



Safety Management System

Safety Bulletin

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Safe Hydration and Inflight Relief

Safety Bulletin No 01/22 addressed hazards associated with overheating, heat stress, heat exhaustion, and dehydration, in the context of scenarios affecting gliding activities. Authoritative advice from NSW Health was cited.

That generated healthy discussion about similar experiences and scenarios, along with dialogue concerning recommended hydration practices, and risks associated with over-hydration and salt imbalances. This bulletin discusses guidance on safe hydration practices, appropriate for most reasonably healthy pilots, underpinned by advice from aviation medical experts.

Note: This bulletin does not discuss medical issues concerning complications associated with comorbidities and any underlying health conditions that may affect body temperature regulation, gastric and kidney function, and metabolisation of salts, sugars and water. *Any pilot with such conditions must seek advice from their medical practitioners. Any pilot in doubt concerning appropriate fluid intakes must seek advice from their medical practitioners.*

HAZARDOUS SCENARIOS

Consider the following scenarios and your potential exposure to similar circumstances:

Hot Pilot with Heat Distress leading to Over-Hydration – A pilot over-exerts on the ground and shows signs of heat distress. They consume a large quantity of water, yet they continue to feel hot, with ill effects of overheating. This leads to them consuming yet more water, leading to feelings of nausea, vomiting, extreme tiredness, then trembling and spasms. An ambulance is called...

Long flight with Water, No Electrolytes or Sugars, Ill Effects – A pilot undertakes a long dual cross-country motor-glider flight of many hours duration in hot weather, carrying plenty of water, with no added electrolytes and sugars. The pilot drinks plenty of water, feels quite full, but mid-flight begins to lose concentration, suffers a severe headache, with nausea, then eventually hands over control and flight management to the co-pilot, who lands safely. If the pilot had been solo, the flight may have been cut short, or may not have ended well.

Long Flight with Avoidance of Urination – A pilot flies on a long cross country, without any means of inflight relief. The day is hot, and the pilot is anxious to avoid urination. As a result, the pilot avoids fluid intake and gradually dehydrates, resulting in heat distress and seriously degraded inflight performance. The pilot nearly crashes on landing.

Do any of these scenarios sound familiar?

What should be done instead?

POSITIVE SCENARIO

Competition Pilot – A highly skilled and accomplished gliding competition pilot puts much effort into staying in good condition. They remain current and in practice in cross-country flying, and longer local soaring flights in weak conditions. They take care with hydration prior to flights, routinely carrying a hydration backpack with several litres of a balanced sports electrolyte, with both sugars and salt dissolved in water. Light nibbles and nourishment are also consumed in flight. In-flight relief is also used, with urinary output aiding both comfort and body salt balance. Their in-flight work cycle includes a deliberate refresh routine with intake of fluids at the top of thermals and prior to any high activity phase, including circuit and landing. They suffer no ill effects; their consistent well-being is in fact a performance enhancement.

How well do your preparations and inflight arrangements correlate with this?

What could you do differently?

SYMPTOMS, MEDICAL ISSUES AND ADVICE

There are hazards associated with over-hydration. Those hazards are exacerbated by excessive ingestion of water not containing electrolytes (most notably sodium) and no sugars. A balanced intake is important.

Some members may have heard of a condition called hyponatremia; this occurs when the concentration of sodium in your blood is abnormally low. Sodium is an electrolyte, and it helps regulate the amount of water that's in and around your cells.

In hyponatremia¹, one or more factors — ranging from an underlying medical condition to drinking too much water — cause the sodium in your body to become diluted. When this happens, your body's water levels rise, and your cells begin to swell. This swelling can cause many health problems, from mild to life-threatening.

Hyponatremia signs and symptoms may include:

- Nausea and vomiting
- Headache
- Confusion
- Loss of energy, drowsiness and fatigue
- Restlessness and irritability
- Muscle weakness, spasms or cramps
- Seizures
- Coma

Limited fluid intake, medication and hospitalisation may be required.

So, water intake is not the whole answer. Pilots must maintain safe hydration, which also means two things:

- An intake of electrolytes with fluids, to maintain balance of salts in the body, and
- For mid to long duration flights, urinary output by safe and comfortable means, to maintain balance of salts in the body and elimination of wastes.

Higher urinary output is inevitable with electrolyte drinks. It is a sign you are doing the right thing.

¹ <https://www.mayoclinic.org/diseases-conditions/hyponatremia/symptoms-causes/syc-20373711>

Here, I wish to cite Dr Ken Wishaw MBBS FANZCA, a GFA member and pilot who has written on this subject in the CASA Flight Safety Journal No 10², May-June 2010.

Dehydration is an often-forgotten factor in safety and performance in our sport.

As a medical specialist (anaesthetist), fluid physiology and fluid management is a central part of my practice every day.

Commonly I hear people only using water to counteract their fluid loss from sweating on hot days, obviously not realizing that strict adherence to water only may in fact degrade performance to the point of being hazardous.

A few facts needed to be understood as to why this is so. If basic arithmetic and technical details turn you off, skip to the recommendations!

Our blood and body fluids normally contain 135-150 millimoles (mmols) of sodium and 100 mmols of chloride per litre.

We probably sweat at around ½ to 1 litre per hour on a hot day while gliding. Additionally we lose water at high altitude from breathing air that has a low water content.

What we lose in sweat depends partly on our genetic makeup, but more importantly on whether we are acclimatized. The more acclimatized we are the less sodium and the more potassium we lose in our sweat. Sodium losses for a person that is well acclimatised is of the order of 5-30 mmols per litre. For someone who is not acclimatised (say an office worker who flies one or two days a week) sodium losses in sweat may be of the order of 40-100 mmols/litre.

(As a crude way of gaining an appreciation of these figures, one level teaspoon of table salt, which is just sodium chloride, dissolved in a litre of water equals approximately 100 millimoles per litre).

We do possess a very sophisticated sodium control system in our bodies that works well providing we are sufficiently hydrated to produce reasonable amounts of urine. Most of us readily excrete excess sodium in our urine. Conversely, we also have a specific salt appetite. Glider pilots with low sodium levels often love salty foods at the end of the day!

Ingestion of water to replace sweat losses will decrease the sodium concentration in our blood, as we are not replacing the sodium that we are losing. Severe acute decreases in blood sodium (say 10%) may cause headaches, lethargy, apathy and confusion. Severe acute decreases (over 15%) may cause convulsions. While this is extremely unlikely to occur in our sport, cases of convulsions occurring in top athletes who only use water replacement are documented. Suffice to say even the mild symptoms are highly undesirable for a pilot!

Potassium losses may cause low blood pressure and weakness.

Small amounts of sodium and potassium in rehydration fluids increases the rate at which the gut can absorb the fluid. Drinking only water, apart from leaving you still dehydrated (because you haven't absorbed the fluid) can make you feel bloated and nauseous.

Pure water ingestion tends to shut off the thirst reflex, even when we are dehydrated.

Taste is a critical factor on whether athletes drink adequately during exercise. Some people love pure water, others loathe it.

High carbohydrate drinks such as energy drinks, fizzy drinks and fruit juice contain 10%-30% carbohydrate. Levels of carbohydrate over 8% inhibit intestinal absorption of the fluid. None of these are appropriate for rehydration during flight.

Sports drinks are not excessively high in sodium. At recommended strengths they contain 10-25 mmol/litre. They are also designed to replace potassium losses. They do contain carbohydrate but this is of the order of 6% which will not impede absorption or cause large fluctuations in blood sugar levels.

Recommendations

Guiding principles (on the basis that you are essentially fit and healthy) should therefore be

- Do not take off already dehydrated. Remember ground preparation is sweaty stuff
- On short flights, whether we drink water or an electrolyte replacement is not critical.
- On longer flights (say over two hours) we should be aiming to replace what we are losing. Sports drinks are appropriate for this. As we are a "light physical activity in a hot environment", some dilution from the recommended concentration can be used if this makes it more palatable. Which one is not as critical as what tastes good to you.
- The carbohydrate (sugar) content is not harmful. Carbohydrate ingestion could only lead to a problem if a large carbohydrate load is taken at widely separated intervals, with the risk of insulin over secretion and low sugar levels occurring some hours later. If you don't want so much glucose,

² <https://bit.ly/3A27I3j>

then mix the sports drink powder in a glass first then decant into your drink container. As the electrolytes dissolve faster than the sugar, you can leave some of the sugar behind. Alternatively rehydration effervescent tablets e.g Hydralyte do not have excessive sugar.

- Never take high sodium loads such as salt tablets.
- Food will help contribute to electrolyte intake
- Heavy coffee and tea drinkers are prone to severe headaches on acute withdrawal. Recent studies have shown that caffeine is not deleterious to sport performance and a small amount on the long flying day before or after the flight is OK.
- For the technically minded or undertaking long flying you should meet these three criteria at the end of the flight.

1. Body weight loss should be less than 5%.
2. Urine colour should be pale (drugs and B vitamins can alter this).
3. Urine volume should have exceeded 0.5 (ideally 1.0) mls per kilo per hour.

By way of example, I undertook two seven-hour mutual flights on successive days in a Super Dimona motor glider. Both days were hot and dry, and the tasks were identical.

On the first day I stuck to a water regime. By the end of the day, I was nauseous, bloated had a severe headache, and mild dizziness. I opted to let the other pilot (and aircraft owner!) to do the landing. My urine output was very poor.

The following day was identical except that I used a sport drink. At the end of the day, I had none of the effects of the previous day (and a far healthier urine output). We flew and landed safely under my control!

THE ELEPHANT IN THE ROOM

Many pilots do pay attention to fluid intake, but scant attention to inflight relief. The elephant in the room is adequate provision of inflight urinary relief, safe and comfortable arrangements to pee properly.

Failure to make these arrangements can have the following consequences:

- Peeing your pants inflight, with accompanying discomfort and embarrassment on landing
- Holding on, landing with a full bladder, with great discomfort, increased risks of pain, discomfort, dehydration and kidney complaints
- Dehydration and heat distress, body salt imbalances, degraded performance
- Combinations of the above!

So, let's have a conversation about this. Let's discuss what works, and what doesn't work.

Yes, we must acknowledge that options for male pilots are greater than for female pilots. To state the obvious, one size does not fit all.

For some pilots, various kinds of catheter, sheath or receptacle draining into a reservoir, bladder or pee tube are good options. Devices such as "Uridomes" and "Sheweets" are used by some pilots. Others use the trusty recycled wine cask bladder with removable rubber valve, and various portable receptacles. Leakage risks vary for these options.

Some pilots choose to fly with incontinence pads or pants. There is a temporary discomfort factor, offset by simplicity and usually no leakage.

Our airworthiness colleagues will remind us that pee tube drainage can be a factor in causing corrosion in metal components in fuselages. Cleaning of urine drain lines and prevention of corrosion in adjacent structures can be an unpleasant task. GFA AD 688³ Issue 1 modified 29 June 2020 *Corrosion of Controls and Fittings in Aft Fuselage* refers.

³ <https://bit.ly/3fffHNt>

MITIGATING THE HAZARDS

From the above, there are self-evident hazard mitigations:

- Manage your personal fitness to fly, and the well-being of your gliding colleagues
 - IMSAFE
 - Seek medical advice regarding any underlying conditions
- Ensure good hydration pre-flight, pre hot work
- Ensure adequate and balanced hydration inflight or during hot work
 - For short flights, use water or electrolyte drink
 - For long flights, use an electrolyte drink
- A reliable and comfortable inflight relief system is essential for mid to long duration flights
- For someone suffering heat distress and dehydration, avoid over-hydration
 - Keep calm, manage stress levels – anxiety may contribute to over-hydration
 - If in doubt, or adverse symptoms are seen, seek professional medical attention.

Note that while the probability of over-hydration is lower than that of dehydration, amongst healthy individuals in hot environments, the consequences of both are serious, may be debilitating.



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Know thyself. Keep safely hydrated and avoid situations where over-consumption of water might put you or colleagues at risk. Use electrolytes to ensure balanced salts and avoidance of ill-effects. Hydrate safely inflight, and pee regularly via comfortable arrangements. Further dialogue is welcomed.

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⁴ Illustration: Flight Safety Magazine 2015 Collector's Edition – Aviation Medicine <https://bit.ly/3I7LwaF>