

Written Transcript  
On The Line Episode 1.7 “Hydration”

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Charlie Palmer: We're back On The Line, a podcast for today's wildland firefighters, brought to you in part by The Black. We are joined by a couple of the usual suspects. Again, Dr Brent Ruby, exercise physiologist at the University of Montana, director of the Montana Center for Work Physiology and Exercise Metabolism and Dr. Chuck Dumke an exercise physiologist at the University of Montana as well. Gentlemen, we're going to talk about hydration today. It's come up in a couple of our previous podcasts. It definitely had a role in the heat related illnesses in the rhabdomyolysis and then also in the recovery podcasts, but we also recognize that it's worthy of its own podcast as well. And so we're here to talk about hydration today. Chuck, what can you give us with regards to our historical understanding of recommendations with regards to hydration?

Chuck Dumke: Hydration is a very hot topic nowadays and our governing body in our field is the American College of Sports Medicine and they come out with what are called position statements. And they can range on a number of different topics, but of course one of the first that they ever produced was on hydration and I don't have it right in here in front of me, but I think this was in the late eighties and early nineties and you know, this is a panel of experts, right? Making recommendations on how hydration can improve or otherwise reduce the reduction in performance during sport. And you know, we've always been referring to the wild land firefighter as an endurance athlete. So there's applications to that as well. But one of the conclusions that they came to and the kind of the overarching sort of take home message from that position statement was you sweat more than you could possibly drink, so you should just be drinking as much as you can. Of course, that's not what literally what it said, I'm paraphrasing, but that's kind of what came across. And in the end that recommendation is not great. And of course they surveyed the literature in the literature, you know, measured sweat rate and swimmers and cyclists and runners and seen sweat rates at over two liters, liter and a half, two and a half liters and people taking in fluids at rates that are on the order of half of a liter or even less than that, depending on the sport and whether they're dependent on timeouts and whatever. So again, when they were presented with the data that they had, the recommendation kind of did make sense that you're not gonna over hydrate, so just try to get as much as you can. But that position statement has become dated and indeed participation in sports has evolved. You know, now we've got tens of thousands of people doing marathons and they're doing them in five, six and seven hours of time. So their rate of fluid intake can exceed their sweat rates. So they redid their hydration statement and basically it came down to drink so that you don't become hypo hydrated. Now I use the term

they're hypo hydrated. That is the correct term for having less fluid in your body than normal, right? People's talk about being dehydrated when in fact dehydration is a process, not a state. But that's just nitpicking semantics, but nonetheless, we know pretty confidently that if you get probably over two percent hypo hydrated, meaning you lose two percent of your body weight in fluid, your work output your performance is going to decrease. So that became kind of where the new position statement evolved to and that is don't drink enough so they don't get two percent dehydrated and that's the challenge. Everybody is so different, you know, two people doing the same work next to each other can be sweating and losing fluids at completely different rates. And so making specific hydration recommendations becomes an amazing challenge. That can only be done on an individual basis.

Brent Ruby: Yeah, it's such a complex measurement and there's so much diversity from one group of athletes are workers to another. I think it's fascinating that the field has developed all these exhaustive recommendations, yet when they're unveiled to the end user, they're not unveiled with the appropriate ways to measure hydration. And so the best way to measure acute displacement of body water is look at your body weight changes. Well, you can't do that during a marathon, so how do you know you're taking in enough and you can't look at the color of your urine during a marathon unless you want to get in trouble, and I don't necessarily buy completely into the urine color thing anyways.

Brent Ruby: We can talk about that later, but it's difficult for an individual to self monitor and so you can say you need to do this. Here's your perfect scenario, and because there's no way to really efficiently monitor it during activity, the best weapon you can carry forward is experience.

Charlie Palmer: Okay, and then probably to both of you guys. Then as far as we start talking about amounts, how much should I drink, Chuck? From what you just said, it might vary then depending on person to person, and yet oftentimes people want recommendations. Exactly. How much should I drink? How much should I be taking in every hour over the course of a work shift? What do we say about that then?

Chuck Dumke: Well, right. And that's one of the major challenges, just as an anecdote, a friend of mine was training for a ultra distance running race. 100 miles through the mountains in the heat. So she went in and worked out on a treadmill and a sauna and she measured her sweat rate and like Brent was saying, the really only decent way we have of doing that is how much do you lose in your body weight? And then of course you have to account for whatever you might drink. And she was losing only like a half a liter in hour exercising in 100 degrees in a sauna. And if I were to be in that same situation, I'd be nearly three liters in hour. So having done similar things in similar situations. So you know you can and it is in part the recommendation of the position stand by our governing body. It isn't written to the individual per se as it is to the coaches, the athletic trainers, you know the people working with the athletes over time and over experience. You can get a good gauge on body size, right?

Chuck Dumke: Obviously environmental temperature, you know the intensity of the exercise to gauge and ballpark a recommendation for fluid intake with an hour. Now with a wildland firefighter, that becomes incredibly difficult because you've got sawyers, you're digging line your drip torching. You might be taking a break, you know, so if you try to determine your sweat rate while digging line and then extrapolate that over your 14 hour shift, you'd be drastically overestimating because of all the downtimes in between. So individuals can individualize their own right, and then again based on body size and a little bit of more information on the exercise type and the conditions, et cetera. You can make ballpark recommendations, but again, that's very hard to do to a general population.

Charlie Palmer: Just so our listeners are clear, are there guidelines that we can give them as far as amounts?

Chuck Dumke: So I'll feed Brent with that one because he's got some data from the field on that, so I won't spoil that show.

Brent Ruby: Well, there's a few ways you can measure it. You can have people just count canteens, you can have them drink everything out of a camelback and put a digital flow meter and the camelback and measure that. And we've done that with some really unique camelbacks that were digitized with a nice flow meter and we could get drinking behaviors in terms of how many drinks per hour were they taking, how frequently, what was the size of each drink, how much did they consume each hour, where there hours when the weather was different that they were consuming more? We did all that with digital camelbacks, but that is equipment heavy and we didn't have very many of those. So another technique that we've used similar to the same technique that we use to measure energy expenditure, we can deliver an oral dose of a heavy water, a single stable isotope that can tell us the individual's total body water at say the beginning of a, let's say five day window of work. But as that isotope is diluted, when they add more water to the system and evacuate water and sweat and urine production and so on, you can calculate quite accurately the total water turnover, how much water is coming into the system, how much water is leaving the system. So it's a very dynamic measure of hydration and hydration practices. So we have done that with, oh boy, I don't recall the total number, but it's close to 60 firefighters over several years and over multiple studies. And the numbers that we continue to see is like the energy expenditure. It's very environmental and job specific. So a fire on the flat lands of Florida might not be as much as steep ground on the Salmon River in Idaho, but the weather in Florida, the heat and humidity combination may necessitate similar total consumption patterns. But those numbers show routinely over and over and over between six and a half and 10 liters in a 24 hour window. So if you think about people like, oh, I don't speak my volume in the metric system, but everyone knows what a nalgene bottle looks like. So six and a half to 10 nalgene bottles of fluid in 24 hour period is what we have measured in real wild land firefighters.

Charlie Palmer: That's their intake.

Brent Ruby: That is their intake. Yeah.

Chuck Dumke: And want to add a little bit, Charlie, you mentioned about, you know, well what can we tell people you know, and one of the amazing things about our physiology is we have these two things called kidneys. And so to have to try to think that you have to pinpoint exactly one point three liters for every, you know, two hours I'm out there is a bit overwhelming for one and two, we've got a corrective system built in and that is you'll pee out excess. You know, it's an amazing thing about our physiologies. Now I've danced around and haven't mentioned the fact that if you do over hydrate, there is this interaction with exercise and exercise can have an effect on how your kidneys to work. So exercise, especially in the heat upregulates what are called antidiuretic hormones, of which there's a few aldosterone, ADH, ADP, vasopressin that by being antidiuretic are basically telling your kidneys to withhold more fluid.

Chuck Dumke: And the interaction between those two can cause you to withhold more fluid and you know this is one of the reasons why hydration is such a hot topic now and that is because if you overhydrate, you put yourself at risk for what's called hyponatremia. And hypernatremia is when you dilute your body, sodium and this can actually have central nervous system effects and cause seizures, coma and has even killed people. Being hypo hydrated or getting dehydrated does not kill you. It can certainly cause problems and possibly relate to heat stress and heat related injuries, but it's not going to kill you. Hypernatremia can. And that's going back to this original position stand and why they had to scramble to Redo it is because there literally was some deaths in some marathons...

Charlie Palmer: Because people drink too much water...

Chuck Dumke: Because they ended up gaining weight, withheld more fluids, diluted their bodies's sodium, caused hyponatremia and died. Yes, that can happen even in the period of time post exercise. A lot of times people will finish a bout of exercise and feel like, wow, I'm hypo hydrated. I needed to be taken in a bunch of fluids and that can actually cause a problem still. Um, so there is a very intricate system in our fluid retention system. Our physiology is pretty complex that way and so there is this interaction between exercise, exercising the heat, how our kidneys work and the fluid we take in. So that causes a little bit more difficulty in giving these particular recommendations and you know, it's not that hard to kind of figure out for yourself in a similar situation how much fluid you lose. And that's kind of the, the individualizing of the hydration plan that I was referring to earlier.

Charlie Palmer: And oftentimes what comes up is that water might not just be the only thing that maybe I can incorporate a sports drink. And then we start getting into debates of how much of a sports drink should I cut it with water? Do I drink it at full strength and ad nauseam. What advice can you two give us with regards to how sports drinks figure into this issue?

Brent Ruby:

Well, I mean that's. You could spend a whole podcast just on sports drinks and the design of those, but no one's going to pay for them. The catering contract, the way it sits is not specific, and so you could show up on one fire and you might get gatorade. You show up on another fire, you might get powerade, you show up on another fire and you've got the Costco Kirkland special. Not that there's that much difference across the board. But if you want your own sport drink, you're probably always going to have to bring it yourself. And even now on fires it's amazing. Since we've been doing the studies we've done, it seems like more and more, most of the water on the fire is bottled water and so there's an enormous expense to the incident that is bringing in all this bottled water. When we first started doing these studies, they had pottable water trucks and you filled your own stuff with the pottable water they brought in. I can't even. I don't even know how much money is spent on bottled water, but the perception is, oh, hydration is so critically important.

Brent Ruby:

We don't want to skimp on that. We're willing to pay for the bottle of water and it's like there's a tendency to put the cart before the horse. Hydration gets put up on a podium as being this critical thing to maintain health and reduce the risk of heat injury on the fire line with almost no discussion about the work to rest ratio. And I know people that have been involved with that position statement and multiple position statements with the American College of Sports Medicine and they've sort of. I wouldn't say they reversed their position, but they definitely have reevaluated what message it sends and how important it is to first emphasize the work to rest ratio at maintaining normal body temperatures. And we talked about that in the heat related illness podcast, but it seems like most people when they think about hydration, they think of it as a mechanism to protect against heat related injuries. And the human physiology is far more complex than a radiator system. That if it goes low, the overheat chances are higher. So most of the people that drop with heat exhaustion have normal hydration status. So we talked about that with the heat related injuries, but I think that the what's in your canteen, if it's sport, drink or whatever, all of those are going to contribute to your ability to maintain total body water

Charlie Palmer:

And there might be some things that essential perhaps in those sports drinks that they're going to replenish some things that you've lost, correct?

Chuck Dumke:

Well, there's certainly a lot of things that affect your ability to take in and retain fluids. And one of them, you know the hormones I mentioned about right? The presence of the antidiuretic hormones. Are you exercising and in the heat? Blood flow to your gut. So if you allow yourself to become hypo hydrated, you will actually shunt blood away from your gut and people might have experienced this like taking in fluids maybe a little bit too late and they feel it sloshing around and never kind of getting out right? That's because you waited too long, right? You're already hypohydrated, so you better slow down, obey your work to rest intervals to allow that fluid to be taken up. Now can the constituents of the drink also affect it? Sure, but as Brent kind of alluded to and actually did a whole podcast on on tactical nutrition on the line, if you're eating as well, the contents of your food are also contributing to your ability to retain

fluid that you take along with it. So so many things are interacting here. It's really hard to make the recommendation. Now if you are drinking in a fasted state, right, and you're exercising in the heat, water can be great, but having some sodium in the fluid does aid in retention. Now, we did a study just recently here at the University of Montana where we compared a sports drink and compared it to an oral rehydration solution and oral rehydration solutions are formulated to recover people from a dehydrating event like diarrhea. So it doesn't have the interaction with exercise that sport drinks kind of have a history of being used in. Oral rehydration solutions have been shown to be like nearly as good as an IV in recovering somebodies hydration when they're dehydrated from diarrhea.

Chuck Dumke: And of course, the World Health Organization has come up with a formula and that's their goal, right, to treat third world countries where people get the wave right, so, but it's never been compared, believe it or not, while exercising in the heat, and indeed we found no difference. Sports drinks have a little bit more glucose than an oral rehydration solution, and an oral rehydration solution has a little bit more sodium than a sports drink, at least across the board. So there was no evidence on a number of different hydration markers, etc. There was a little bit of difference, as you might guess, on blood glucose. So if you're going to be using a drink to avoid hypohydration and you don't have a meal in site, meaning you're going to be out on the line for a period of time. A sports drink would probably be better choice than water. But if you're going to be sitting down at dinner at night and you're going to be pounding a huge amount of food, you don't need a sports drink, just drink some water.

Brent Ruby: Yeah, and the beauty of having a mixture like the calories, like your tactical feeding strategies, having the combination of fluids is probably quite valuable out there because you're going to get tired of what that canteen, water or camelback water tastes like. And so having something with a little bit of flavor that just takes the edge off of the plasticity flavor that's going to get you to continue to keep up the normal hydration state and that's critical. So diversity again, is really important.

Chuck Dumke: Brent brought up the idea of canteens versus camelbacks and you know, we just got done talking about what's in them, but there is another component to hydration which is just frequency. If you think about what you're trying to do, you're trying to replace fluid that's lost and you don't, not sweat and then just dump out two liters. You're sweating slowly over time. So if you can kind of aid your body's physiology by drinking frequently in smaller doses, then it's less of a challenge to your kidneys to retain that fluid and you have a better chance at avoiding hypohydration.

Charlie Palmer: That's right in line with what my question was going to be, which is when I was operational, I'd Get to the end of the shift and be back in camp or wherever. And I think, oh, maybe partly because of this hydration messages always pushed so heavily I think, hmm, I probably didn't drink enough water today. I'm going to sit here and camp and just drink a lot of water. And then the downside of that

was I'd be up oftentimes during the night and having to void all of that urine and then I'd sleep like crap and I really wanted to sleep well. So I got to the point then where I'd stopped drinking before going to bed. Is that your advice there? Just stop trying to do massive amounts or not at all and just be better at timing and spacing it out throughout the day?

Brent Ruby:

Yeah, I'd say it'd be better at timing. I mean, just like your calories, a bolus of anything is never that great. A big serving of a meal in the middle of the day, wrong, a big two liter serving of fluid in the middle of the day, wrong. It's going to be very hard to catch up if you start to fall behind and so constant attention to frequent consumption is really important. And that's what we found in the camelback study that we did where we use those digital camelbacks, so we put two different beverages in those. We put water, straight water in one group and the other group had an electrolyte mixture, didn't have any calories in it, it just had the electrolyte. And the electrolyte group ended up overall drinking less total water throughout the day, but the drinking patterns of both groups fell in line with the tracer data looking at about six liters in an operational shift. But the electrolyte group drank less, but at the end of the day their weight loss was quite similar. Their blood chemistry was quite similar. There's not a magic bullet you can put in your canteen besides water, especially when you're consuming a lot of electrolytes that are going to contribute to the maintenance of normal blood electrolyte concentrations.

Chuck Dumke:

Another study that backs that up, well, they compared cyclists who are doing one of these 100 mile charity rides for diabetes or something like that and it had a group who were using camelbacks and that group that were using traditional water bottles on their bike. And they found that the volumes that were drunk by the two groups didn't differ, but the group who drank from camelbacks peed less and it turned out the people who had the bottles on their bike frame would see an aid station coming up and say, oh god, I forgot to drink and chug their whole bottle down and replenish that bottle and then spend some time in the porta potty right before they get back on their bike and keep going. The camelback people would be, you know, the nipples right there hanging over their shoulder. That'd be drinking constantly and frequently and taken in small amounts and so they retain that fluid better and had better markers of hydration. And I use that term almost an air quotes because as Brent alluded to earlier, there's lots of ways we think we can measure hydration status, but the people in the field have a hard time sort of agreeing on which is best. There's plasma osmolality, there's hematocrit, there's urine osmolality, there's urine color, there's all these different things.

Brent Ruby:

There's are you thirsty?

Charlie Palmer:

Maybe a good segue into the camelback versus canteen discussion because Chuck from part of what I just grabbed from what you said is that there are some benefits to the camelback perhaps in some ways, and yet Brent, I know from our heat related injuries podcast, you had mentioned how the challenge with camelbacks is they make it so easy to drink, that you perhaps don't slow

down your work output because it's so easy to drink. Versus stopping getting your canteen out, getting a drink that you've lowered that work output, which is really, really beneficial. So what do you guys have to offer on that? If we're going to debate camelbacks versus canteens.

Brent Ruby:

Oh golly. I. It'd be great to get the take of a current crew members. I think that's a neat discussion that you can have within your own crews is what do you guys like about camelbacks? What do you not like about camelbacks? I mean the one, one thing I. I never use a camelback for any of the activities that I do. Most of the time I have my hands available. The only times when I didn't. Were in races on a bike or whatever or triathlon and sometimes you do forget to drink or sometimes it's inconvenient to drink because you have to move your hand off of your bars to get the bottle and maybe the wind conditions are not conducive to doing that. And so the same thing holds true on the fire. Sometimes it's not convenient to stop digging and grab your bottle. Well that's why it's important to put drinks in different locations so you can access them frequently. Some other potential flaws with the camelback system is it's difficult to keep them clean. If you start to introduce products other than water. As soon as you put a sugar oriented product in there, the likelihood or the possibility of developing bacteria or something else that could cause other problems, other reasons to visit the toilet, you got to watch out for that, so I just don't think we give enough credit to the physiology that we haven't designed ourselves, but as currently available for our use. The thirst mechanism is ideal. Our ability to regulate fluids on the body, like Chuck mentioned through the kidney system is beautiful and so to say, I'm going to ignore all that and I'm going to write my own algorithm and use my camelback so that I don't get thirsty. That's a disservice to the physiology and you're more likely to create problems. The best way to know how much to drink on a fire line is be a firefighter for awhile and you will self select the most appropriate strategy that works well for you.

Charlie Palmer:

No clear winner. Then in our camelback canteen rumble.

Chuck Dumke:

I don't think there is and I think to think that because someone might wear a camelback, that they won't take a break. I, I don't, I can't imagine that happening because crews are going to take breaks as crews do together. Right? And just because someone's wearing a camelback is like, oh, I already drank my stuff, so I'm just going to keep working while you guys sit down. I don't think it's going to happen. So you know, I do think it's important to have those work rest intervals to allow your core temperature to come down, independent of taking in fluids. And that's kind of speaking to what Brent pointed out, but I do think the camelback wins in the ability to deliver fluids in a more frequent manner without disrupting your work. I don't think that's arguable. Now whether somebody who's young, and I think Brent made a good point about, you know, you're going to figure it out if you're going to do this for more than five years, right? Who somebody who's young and empties their camelback and the first two hours of the day you learn your lesson. Young buck, because you know you're going to go thirsty the rest of the day.

Brent Ruby:

I think a combination will be optimal because you can't. You're not going to be pouring gatorades or any other sport drink into your camelback, so you got your camelback and reserve. Most of those big ones will hold three liters, so you got that fluid in reserve. If you're going to do anything to alter what's in that, you might want to put a little electrolyte in there, no sugar, just some electrolyte, and you have that on reserve. It's convenient, it keeps your mouth wet, it provides hydration, But in your other arsenal you've got sport drink that might come in handy later in the morning when you haven't been able to consume enough calories on the right schedule, so you've got the sport drink available. You've got a different beverage later on. Maybe that's got some caffeine in it or or you have a juice, but you've got a wide range to pick and choose from. And that diversity plays into helping you an optimized hydration status. You start to look forward to, oh yeah, I have that in reserve. I'm going to have that at 3:00 or I've got this in reserve. Another thing that we also haven't mentioned is the temperature of the beverage, because the temperature of the beverage plays into thermal regulation almost if not maybe more then maintaining precisely the overall volume and so we've done studies where we've used like an ice slurry mixture and looked at thermoregulation and how it can be different depending on the temperature of the fluid. And nowadays the vessels that are commercially available. We've done a simple study with several different vessels that are available at any outlet like REI or whatever, and some of those vessels can maintain the temperature of the fluid inside of them for over 12 hours. So if you had a way to put some ice in a vessel with some water or your favorite drink of choice that you wanted to keep cold, you could put that in there and have that as a backup reserve as well. So then you've got your camelback. You've got your cold stuff, you've got your sport drink, you got your juice and you got a little coffee surprise or whatever. So you've got all these different options. I think that would be the ideal approach.

Charlie Palmer:

So if we had any sponsors, this is where we'd cut to yeti or whoever we could.

Brent Ruby:

Yeah, we played with a lot of different vessels.

Chuck Dumke:

Slurpee! (All Laughing)

Chuck Dumke:

So to that as well as a couple of recent studies came out, one that reviewed the literature actually by an acquaintance of mine, friend of Brent that kind of reviewed the literature is like, okay, what is the best hydration drink out there? What's going to keep you hydrated the best? And the concluding statement after about 35 pages of review article was that you got to customize a hydration strategy, right? Because to know how much sugar do you need, you need to know how much intensity you're working at. To know how much sodium you need you need to know how hot it is outside to know how much volume you need. You need to know all of those things. And so that's the. That's the challenge that everybody is faced with. Another article I mentioned, there was two came out and did a multisite study where they compared a bunch of different drinks. I mean they had water, they had coke, they had milk, they had oral rehydration solution and they gave these to subjects so they came in and

these subjects, however were fasted, so they came in in the morning overnight fast. and euhydrated right and gave them these different...

Charlie Palmer: Euhydrated meaning they were perfectly hydrated?

Chuck Dumke: Normally hydrated, yep. And gave them all these different drinks on different trial days, etc. And then compared how well those drinks were retained and believe it or not, milk was just as good as an oral rehydration solution in retaining the fluids, but in reality they weren't all that different and they tried to come up with this hydration index or drink index to measure the drinks ability to do that. But my criticism of that article is they're comparing it to euhydrated, non exercised, rested, fasted individuals. And like for all the reasons we've been talking about throughout this podcast, all of those things affect your ability to retain that fluid in addition to whether it's with solids, whether it's with food, so you know, unless you're in that situation, those results don't really apply to how you're going to end up utilizing that drink.

Charlie Palmer: Because if I'm a firefighter, I'm tired, I've been working, I'm perhaps hot or whatever, and that changes the whole picture.

Chuck Dumke: Exactly.

Brent Ruby: You don't see milk on the line.

Chuck Dumke: Rarely.

Charlie Palmer: You both had mentioned it. Then with regards to this power of kind of personal choice and how oftentimes how just left to our own druthers, we actually oftentimes make really, really good decisions if we know ourselves well enough. And Chuck, you and I talking offline, you had brought up a study with some ice hockey players that I think might be relevant here with regards to the power of just letting people pick how much they want to drink instead of specifically prescribing certain amounts.

Chuck Dumke: Yeah, it was kind of an interesting study that just came out this, this month actually, and they tried to prescribe a hydration plan to hockey players during training practices. And they compared that to then what we call ad libitum intake, which is just what they take in by choice. that they could drink however much they want, and the hydration plan, what they were prescribed, prescribed a higher amount of fluids. Than what they took in when they were just given their own choice, but it didn't necessarily result in a better performance. They had some kind of performance measures and they had some kind of hydration measures. None of those kind of really reached what we call significance. Right. Didn't really work out to be a better plan than just letting them drink when they could. But it was interesting and I think it was lost on some of the other readers, is that all of those players showed up hypohydrated and it's interesting. I teach our grad students how to take blood and we compare, you know, hematocrit

and hemoglobin and things like that. And you might believe that our grad students are all doping because their hematocrits are so high, they're walking around hyperhydrated and I think that we'd be mistaken to not mention that our society nowadays goes from coffee in the morning to soda at lunch to beer and alcohol at dinner. Right? That we are kind of walking hypo hydrated. Often times you hear about eight glasses of water a day, right? You know who made that up?

Charlie Palmer: No.

Chuck Dumke: Weightwatchers. Weightwatchers made that up as a diet intervention because if your stomach's filled with fluid, you're less likely to eat. Right? It has nothing to do with hydration. Okay. Now that kind of sounds like I'm going both directions. We're walking around hypohydrated, but eight glasses of water doesn't mean anything. Point being right. Athletes going through repetitive bouts of dehydrating events have a challenge of showing up for their next bout in a hydrated state. So that can be a function of, as you were mentioning late at night for the wild land firefighter, just trying to drink as frequently as possible, drink around meals. And not take it in and big boluses idealize the formula if it's not being taken with other things like a big meal, etc.

Brent Ruby: The other thing to think about with the eight glasses of water per day, what a glass of water per day means is that you consumed eight glasses of water in a day. That's about it. Uh, doesn't mean it's gonna work for you. Me, Chuck. Anybody else? The same in the water turnover studies that we did with the fire crews, we also threw in a university student comparison group. Not really a control group. Just the comparison group, like what's the average person like and the numbers that we're seeing in those, they were more like three liters, two liters, two and a half liters to three and a half liters per 24 hour window. This is during the fall in Missoula, so not the hottest of climates, but not the coldest of climates. And they were maintaining normal hydration status with about two and a half to three and a half liters per day in comparison to the firefighters that were up in the seven plus range. So going back to those turnover studies, the nice thing about those studies is they've been done on real firefighters doing real work on the line. So it gives us a foundation to at least say, what can we expect. What do I need to migrate to to be in the norm? Knowing that and setting that as sort of a foundation and then having each individual fine tune that. The first thing, an exercise physiologist or a sport nutrition wants to do when they swoop in, they want to measure things and tell you how to change your own behavior so it'll be more optimal. When in fact, if you were trying to do that with one of these elite wildland firefighters, it probably wouldn't work because they're far more calibrated for what they need to do. Then most of the instrumentation that we can put on them or in them to tell them that they need to do something different.

Brent Ruby: That's what those data I think really do provide is a nice foundation. When you look at the militaries hydration work to rest ratio chart, they've got several different environmental conditions which are based on wet bulb, globe

temperature, which is a function of radiant heat, humidity, ambient temperature and so on. So they've got different weather conditions. They've got a series of different work intensity from low to moderate, vigorous and so on. But when you look at the hourly recommended fluid intake among all of those possible combinations of temperatures or environmental conditions and work outputs the values fluctuate by a quarter of a quart. It says three quarters of a quart or one quart an hour. So there's not a lot of fluctuation. And the reason they do that is because the last thing they want to do is to suggest always you should have a liter an hour. Because at that point sometimes some operations is be like, wait, if I'm supposed to consume a liter in hour, that means I'm going to consume 12 liters and then you're guaranteed to finish the work shift hyponatremic. But the problem with most things, supplements, foods, supplemental foods and fluids in America. If one is optimal, three is better and so people think that about hydration, if this much as what the recommendation suggests will obviously more would be better. And that's certainly not the case with water.

Charlie Palmer: Parting shots. Hydration. Chuck?

Chuck Dumke: Well I just want to add real quick to what Brent was saying. I'm not sure we effectively made the point that fluid needs are also dependent on all the many things we talked about. Also simply body size. You know we talked about two percent body mass loss being kind of critical hypohydration, but if you're 140 150 pound female IHC and you're listening to what Brent's saying, you know, that might put you at above what you need because that's probably targeting more like 180 190 pound IHC person. But as far as parting shots, that's another thing that adds to the complexity of hydration recommendations. You know, I think we kind of made that point effectively is we can't simply sit here and tell you you need one and a half liters an hour. Right? Because again, you extrapolate that over a 14 hour shift, that's too much probably, and you're probably ended up eating a lot, but it's also an important point. Brent made this. I think we both effectively got across that it's not a rescue from heat related injuries, you know, it's an important perhaps component to avoid hypohydration, but hydration isn't going to rescue you from other bad decisions.

Brent Ruby: Yeah. I think with those water turnover numbers, when we talk about seven to 10 liters, that's inclusive of everything in the 24 hour window, that's not the recommendation for once you hit the fire line. That may only be four liters in a 12 hour shift and there's going to be fluctuations. We certainly haven't measured every firefighter. We can't afford to do that. We've only studied hot shot crews in those studies, but we have a big population of subjects. males and females have different sizes to come up with those numbers. So I think like Chuck said, hydration is such a trendy topic. Everybody in their arm chair, sport nutritionist, love to talk about hydration and how important it is, but I can guarantee you the guys that are breaking the world record in the marathon or not finished optimally hydrated according to the average sport nutrition research article.

Chuck Dumke: So again, it's a component of environment, body size, work intensity. One thing we didn't mention is what you're wearing, you know, clearly and the wild land firefighter community. That's pretty universal. As far as the Nomex PPE. We actually did a study where we looked at the undergarments below the Nomex and we didn't think we'd see anything, but it turns out that that can also affect how much fluid you need. The drink constituents, right? The meal constituents. It's just such a difficult recommendation to make and to know that you have these built in correction factors called kidneys is kind of the safeguard, but again, there have been situations where people have drank too much.

Charlie Palmer: Dr Ruby, Dr. Dumke, once again, thanks for your time.

Charlie Palmer: You've been listening to on the line, a podcast for today's wildland firefighter, our audio engineer's Mike Matthews, production assistant Joey Moore, and I'm your host, Charlie Palmer. Thanks for listening and we hope to connect with you again On The Line.

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