



# SOARING Rx

BY DR. DANIEL L. JOHNSON

## Isotonic Volume Loss

### When Dehydration is not *De-hydration*

Oscar's soaring juices were running. A cold front had swept through yesterday evening. Though cool, the early-April day promised bases at 6,000' and strong lift; perfect soaring. The day's high was to be about 60, the sun was shining. He zipped through breakfast and assembled his gear, logger, and a snack – and warm clothes, because the temperature at cloud base would be in the mid-thirties. He was on the ramp by 9:30, to start assembling.

He took his time, being extra-careful because it would be his first flight of the season. It was sunny, and pleasantly cool; the trees along the airport border were still thinking about whether to put out buds. After he finished assembling and was ready to tow out to the staging line, Oscar felt a little surprised that he needed to pee. It had only been a little more than an hour, and because it was so cool he hadn't been sweating and hadn't been thirsty. He put one bottle of water in the cockpit and made a pit stop.

It was indeed a glorious day. The only drawback was that it was pretty cold under the clouds. He used his relief system several times, and had a snack. He took a few swigs from his bottle to wash down his snack bars, but really wasn't thirsty at all.

After four hours, he was glad to be nearing home. His feet were cold, and during his last climb to cloud base he started shivering a little. This quickly stopped when he flew out from under the cloud's shadow and the sun warmed his clothes. He threw away thermal after thermal as he sped home on final glide.

He warmed up during the physical activity of trailering his glider. He was glad that the inconvenience of all that frequent peeing in the glider had stopped. He put his GPS logger and the other

detritus along with his warm clothes in the pickup and happily drove home.

An hour later, a nagging headache began. He took a couple of ibuprofen with a glass of water, and short time later realized that it seemed to have made him nauseated. He really didn't feel like eating much at supper, and afterward, it seemed like too much effort to upload his log file to OLC. He felt a little dizzy when he walked around the house, so he sat in front of the TV and quieted his stomach with a couple of beers, then got ready for bed.

He noticed with mild surprise that it was the first time he'd peed since he'd landed. His urine was dark.

The next morning, he felt sluggish and headachy. He wished he could have called in sick, but there was an important all-day meeting. At least he wasn't sick to his stomach. He had an extra glass of orange juice with breakfast, and drove to work.

All morning, his head felt thick. He had coffee three times and still it wasn't quite clear. After lunch, he felt especially thirsty for some reason, and had three glasses of water in the first part of the afternoon's session.

Finally, about 3 pm, his brain started feeling normal, and energy returned.

### What happened to Oscar?

"Cold exposure can cause substantial fluid loss, causing individuals to dehydrate by 2-5% of body mass." [European Journal of Applied Physiology, Volume 92, Numbers 4-5, 565].

"Exposure to an environmental temperature of 59dF (15dC) is sufficient to trigger diuresis in an individual." [Forensic Pathology, Di Maio & Di Maio CRC Press, 2001]

In case you don't want to do the arithmetic, let me point out that 15 degrees Celsius is not "cold," and in fact most

people feel it's an ideal temperature for physically vigorous activity. Of course assembling may qualify as vigorous activity, but piloting is not.

And, for our average Wisconsin Portly Packer-Backer, this 2-5% weight loss is *four to twelve pounds* (2-5 kg)!

### Cold Diuresis

Here's the deal: when we begin to cool down – without ever *feeling* chilled – our bodies protect our core temperature by first constricting the superficial veins under the skin, then the deeper veins and arteries. This reduces the total volume within our blood vessels (*intravascular volume*). As we had enough blood to fill them before, now we have too much blood for the available space.

Where does this go? Right. Out the kidneys, into the emissions-control device, to be voided at intervals. ("Die-ure-sis: increased excretion of urine.") And if we're cooling down quickly, those intervals get pretty frequent. By the time we've been in the cooler for a few hours, we may be well into that 2-5% range.

There are two important factors at work here:

One is that we are losing the *liquid* of our blood: this is not merely water, it is *salt-and-water!* Yes, we are getting dehydrated, but it's not purely water we are losing. We are losing both salt and water, because blood is a balance solution of salt and water and miscellaneous particulate matter. The particulate matter can't be expelled so easily (that is called "bleeding"), so it gets more concentrated.

The other is that when we warm up we need to replace this lost *volume*. ("Volume" is a technical medical term meaning "water plus other stuff.") It's not enough to merely drink, we must also eat salt. Which we prefer to take in the form of brats, chips, or cheese, one of the reasons that soaring clubs don't keep a salt block at the clubhouse (the other reason being that this would attract wild animals, who are smarter about salt than people, but which we'd not prefer to see lolling about on our runways).

So Oscar had experienced *cold diuresis* and this made him *volume depleted* when he warmed up again and his blood vessels re-expanded. There isn't any fluid-storage area in our bodies!

He failed to replete his volume: partly because volume loss does not cause



thirst until it's rather severe (4-5%), and partly because one of the consequences of volume depletion is, ironically, nausea – which sort of gets in the way of solving the problem, don't you know.

He also suffered the other consequences of volume depletion: headache, lassitude, and mental dulling. (Honestly, part of a hangover is probably volume depletion from the diuretic effect of alcohol, not that this has anything whatever to do with gliding.) Of course, Oscar's beers didn't really contribute as much to volume repletion as V8 juice would, even though they were more fun.

If Oscar were Finnish, he might have taken a sauna in the false hope of "revivification." Such an act might actually lead to loss of consciousness without preparation – enthusiastic eating of salty food and drinking of water. (A faint in the sauna might lead to the very expensive 9-1-1 phone call and a lot of costly and wildly misdirected medical tests and interventions by physicians lacking the basic knowledge about Oscar getting mildly cold and failing to replenish blood volume. But, I digress.)

### This isn't a purely Northern Problem

Think about it: what's the temperature at cloud base? The dewpoint? In the desert west, that's usually pretty low, certainly below 60F.

In the mountainous desert, it's often really hot on the ground, and pretty cool up high. So we sweat like pigs until we've climbed significantly, and hydrate aggressively all the while.

Then we cool down as we soar around, and the magic of *cold diuresis* gets rid of all that and more. In fact, if we forget to hydrate aggressively in preflight, going high and getting cool will save us from our own foolishness, for our vasculature shrinks around our smaller blood supply. This is very convenient.

Regardless, we *must* rehydrate as we warm up. *With electrolyte solution.* If it's hot, or we work hard, we sweat; and in our sweat lose some salt as well as water. If it's cool and we have cold diuresis, we lose water and lots of salt. Either way, when we get warm again, we need to rehydrate with salt as well as water. Sport drink is ideal after sweating; however, it's doesn't have enough salt to restore the volume lost through cold diuresis.

The two drinks with a salt content closest to blood are, interestingly, tomato juice and V8 juice. (No, a quart-size Bloody Mary is not what I was thinking, dear!) Otherwise, here's the permission you wanted to have salty food along with your beverage. (You were going to do that anyway, but now you don't need to feel medically guilty.)

### Duration

It is important to note that the after-effects of volume depletion are long lasting. In my own experience, the symptoms have lasted about 24 hours even when I realize within 3-4 hours that I've failed to hydrate. In patients depleted from diarrhea or vomiting, I've seen the nausea and lassitude last for 3-5 days.

So hydration does matter, and it needs to be done while we're getting warm (or hot, depending on one's location).

It's *impossible* to "hydrate" while our body is cooling; we are not in any sense camels, and all this might do is create some edema (tissue swelling) if the kidneys can't excrete the excess blood volume.

### Clues you can Use

How can you recognize when this is happening to you?

It's hard: this condition, *isotonic volume depletion*, does not produce thirst. Only a water deficiency produces thirst. Even that takes a 1-2% water deficit.

This leaves you with only two things, but they're reliable: one, the circumstances; and second, the results.

#### Circumstances:

- Ambient temperature below 60dF/15dC;
- A sense of feeling cool (or rarely, cold – if you've gotten cool enough to shiver, count on being significantly volume depleted, and take your pint of tomato juice into the sauna if you go);
- Urinating more often than usual, despite drinking little or nothing and not being thirsty

#### Results:

- Headache
- Nausea
- Lightheadedness on standing
- Lethargy & fatigue
- S low thinking

If you're going where it's pretty cool, or, especially where it's cold, you can't avoid body adaptation and cold diuresis. You can't get ahead of it by eating salt or drinking water. You can only respond to its circumstances by aggressively restoring volume (salt plus water) while you warm up. If you're nauseated by the time you realize this, the key thing is to sip rehydration fluid. A 4-ounce juice glass every 20-30 minutes, in sips, is hardly more than the spit we continually secrete, and will bring gradual rehydration, and relieve the nausea. (This is a good strategy, too, if you are stuck at home with the "stomach flu".) ➤

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