking at the paper closely there are some criticisms. The most glaring one is that there was no record kept on what each athlete drank or ate during the race. Furthermore, the supplementation group consumed an extra 3.6 mg of sodium during the race which equated to less than 300 mg/hr. Considering that published net sodium losses per hour range from 600 to 6000 mg/hr this supplementation is considered to be too low to have a meaningful effect on performance*

*The same criticism of using too low a dose of sodium supplementation can be applied to the study published by Merson in 2008. Only a small dose of 20 mmol/l sodium was used which showed improved hydration but no increase in performance*

*Hew-Butler et al. Sodium supplementation is not required to maintain serum sodium concentrations during an Ironman triathlon. Br J Sports Med 2006;40:255–259*
*Merson et al. Rehydration with drinks differing in sodium concentration and recovery from moderate exercise-induced hypohydration in man. Eur J Appl Physiol. 2008;103:585-94*

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# Cramp is a difficult subject area and has many possible causes, however one of them is certainly a loss of Sodium..

## The mechanism of cramps in sports is hotly debated with theories ranging from electrolyte depletion to neural imbalance to muscle fatigue

One area of performance that we have shown to benefit from sodium supplementation is cramping. Sodium imbalance appears to be important as shown by published work in cramp-prone professional players in the USA. This group was compared to players who had never cramped over a 2-day training camp. The cramp-prone players had much higher net sodium losses (5.1 ± 2.3 g vs. 2.2 ± 1.7 g). The cramp-prone group also had twice the sweat sodium concentration than the control population (54.6 ± 16.2 vs. 25.3 ± 10.0 mmol/L). In 2009 another similar study replicated these findings.

At Precision Hydration we undertook an analysis comparing athletes that were cramp-prone (often and always cramped) to those that scored themselves as 'never' cramped (33 vs. 49 athletes). The cramp-prone athletes had higher sweat sodium values (mean 56.2 ± 15.1) compared to the athletes who never cramped (mean 41.0 ± 11.6). This was a statistically significant finding ($p<0.001$; 2-tailed Mann-Whitney Test).

Importantly in all 33 athletes that we tested and recommended appropriate sodium supplementation we either dramatically reduced or stopped their cramping – a 100% response rate

*Stofan et al. Sweat and sodium losses in NCAA football players: a precursor to heat cramps? Int J Sport Nutr Exerc Metab. 2005;15:641-52*
*Horswill et al. Sodium balance during U. S. football training in the heat: cramp-prone vs. reference players. Int J Sports Med. 2009; 30:789-94*
*Precision Hydration Aug 2011 Trials, Porsche Human Performance (unpublished data)*

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# OK.. It Makes Sense So Far…….
# So How Much and What Do I Drink?

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Getting this right is about addressing two questions, more obvious is how much should I drink, less so is what should I be drinking?

**Replacing lost volume is crucial to performance. Adequate hydration aids thermoregulation and reduces heart rates during exercise**

Over the years there has been much confusion about how much to drink. This section will provide a simple and 'common-sense ' approach backed with current scientific methodology

Let's approach the subject looking at the following:

- American College of Sports Medicine. Position Stand on Exercise and Fluid Replacement
- What you can do as an athlete everyday to monitor your hydration
- What tools are available for more accurate monitoring

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# American College of Sports Medicine (ACSM) Position Stand on Exercise and Fluid Replacement

## A good guide for every athlete

**Before Exercise**

Ingest 500 ml fluid 2 hrs before exercise to allow adequate hydration and allow excessive water to be excreted by the kidneys

**During Exercise**

*".....individuals should be encouraged to consume the maximal amount of fluids during exercise that can be tolerated without gastrointestinal discomfort up to a rate equal to that lost from sweating....."*

*American College of Sports Medicine position stand. Exercise and fluid replacement. Med Sci Sports Exerc. 1996 Jan;28(1):i-vii.*

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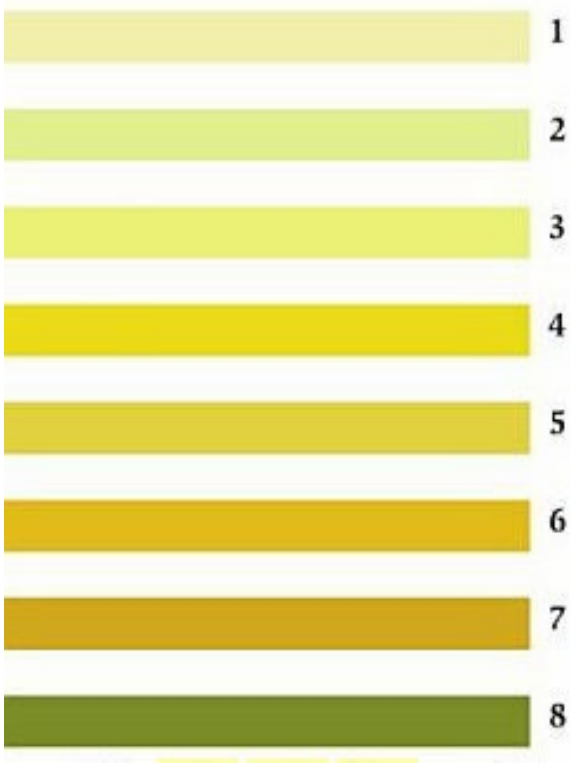
# How to Monitor Your Own Hydration

**Are you well hydrated to begin with?**

An easy test is to monitor the colour of your urine. Use the Armstrong Urine Chart to see where you are

You should try and maintain Grade 1, 2 or 3. Increase your intake if Grade 4 or higher

This chart works well for daily hydration as well as maintaining adequate hydration during competition or tournaments

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# How to Monitor Your Own Hydration

## How Do I Maintain Hydration During Sport?

As the ACSM recommends, figure out your sweat rates simply replace what you lose

The simplest way to do that is to **weigh yourself** before, during and after training or competition (if possible) and replace each 1g loss with 1ml. So, for example 1.2kg loss would be replaced with 1200mls of fluid. Use this along with the Armstrong Urine Chart to increase accuracy

Also drink to thirst. Thirst is dictated by your brain getting feedback from osmoreceptors in your body.

*Top Tip*

*Use the same (preferably medical quality) scales and same location to increase accuracy*

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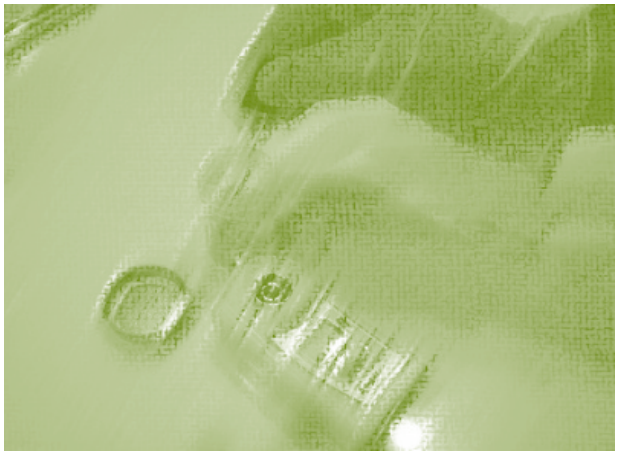
# Tools Available to Monitor Hydration Better

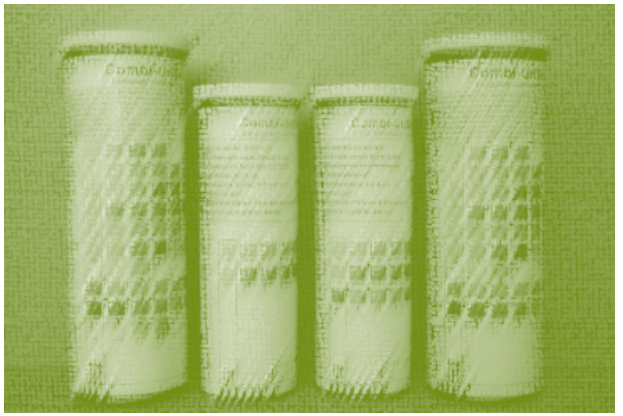
## Urine Osmometer

This machine is used by sports scientists typically in the first voided urine sample to assess level of hydration. It evaluates the concentration of dissolved salts and sugars in urine. The higher the reading the more dehydrated your are. Normally >900 mosm/kg indicates that fluid intake should be increased



## Urine Specific Gravity

This test looks at urine concentration and gives a reading between 1.000 (equivalent to water) to 1.035 (very dehydrated). The test can be done as a urine dipstick which is inexpensive



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# Ok… That's 'How Much' Sorted
# Now How About What To Drink?

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So how much should I drink can be managed, what should I be drinking given the wide range of difference between people is rather more difficult.

Generally we recommend that you **separate** your energy and electrolyte requirements

It makes little sense for anyone competing a short duration low intensity race to take on a high sugar load found in a conventional sports drink when what they need is electrolytes lost in sweat. Separating the two components also allows you to have greater flexibility to adjust each depending upon your requirements during training and competition

The American College of Sports Scientists Position Statement suggests:
*"…. during exercise lasting less than 1 h, there is little evidence of physiological or physical performance differences between consuming a carbohydrate-electrolyte drink and plain water….."*

*American College of Sports Medicine position stand. Exercise and fluid replacement. Med Sci Sports Exerc. 1996 Jan;28(1):i-vii.*

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# Which Electrolyte Drink?...ACSM Recommendation

The American College of Sports Scientists Position Statement on electrolyte replacement is clear.....

*"..... a primary rationale for electrolyte supplementation with fluid replacement drinks is, therefore,* ***to replace electrolytes lost from sweating***

*".....drinking water can lower elevated plasma electrolyte concentrations back toward normal and restore sweating,* ***but complete restoration of the extracellular fluid compartment cannot be sustained without replacement of lost sodium.....***"

*".... since it may be advantageous in enhancing* ***palatability, promoting fluid retention, and possibly preventing Hyponatremia...."***

*American College of Sports Medicine position stand. Exercise and fluid replacement. Med Sci Sports Exerc. 1996 Jan;28(1):i-vii.*

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# Which Electrolyte Drink?... European Commission – Scientific Committee on Food

Report of the Scientific Committee on Food on composition and specification of food intended to meet the expenditure of intense muscular effort, especially for sportsmen
Report SCF/CS/NUT/SPORT/5

***"....the only electrolyte added to drinks consumed during exercise that is known to confer physiological benefit is sodium...."***

http://ec.europa.eu/food/fs/sc/scf/out64_en.pdf *(accessed Dec 2011)*

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Which Electrolyte Drink?...our view

*Choose A Drink That Closely* ***Matches***

***Your Sweat Sodium*** *Losses…*

*Especially If The Exercise Lasts More Than 1 hour*

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# How Do I Get My Sweat Sodium Levels Tested?

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# Sweat Sodium Analysis…How its done

The methods described in the scientific literature and those currently in use involve placing patches on various parts of the body & exercising you until the patches become saturated with sweat. The patch is then squeezed into a bottle and taken to the lab for analysis

A new patented technology developed by **Precision Hydration** involves inducing a sample of sweat using a chemical called pilocarpine on your forearm. The test takes 20 min and does NOT involve exercising. The sweat sample is collected over a small 2 ½ cm (1 inch) area on your forearm and the saltiness of your sweat analysed to give **a number that is unique to you.**

The test is a **one-off test**

Hydration to provide an **individualised hydration strategy specific to you** and the conditions under which you race and train

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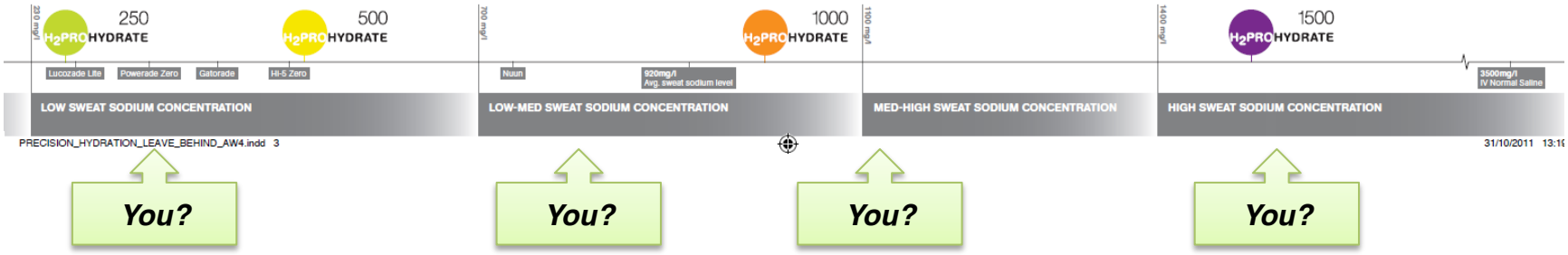
# Your Personal Hydration Strategy [www.myh2pro.com](http://www.myh2pro.com)

Based upon your sweat sodium levels and variables such as training intensity, duration and ambient conditions a strategy is recommended that **aims to replace your sweat losses as you exercise**

Precision Hydration uses 4 products in the form of effervescent tablets (1 per 500ml) to provide the ideal strategy. The products are labeled H2ProHydrate 250, 500, 1000 or 1500 depending upon levels of sodium per liter of constituted drink




H2PRO HYDRATE

# H2Prohydrate products have been developed to match the wide variation in sweat composition found between people & to provide individual like for like replacement

H2Pro Hydrate products replace 250, 500, 1000 or 1500 mg of sodium per liter (when mixed as 1 tablet per 500ml)

We have demonstrated that the average sweat sodium value is 920mg/l but that distribution across the range is relatively flat. This is not like shoe size!

Based on your sweat sodium score and volume of sweat loss a recommendation for the most appropriate combination of H2Pro Hydrate drinks can be made.

This often means using plain water and H2Pro Hydrate 250 for light training sessions and hydrating effectively when not training. A combination of H2Pro Hydrate 500, 1000 and 1500 are likely to be more appropriate for times when you are training hard, for long durations or in the heat.

No other sports drinks are available with different compositions to match different sodium requirements (nor are they able to offer a simple sweat test to measure your sodium losses)

In fact most sports drinks are not strong enough for the majority of people (drinks currently available only provide between 250 and 500mg/l)

**A range of drinks specifically designed to fit the differences found in human sweat composition**

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# Some FAQ’s and Myth busters

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# What's The Difference Between All The Different Drinks On The Market – It's Confusing!

**Rather unhelpfully the sports drink industry has confused hydration with fuel, with recovery and just about anything else you can think of**

Sports drinks can now by conveniently classified into the following

- ❑Protein drinks (no carbohydrates)
- ❑'Energy' drinks
- ❑Carbohydrate drinks (with or without electrolytes)
- ❑Carbohydrate + Protein drinks
- ❑Electrolyte only drinks

**Let's look at each one in turn with their relative merits and drawbacks**

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# Protein Drinks (Little or No Carbohydrates)

Examples…
USN Pure Protein IGF-1
Maximuscle Promax MyProtein Impact
Whey Protein

Popular amongst bodybuilders. These are primarily designed to **aid muscular recovery** post exercise or to act as a **dietary protein supplement** They are **not aimed at re-hydration** specifically but some (usually marketed as 'Recovery' drinks) do contain small amounts of electrolytes and carbohydrates so contribute something to restoring muscle glycogen and fluid balance after exercise

**Protein drinks are not unhelpful in muscle recovery situations but will not deliver to training/race hydration needs and are typically too light in electrolyte content to help massively with fluid balance post event. Certainly not part of your race hydration!**

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# What About Energy Drinks?

Examples…
RedBull
Relentless
Monster
Kick Energy

These drinks usually contain a **lot of sugar (8-12%) and caffeine** (or natural sources of it such as guarana). They **are not really 'sports drinks'** but are marketed at sporting events and the companies behind them sponsor many top athletes and events, even though athletes are unlikely to be drinking them. They are **too sugary to work as effective rehydration** drinks (above 6-8% carbohydrate fluids are hypertonic and absorption through the gut slows down) and are **often strongly flavoured and carbonated** making them largely unsuitable during exercise

**Sugars are typically higher than concentrations in blood plasma making the drinks hypertonic and so more difficult to absorb through the gut. Unlikely to contain electrolyte volumes found in sweat loss**

**Please avoid for general hydration requirements!!**

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# But Aren't Carbohydrate Drinks Recommended?

Examples…

Lucozade Sport

Powerade

Gatorade Thirst Quencher

These are the 'original' sports drinks typically with **6-8% 'isotonic' carbohydrate solution** to deliver energy and combat dehydration. They often contain modest amounts of electrolytes (approximately 200-350mg/l sodium) to assist with electrolyte replenishment and increase palatability. They have been proven effective in boosting endurance performance for activities lasting > 1hr at a suitably high intensity

One major issue with these drinks is that if they are used at times when fluid requirements are very high (e.g. in the heat or during very long events) and an athlete is drinking a lot of them they are **consuming an unnecessarily large amount of calories** which could lead to gastric upset

**They serve a purpose but have some of the issues of energy drinks and typically will not deal with the electrolyte needs of most people. Mixing energy and hydration needs in one drink will create imbalances in different conditions since often energy and hydration needs are at different ends of the scale**

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# How About New Protein+Carbohydrate Drinks?

Examples…
Accelerade
High 5 4:1

Carbohydrate + Protein combinations are a **relatively new concept** that has attracted a lot of attention recently. They have been shown to **outperform carbohydrate only drinks for muscular recovery** after strenuous training. Some evidence also exists that they can boost performance when consumed during endurance exercise. Most also contain some electrolytes (300-400mg/l sodium)

As with carbohydrate only drinks if they are used at times when fluid requirements are very high (e.g. in the heat or during very long events) and an athlete is drinking a lot of them they are consuming a huge amount of calories which may be unnecessary and lead to gastric upset

**Possibly better than carbohydrate only drinks for recovery and endurance but again low in electrolyte and so not a great hydrator. Suffer same issues as carb/electrolyte drinks in that during periods of high fluid loss (hot/humid/long/intense) the high sugar levels are not required and can lead to gastric upset**

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# So Are Electrolyte's Only The Answer?

Examples…
H2ProHydrate
Hi5 Zero
Nuun
Elete Water

Electrolyte only drinks contain no or negligible amounts of carbohydrate/sugars and no protein so are **designed simply to maximize hydration. They are hypotonic so are absorbed more rapidly** in the gut than carbohydrate drinks. Whilst electrolyte only drinks do not provide carbohydrate or protein sources to meet the energy demands of exercise products such as energy gels and bars can consumed with them. This **allows an athlete to fine tune/balance their intake of fluids, electrolytes and calories separately** depending on the ambient conditions, length and intensity of the activity they are taking part in. Electrolyte only drinks **can be used before, during or after exercise** to replace fluids and electrolytes without the addition of carbohydrates or other calories if they are not require

**Well yes! But everything you have learnt so far is that there is more than a bit variation in electrolyte loss so these will be better than water but not as effective as an electrolyte replacement regime that matches what you are losing in volume and COMPOSITION!**

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# Did You Just Say That Electrolyte Drinks Are Better Than Water?

## Strange concept isn't it? How can an electrolyte drink be better than water?

A recent study done on actively working firefighters showed that firefighters have to drink less of an electrolyte only drink compared to water to produce the same level of hydration

We have replicated this finding in our Precision Hydration trials evaluating H2ProHydrate vs. Evian Water. In the 6 athletes tested the urine specific gravity showed that those on electrolyte replacement had better levels of hydration compared to water alone despite producing higher output under thermal stress

| **Median Specific Gravity values for 6 athletes:** | |
|---|---|
| **Start value on water:** | **1.005** |
| **Finish value on water:** | **1.013** |
| **Start value on H2Pro:** | **1.005** |
| **Finish value on H2Pro:** | **1.010** |

*Cuddy et al. Effects of an Electrolyte Additive on Hydration and Drinking Behaviour During Wildfire Suppression. Wilderness and Environmental Medicine, 19, 172 180 (2008)*

*Precision Hydration Aug 2011 Trials, Porsche Human Performance (unpublished data)*

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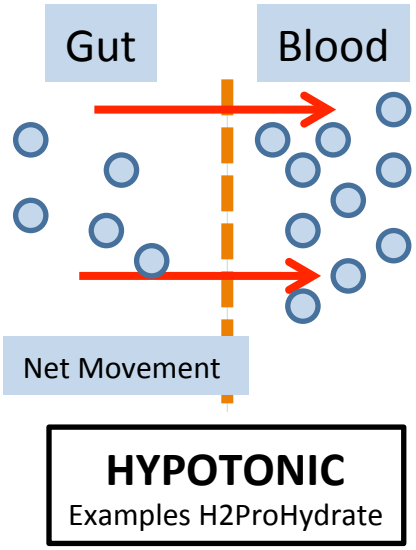
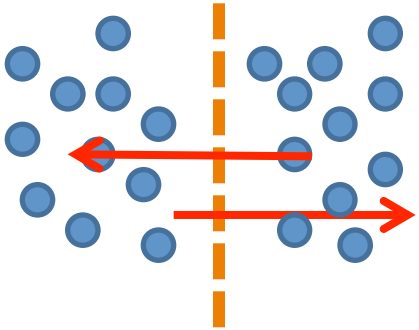
# What is the difference between Hypotonic… Isotonic and Hypertonic Drinks?

**To grasp this you have to first understand the concept of plasma osmolality in your body**

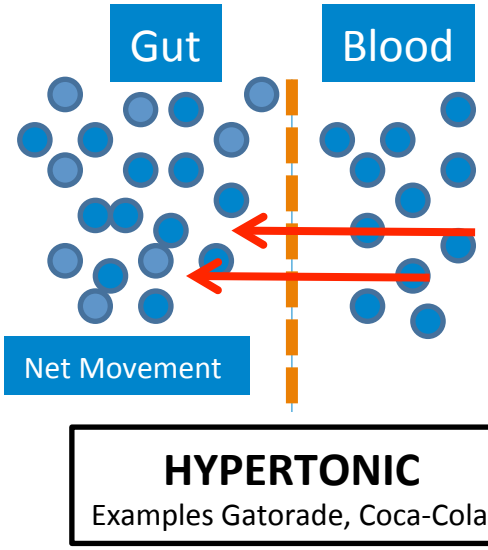
This is the number of dissolved salt and sugars in a unit of plasma. This figure is tightly regulated **between 275-299 mosm/litre** The more dehydrated you get the higher your plasma osmolality. For your sports drink to move across from the gut to the blood it needs to be less than (hypotonic) than plasma osmolality. Isotonic drinks mean there is movement of fluid both ways. Hypertonic drinks will cause fluid to move from the blood and into the gut.




**HYPOTONIC**
Examples H2ProHydrate



**ISOTONIC**
Examples Powerade




**HYPERTONIC**
Examples Gatorade, Coca-Cola

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# What About Differences Between Hypotonic, Isotonic and Hypertonic Drinks?

Whether a drink is hypotonic, isotonic or hypertonic is important for absorption. There is also recent evidence that hypotonic drinks may also impact on performance and promote athlete comfort

A study published in 2011 compared a hypotonic drink (Mizuno Rapid) at 218 mosm/l to an isotonic drink (Powerade) at 281 mosm/l to a hypertonic drink (Gatorade) at 327 mosm/l. Athletes on the **hypotonic drink achieved highest peak power, had faster absorption rates and greatest gut comfort**

*Rowlands et al. Unilateral fluid absorption and effects on peak power after ingestion of commercially available hypotonic, isotonic, and hypertonic sports drinks.*
*Int J Sport Nutr Exerc Metab. 2011;21:480-91*

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# Will My Sweat Sodium Analysis Number Vary?

The sweat analysis number that you get from forearm testing is unique to you and is part of your genetic makeup. The number is relatively fixed although with acclimation humans tend to adapt to their surroundings

Work on heat acclimation in athletes has shown that with repeated exposure to heat and humidity your body will tend to reduce losses of most sweat electrolytes. There is **no change with 7 hrs exposure** so you are unlikely to need to alter your regime even in a very long race. **At 4 days exposure sweat sodium levels will drop by about 18%. By Day 10 as you fully acclimatize the drop will be around 40%. However, your sweat rate will increase by around 6%**

*Chinevere et al. Effect of heat acclimation on sweat minerals. Med Sci Sports Exerc. 2008 ;40:886-91*
*Montain et al. Sweat mineral-element responses during 7 h of exercise-heat stress. Int J Sport Nutr Exerc Metab. 2007;17:574-82*
*Petersen et al. Partial heat acclimation in cricketers using a 4-day high intensity cycling protocol. Int J Sports Physiol Perform. 2010;5:535-45.*

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# Is The Forearm The Best Place to Measure Whole Body Sweat Concentration?

**Good question!** There is massive regional body variation in sweat concentration and this is one of the problems with patch testing.

In the February 2010 issue of Canadian Running, an editor put a commercially available sweat patch kit from Medion to test and obtained a value of 1102 mg/L sodium. He also underwent a lab-based test at the Gatorade Institute and obtained a range of values from 2,069 mg/L of sodium from the forehead patch, 1,908 mg/L from the back, and 1,563 mg/L from the chest. This shows a large variation (almost a doubling) of the results obtained by Medion patch testing and lab-based tests

We choose the forearm as medical research has shown it is one of body regions that most accurately represents whole body sweat (correlation coefficient 0.88). The others are the thigh and calf. The forearm remains the most convenient.

*Patterson et al. Variations in regional sweat composition in normal human males. Exp Physiol. 2000 ;85:869-75*
*www.runningmagazine.ca/2010/02/sections/health-nutrition/body-work/lab-rat-theories-put-to-the-test-sweating-by-numbers*

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Our Summary then

- ✓ **Figure out how much sodium you lose in your sweat**
- ✓ **Replace your sweat losses with a like-for-like replacement in both volume and composition**