

Medical Needs at Ultra-Endurance Footraces: Special Considerations

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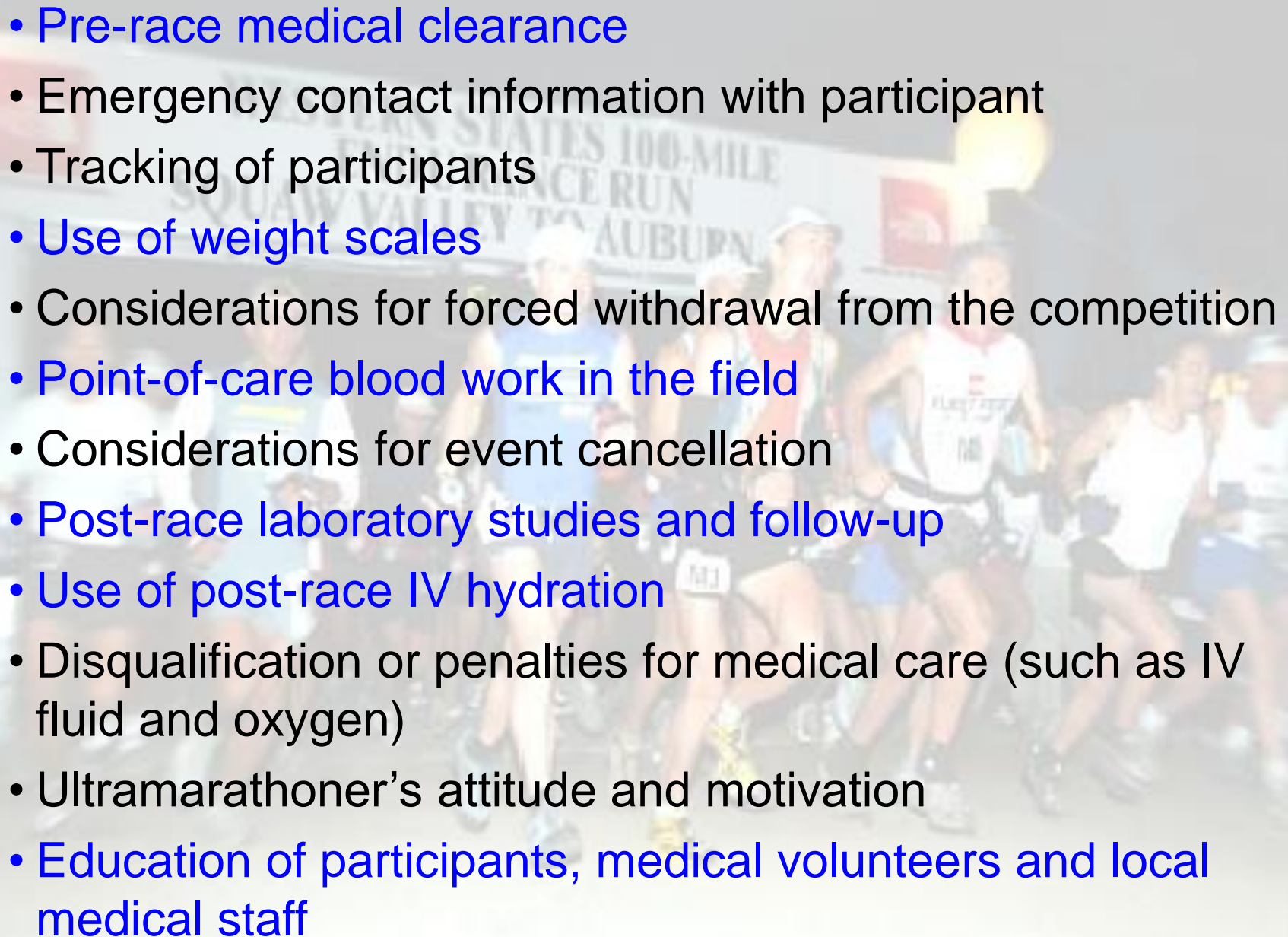
Professor of PM&R, University of California Davis

Director of Research, Western States Endurance Run

Chief Medical Officer, Ultra Medical Team

The contents presented herewith do not represent the views of the Department of Veterans Affairs or the United States Government.



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- Pre-race medical clearance
 - Emergency contact information with participant
 - Tracking of participants
 - Use of weight scales
 - Considerations for forced withdrawal from the competition
 - Point-of-care blood work in the field
 - Considerations for event cancellation
 - Post-race laboratory studies and follow-up
 - Use of post-race IV hydration
 - Disqualification or penalties for medical care (such as IV fluid and oxygen)
 - Ultramarathoner's attitude and motivation
 - Education of participants, medical volunteers and local medical staff

WESTERN STATES 100-MILE
ENDURANCE RUN
SQUAW VALLEY TO AUBURN

Pre-Race Medical Clearance



2013 WSER Medical Clearance

Past Medical History

Cardiovascular disease
High blood pressure
Head, neck, or spinal injury
Seizures, convulsions, fainting
Dizziness or frequent headaches
Eye problems (except glasses)
Lung disease (including TB and asthma)
Diabetes
Kidney disease
Permanent defect in skin or scarring
Any major illness in the last 5 years
Any operations in the last 5 years

Drug allergies

Currently medications

Describe any medical/physical conditions that may affect your ability to safely compete in this event.

2014 WSER Medical Clearance

- 1. What medications are you on?**
- 2. Do you have any medical conditions the knowledge of which would help the medical staff provide treatment to you in the event of an emergency during the race?such as drug allergies, diabetes, or a history of cardiovascular disease, arrhythmias, seizures, convulsions**

(pre-race email to runners requesting any updates)

Considerations - Who Can Participate?

- What problems might the athlete face due to their disease physiology when applied to the specific race environment?
- What problems might the athlete face due to their disease physiology when applied to the specific strenuous requirements of the race?
- What problems might the athlete face due to their specific medication requirements (storage, availability, administration route, side effects)?
- What are the known limitations of evaluating the athlete's condition for any symptom related to a possible exacerbation or complication of their disease when applied to a wilderness or austere environment?
- What is the likelihood of evacuation being required for a routine complication of the athlete's disease?

My Recommendations on Pre-Race Medical Clearance

- Obtain past medical history
 - Update new information
 - Make available to medical stations
- Who can participate? A decision of RD, medical director, treating physician and athlete
- Heart rate and BP check – NO!
- Pre-race body weight (?)

WESTERN STATES 100-MILE
ENDURANCE RUN
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Use of Weight Scales



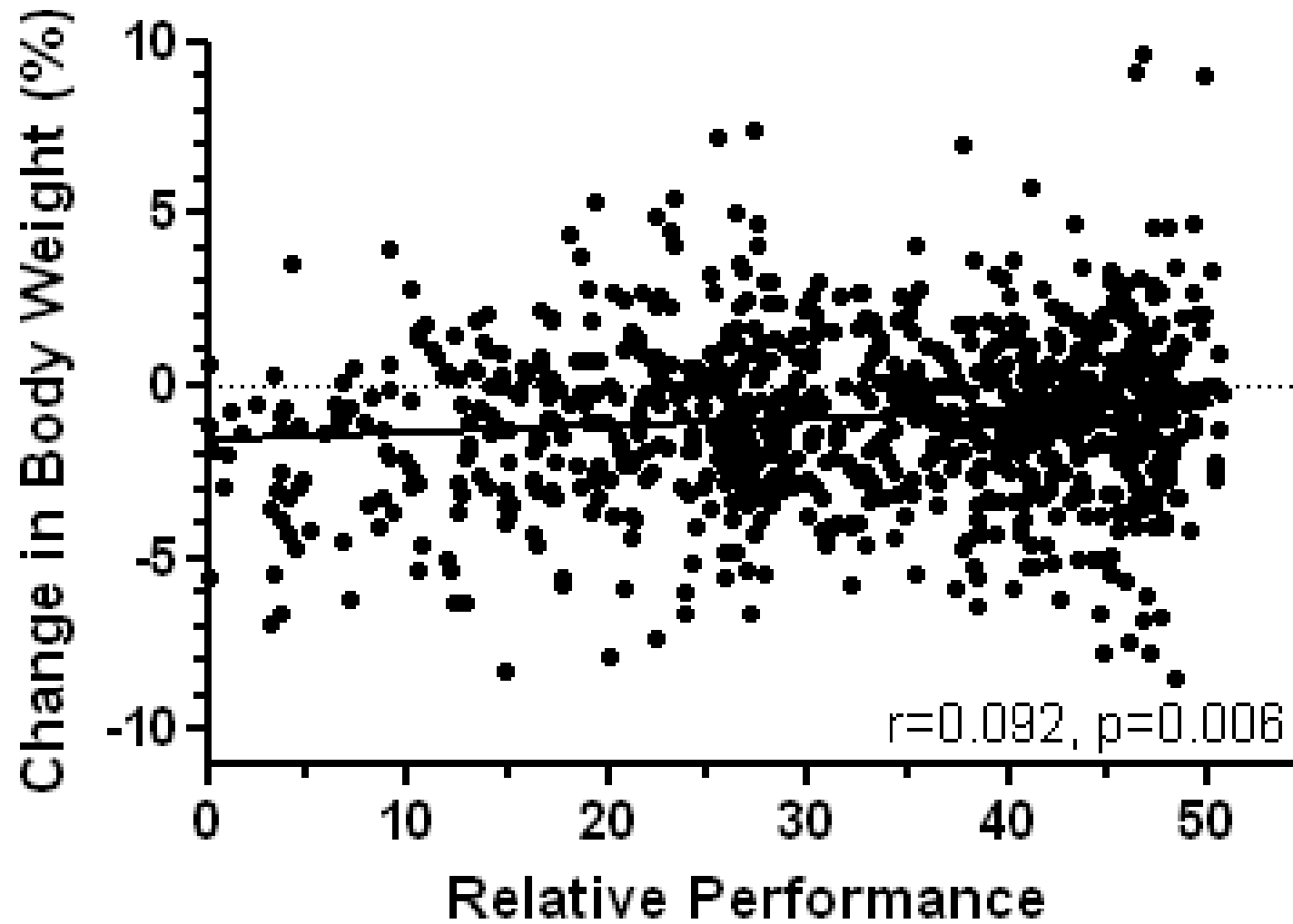
WSER Weight Change Guidelines – pre 2010

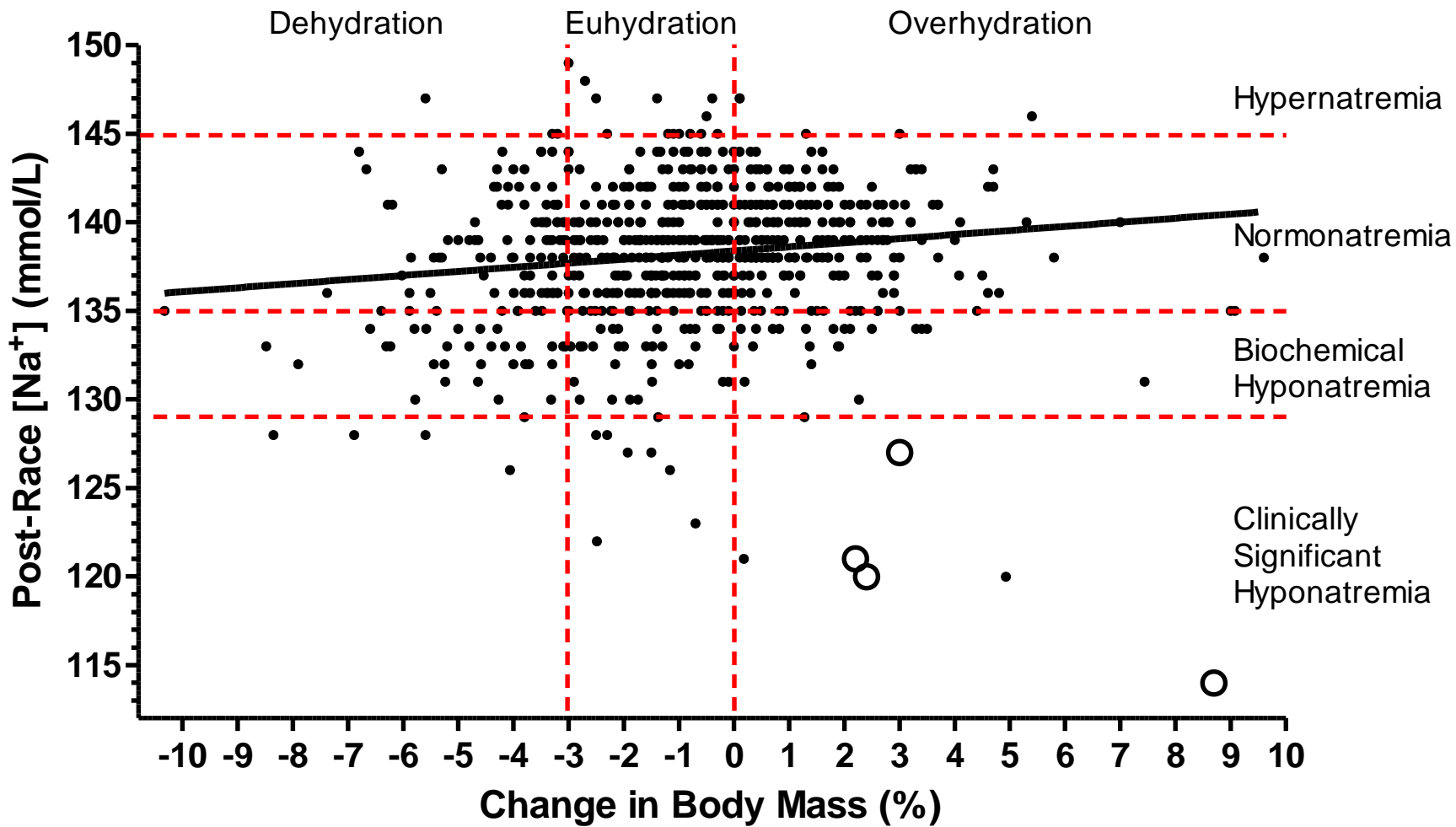
WEIGHT LOSS (Weight Loss Chart on Back Cover of Binder)

Perhaps the most important factor in evaluating a runner's physical condition, is the amount OF weight he/she has lost in relationship to his/her starting weight. The following is a guide to assist medical personnel in how to monitor a runner's weight loss.

- **3 percent** - weigh runner and allow him or her to continue.
- **3 to 5 percent** - weigh runner and check vital signs. Convince runner to slow down and hydrate adequately.
- **5 to 7 percent** - weigh runner and check vital signs. Forced rest and rehydration until weight returns to 5 percent loss. Advise runner to continue slowly.
- **7 percent or more** - stop the runner with a mandatory rest period of 20 to 30 minutes.

The runner has to demonstrate the ability to rehydrate and eat. The runner should be lucid before being allowed to continue and this decision should be based on the judgment of the medical personnel. If vomiting or the inability to rehydrate persists, the runner can remain at the aid station until he/she recovers, and then can continue only after the medical director feels it is safe to continue, but not beyond the absolute cutoff time for that aid station. We would encourage runners NOT to have their wristbands removed until at least one to two hours have elapsed, since many runners have been able to continue after rest, food, and rehydration.



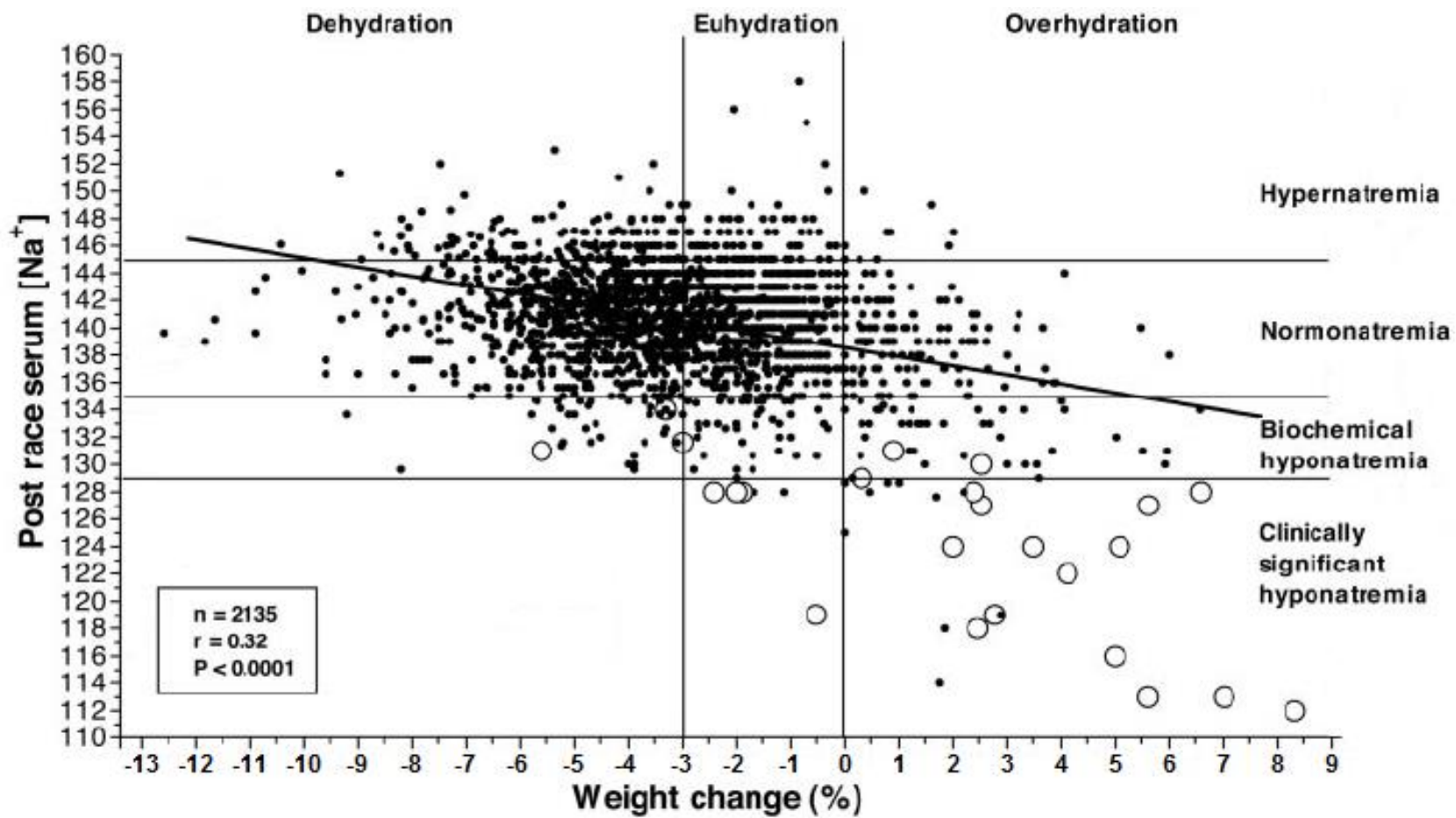


Hoffman et al. Med Sci Sports Exerc 2013

669 observations

EAH incidence 15% (range 5-51%)

$[Na^+]$ with weight change relationship ($p < 0.0001$, $r^2 = 0.02$)



WSER WEIGHT CHANGE GUIDELINES

(implemented 2010)

What should I do if my runner has...

Weight gain or less than 2-3% loss:

Weight gain is a potential problem. It indicates the runner is taking in too much fluid and may also be taking in too much sodium. Note that weight gain cannot be used to diagnose hyponatremia. **The solution for weight gain is to reduce fluid and sodium intake until urination is adequate to reduce weight to appropriate levels.**

Up to 3% loss:

This is an appropriate weight loss by midway through the race.

3-5% loss:

This is an appropriate weight loss by the latter stages of the race. **If early in the race, fluid intake should be increased. Some added sodium may be appropriate.**

5-7% loss:

If weight has consistently been at this range, then the runner is getting dehydrated. **Fluid intake should be increased. Some added sodium is probably appropriate.**

7% or more loss:

If weight has consistently been at this range, then the runner is dehydrated. This level of dehydration is probably not an issue at the very final stages of the race, but should be corrected if earlier in the race. **Fluid intake should be increased. Some added sodium is probably appropriate.**

WSER Weight Trend Guidelines

Super Simplified Version

(implemented 2013)

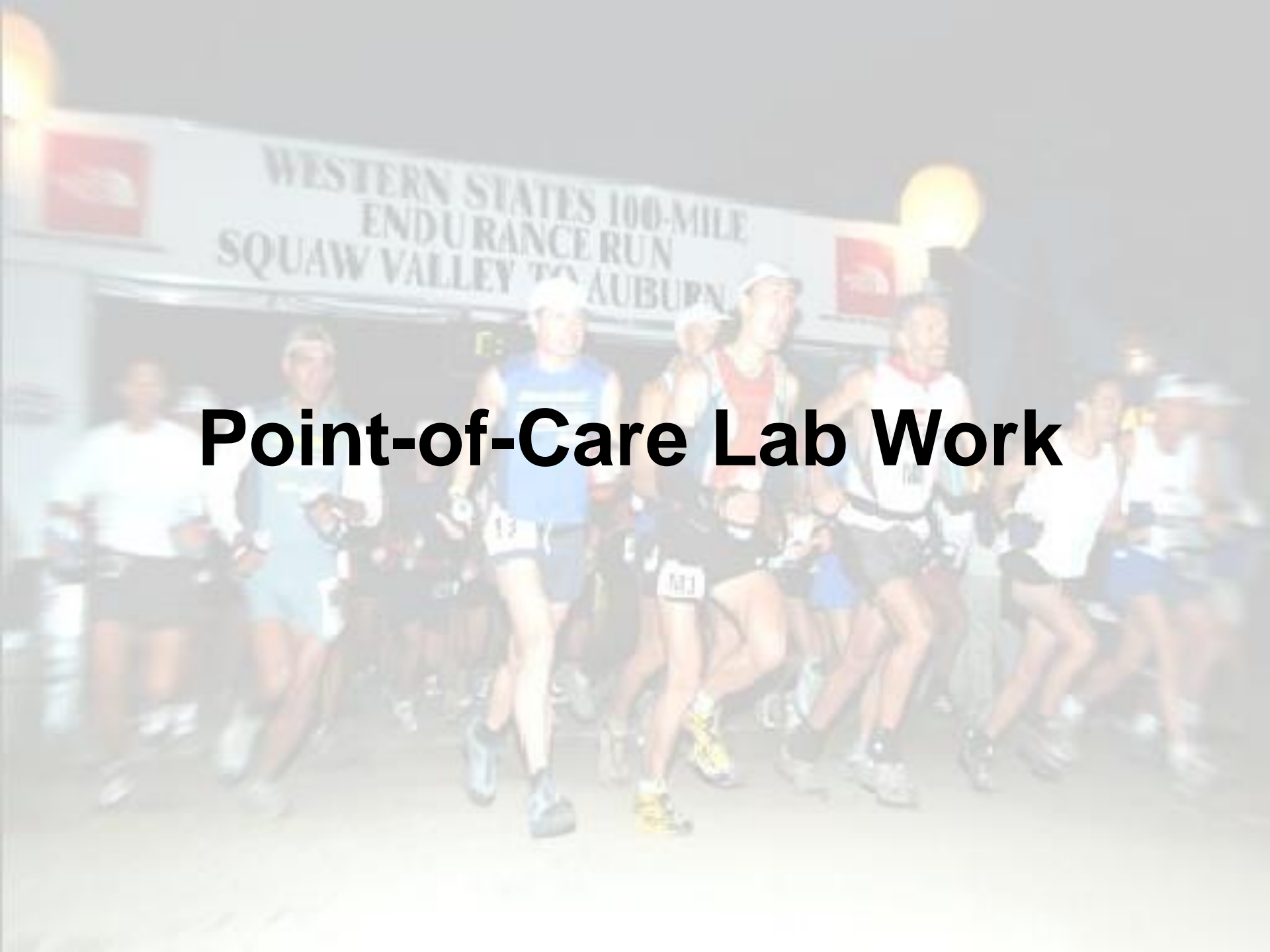
- Weight up, stop drinking until you pee off the excess.
- Weight down, drink.
- Mental status changes, drop and get medical help.

My Recommendations on Use of Weight Scales

- Can be of value to educated athlete
- May be of value to medical staff
- Must be calibrated, on level surface
- Must use trend rather than a single absolute value
- Should not be used for forced holding or disqualification of athletes

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Point-of-Care Lab Work



2008 Hyponatremia Consensus Statement

(Hew-Butler et al. *Clin J Sports Med.* 2008)

“Medical directors should ensure the availability of onsite $[Na^+]$ analysis and hypertonic saline.”

More realistic situation for most events:

No capacity for onsite blood $[Na^+]$ analysis
IV supplies may or may not be available

Wilderness Medicine Society Practice Guidelines for Treatment of Exercise-Associated Hyponatremia

(Bennett, Hew-Butler, Hoffman, Rogers, Rosner. *Wilderness Environ Med.* 2013)

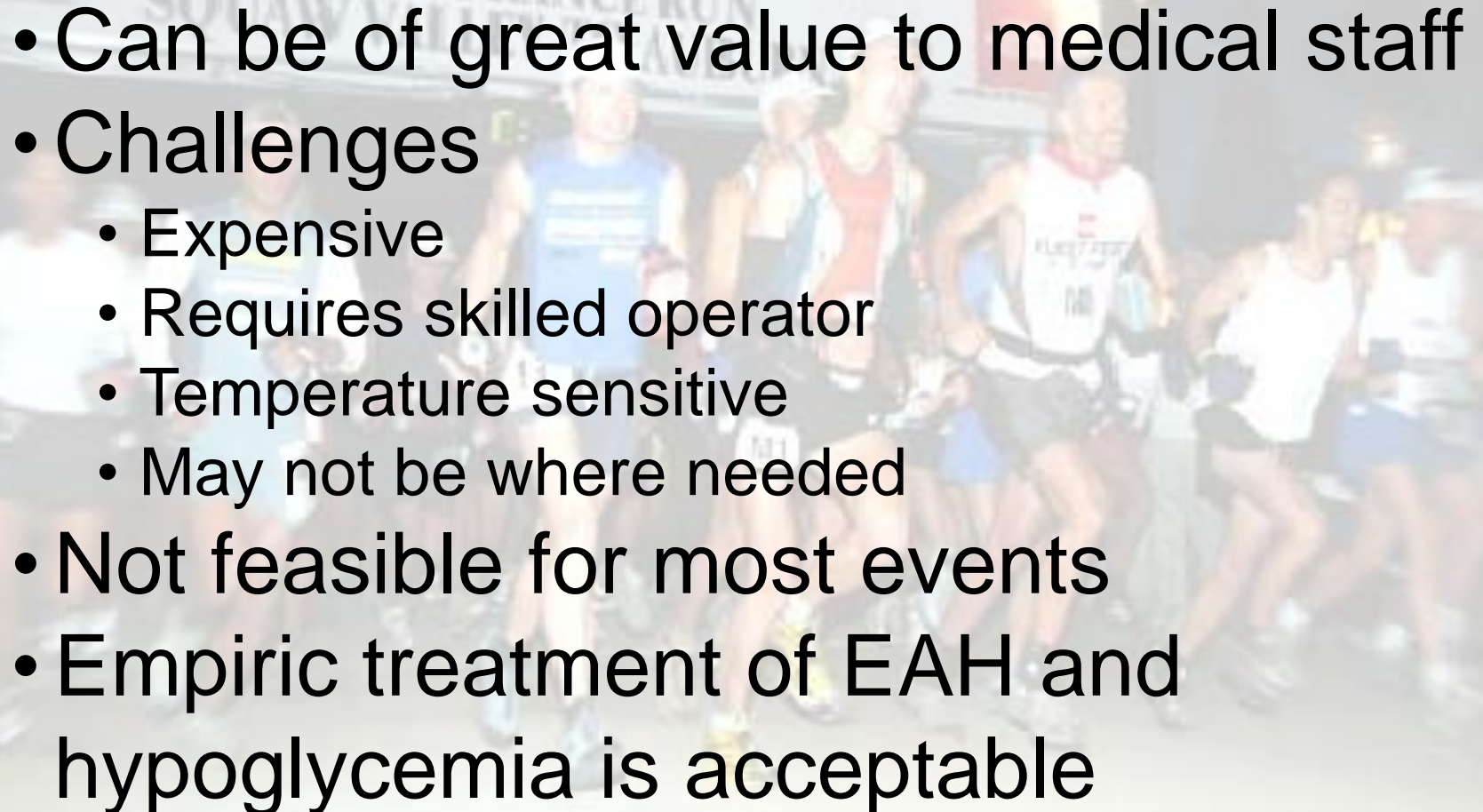
“the reality is that on-site analysis of serum sodium concentration is not widely available at organized endurance competitions nor is it currently feasible to implement. Even relatively large and established events often have no capacity for on-site blood analysis.”

Medical Services at Ultra-Endurance Foot Races in Remote Environments: Medical Issues and Consensus Guidelines

(Hoffman, Pasternak, Rogers, Khodae, Hill, Townes, Scheer, Krabak, Basset, Lipman. *Sports Med.* 2014)

“...these inherent logistical challenges with point-of-care technology in a wilderness environment generally make empiric treatment an acceptable option.”

My Recommendations on Point-of-Care Labs

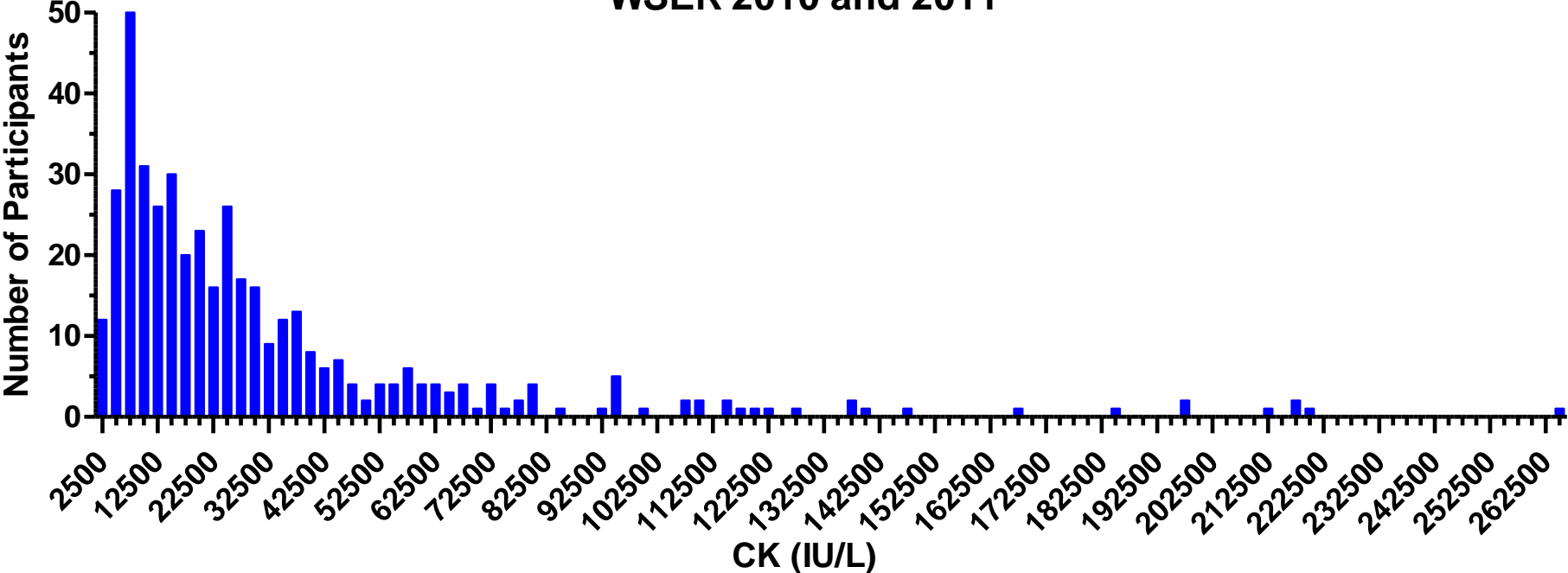
- Can be of great value to medical staff
 - Challenges
 - Expensive
 - Requires skilled operator
 - Temperature sensitive
 - May not be where needed
 - Not feasible for most events
 - Empiric treatment of EAH and hypoglycemia is acceptable
- 

A group of runners is captured at the starting line of a 100-mile endurance race. They are wearing athletic gear and bib numbers. The background features a large banner with the event name and location. The scene is illuminated by streetlights, suggesting a night or dusk setting.

WESTERN STATES 100-MILE
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Post-Race Laboratory Studies and Follow-Up

WSER 2010 and 2011



Dear Joe Runner,

The results of your post-race blood work at the 2014 WSER are as follows:

Sodium 136 mmol/L

BUN 44 mg/dL

Creatinine 1.2 mg/dL

CPK 12000 IU/L

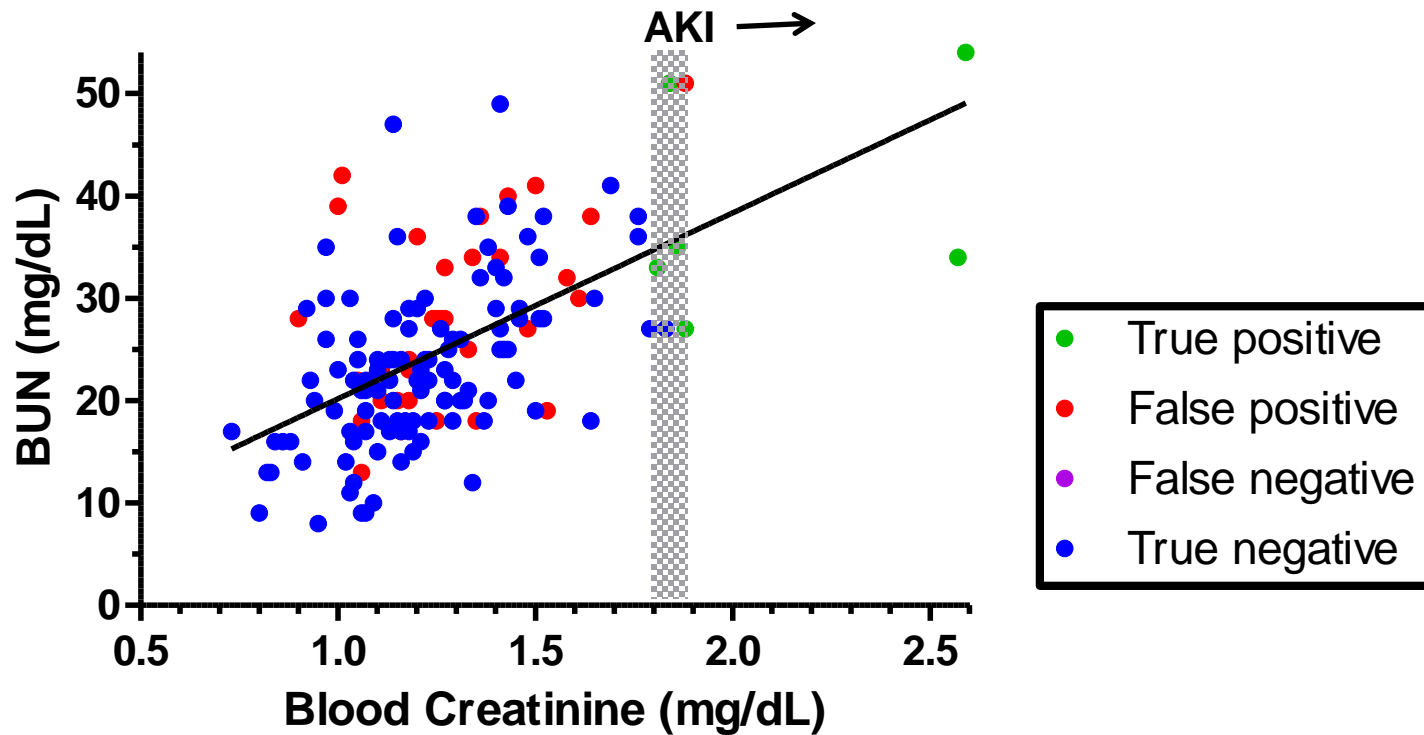
Some information about how to interpret these laboratory values is provided below. If you have further questions about your results, please contact Dr. Marty Hoffman (research@wser.org) or Dr. Bob Weiss (medical@wser.org).

Marty Hoffman, MD

Bob Weiss, MD

Sodium (normal resting values 135-145 mmol/L)

Sodium is an important electrolyte in your bloodstream. It is normally between 135 and 145 but occasionally can drop dangerously low during exercise, usually as a result of overhydration. This condition is referred to as exercise-associated hyponatremia (EAH). A sodium level between 130 and 135 is mild and usually asymptomatic, and will usually self-correct with rest and normal food and fluid intake. A sodium level below 130 may be associated with symptoms such as nausea, weakness, bloating, weight gain, puffy fingers, headache, confusion, seizure, and even death. If you have made it past the first couple hours after exercise without any symptoms of headache, confusion or seizure, then your blood sodium is likely to self-correct assuming you don't drink a lot of free water over and above thirst, and you will be fine. Slightly elevated levels of sodium can also be seen, but generally self-correct with normal rehydration.



Optimal urine dip stick criteria: + protein
 3+ blood
 SG \geq 1.025

Sensitivity = 1.00 (95% CI 0.54-1.00)

Specificity = 0.76 (95% CI 0.69-0.83)

LR for a positive test = 4.2



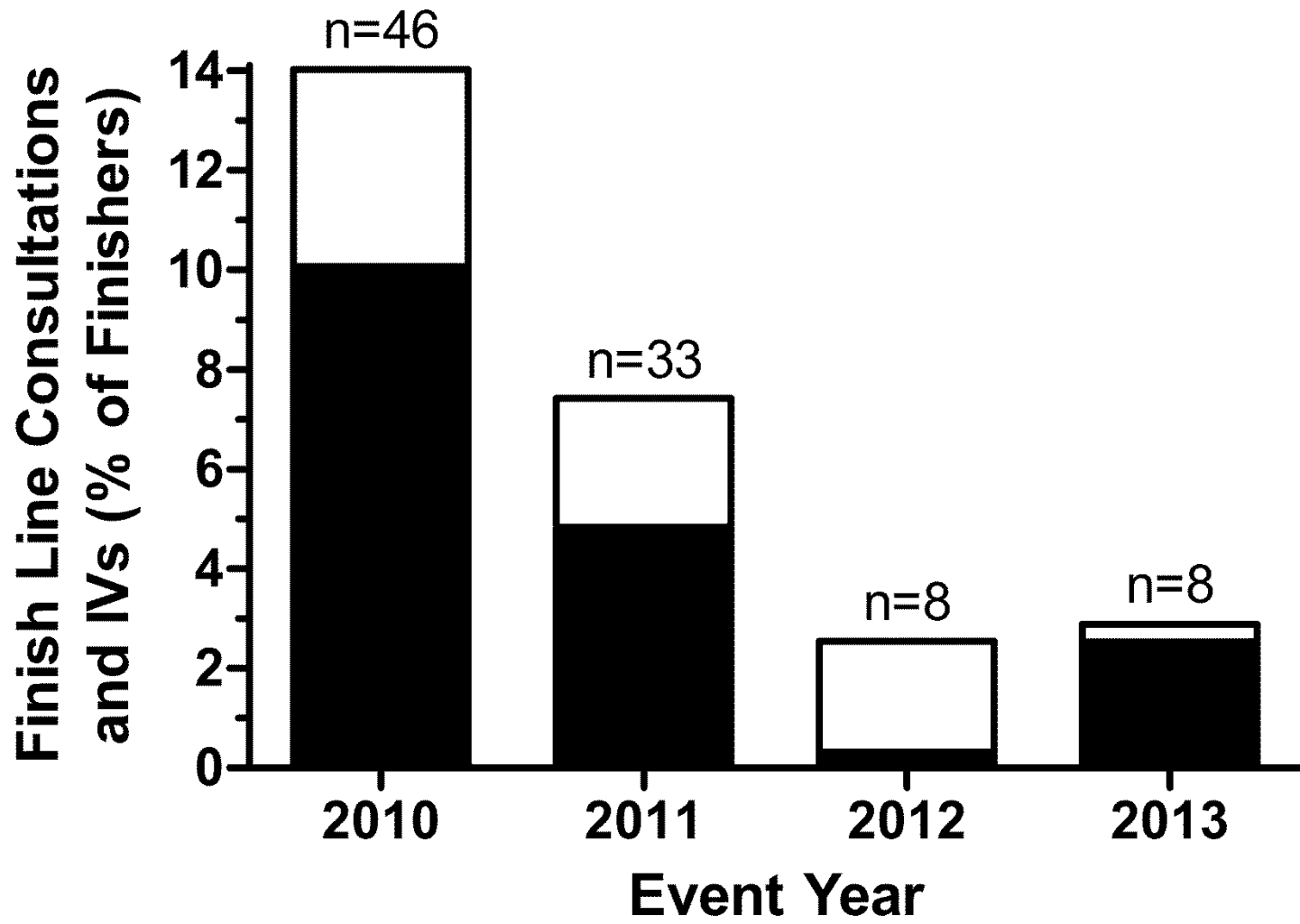
My Recommendations on Post-Race Labs and Follow-Up

- Valuable for research purposes
- Limited clinical value
- Not feasible for most events

WESTERN STATES 100-MILE
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Post-Race IV Hydration





My Recommendations on Post-Race IV Hydration

- Avoid due to risk of exacerbating EAH
- Use oral hydration as first line
- If using, must have 3% HTS available
- Consider limiting to those with:
 - >5% weight loss
 - orthostasis
 - inability to tolerate oral fluids

A banner for the Western States 100-Mile Endurance Run, Squaw Valley to Auburn. The banner is white with black text and is positioned at the top of the image. The background shows a group of runners at the start of the race, with some wearing blue and white athletic gear. The scene is outdoors at night or dusk, with some lights visible in the background.

WESTERN STATES 100-MILE
ENDURANCE RUN
SQUAW VALLEY TO AUBURN

Education of Participants, Medical Volunteers and Local Medical Staff

MEDICAL UPDATE RESPONSIBLE DRINKING ON THE TRAIL

by Marty Hoffman, MD and
Tami Hew-Butler, DPM, PhD

*...the consequences
of taking in too
much fluid during
exercise may not
only impact your
race performance,
but are potentially
life-threatening.*

Drink, drink, drink! That's the message we've heard for years, and it's still being perpetuated. Unfortunately, the evidence is now clear that it is the wrong message, and the consequences of taking in too much fluid during exercise may not only impact your race performance, but are potentially life-threatening. The major health concern associated with overdrinking is the development of exercise-associated hyponatremia.

Hyponatremia is defined biochemically as any blood sodium concentration below the normal range of the laboratory performing the test, which is generally any value below 135 mmol/L. Low blood sodium causes water to shift inside the cells (following an osmotic gradient), which causes all of the cells in your body to swell. Accordingly, one of the most important consequences of hyponatremia is swelling, or edema, of all tissues, including the lungs and brain. When water builds up in the lungs, significant pulmonary edema and shortness of breath develops. More significantly, when brain edema develops, the condition can progress to confusion, disorientation, seizures, coma and even death if left untreated. Exercise-associated hyponatremia is recognized to have been responsible for the deaths of at least five runners in the United States and United Kingdom. Our recent research demonstrates that exercise-associated hyponatremia is a common occurrence in 100-mile ultramarathons. In fact, we found an incidence of 51 percent at the 2008 Rio Del Lago and 30 percent at the 2009 Western States Endurance Run among research study participants.

We are also gaining information demonstrating a link between hyponatremia and rhabdomyolysis, or excessive muscle breakdown. It

Thus the reason for our concern about the message we've heard for years about making sure we drink enough.

In understanding the dynamics of fluid balance during exercise, we need to get beyond the idea that proper hydration is simply a matter of replacing the water and electrolytes that are lost in sweat. The fact is that if you maintain your weight during exercise, then you will actually be over-hydrated. That's largely because water is stored with glycogen (actually about three grams of water for each gram of glycogen), so when you utilize glycogen stores during exercise, you are releasing a considerable amount of water into the body. Most of that water moves into the blood stream. So, assuming you start an event with good glycogen stores and appropriate hydration levels, you should actually lose around two - three percent of your body weight to maintain a stable hydration level. If your weight remains constant or increases during exercise, then you are likely over-hydrating.

Another factor may sometimes be at play in the process of dilutional hyponatremia. Under certain conditions, including exercise, heat stress and nausea (all part of running the typical ultramarathon), antidiuretic hormones like arginine vasopressin (AVP) can be released "inappropriately" (thus the term: Syndrome of Inappropriate Antidiuretic Hormone or SIADH). This hormone acts on the kidneys to prevent water loss into the urine. As a result, when this hormone is released, water is retained which will result in a dilution of blood sodium. This has been thought to occur during exercise in conditions of both under- and over-hydration. Furthermore, when AVP secretion is high and

THE BASICS ON HYPONATREMIA

by Marty Hoffman, MD

Hyponatremia is defined as a blood sodium concentration below the normal range. Depending on the laboratory, that value is generally around 135 mmol/L. When hyponatremia occurs during or shortly after exercise, it is referred to as exercise-associated hyponatremia (EAH).

Low blood sodium causes water to move into the cells following an osmotic gradient, which results in swelling of the cells. Most concerning is when this cellular swelling takes place in the lungs and brain. When water builds up in the lungs, shortness of breath develops. When the cellular swelling involves the brain, the condition can progress to headache, confusion, disorientation, seizures, coma and even death if left untreated.

We've found that EAH can be quite common in ultramarathons. In fact, from our studies at 100-mile ultramarathons in Northern California, we've seen the incidence range from 5 to 51%. Fortunately, as far as I am aware, there have been no deaths in ultramarathons related to EAH. However, EAH is recognized to have been responsible for the deaths of several athletes in other endurance events, including marathons.

For any discussion of the prevention and treatment of EAH, it's important to have an understanding of the underlying cause of the condition. In the most basic sense, EAH must be due to fluid overload and/or inadequate sodium resources. It's the cases where there is fluid overload that seem to be most likely to become symptomatic and potentially serious, and those cases typically involve a couple important hormones. One hormone, arginine vasopressin (AVP, also commonly referred to as antidiuretic hormone or ADH) causes the kidneys to reabsorb water. AVP is appropriately secreted when blood osmolality rises, but there are a number of other non-osmotic stimuli for secretion of this hormone, which include exercise, heat stress, muscle damage and nausea (all pretty common stimuli present during the typical ultramarathon). Another hormone, brain natriuretic peptide (BNP) causes sodium to be excreted by the kidneys. So, it's through this combination of overhydration, water retention and urinary sodium excretion that one generally develops symptomatic EAH.

With this understanding of the underlying cause of symptomatic EAH, it should be evident that the best action one can take once they recognize that they are becoming overhydrated is to avoid worsening the situation with more fluid, i.e., stop drinking (!), and if neces-

sary, take steps to suppress the AVP secretion by such things as slowing down, cooling off and addressing any nausea. Sodium intake, whether taken as a capsule or with food, will not necessarily improve the situation because the excess sodium could just be excreted by the kidneys. Under some circumstances, oral sodium may even stimulate thirst, thereby leading to even greater overhydration.

So, how do you avoid overhydration? First, it's important to recognize that water is stored with glycogen (actually about three grams of water for each gram of glycogen). This means that when glycogen stores are utilized during exercise, a considerable amount of water gets released into the body. Assuming one starts an event with good glycogen stores and appropriate hydration levels, this built-in water store requires you to actually lose around 2-3% of your body weight by the time glycogen stores are depleted to maintain a proper hydration level. A greater weight loss would be expected if you are also dipping into fat stores for energy use. So, any increase in weight, or even a constant weight, during exercise is clear evidence of overhydration. But, even without weight scales, drinking to thirst is probably the most effective method of avoiding overhydration.

Many have presumed that a lack of adequate sodium resources within the body is an underlying cause of EAH. We now know that the body has sodium stores within soft tissue and bone that can get released and activated to maintain blood sodium levels during exercise. In fact, there is good evidence that, for periods of exercise up to around 12 hours (mostly from Ironman triathlon studies), sodium intake during the event is not necessary because these internal sodium stores can be adequately activated. Furthermore, the research has also indicated that if you lost at least 3% of your initial body weight, you would be very unlikely to develop EAH in events of that duration. However, we now have evidence from studies at 100-mile ultramarathons that EAH can develop with considerable (over 5%) weight loss. These cases suggest an underlying cause related to a sodium deficit, either from inadequate intake or a lack of activation of sodium stores. So, it

may be that for events lasting longer than 12 hours in duration, some sodium supplementation may be necessary even with proper attention to avoiding overhydration.

Finally, a comment about non-steroidal anti-inflammatory drugs (NSAIDs) is warranted. NSAIDs cause constriction of the blood vessels leading to the kidneys. These drugs also potentiate the action of AVP on the kidney. Therefore, NSAIDs not only increase the risk for acute kidney injury, but also increase the risk for the development of EAH. It should be apparent that the use of NSAIDs during endurance events is risky business.

KEY POINTS:

1 – Drink responsibly during long periods of exercise, avoiding dehydration as well as overhydration. Assuming good hydration and glycogen stores at the onset of exercise, shoot for a 2-3% weight loss during long endurance events, and more when fat stores are being used.

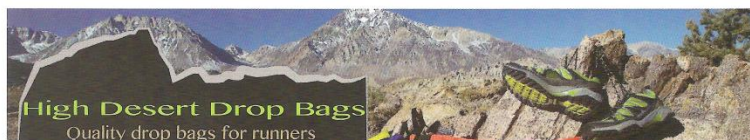
2 – Salt intake during exercise periods of 12 hours or less is probably unnecessary to avoid EAH, but it may be valuable during longer periods of exercise. In particular, if your weight is down at least 2-3%, some sodium intake is probably not a concern and may have some value in stimulating thirst. However, if your weight has increased or is stable, then sodium and fluid intake should be discontinued until fluid balance is corrected.

3 – Avoid the use of NSAIDs during exercise. These drugs increase the risk for EAH and acute renal failure.

4 – Listen to your body with regard to food and fluid intake during exercise and avoid any pre-planned hydration schedule that would promote overhydration.

For more scientific information on this and other ultrarunning topics, see the list of publications on the research page of the Western States Endurance Run website (www.wser.org/research).

Marty Hoffman serves as the Chief of Physical Medicine and Rehabilitation, Veterans Administration Northern California Healthcare System, and as the Research Director of the Western States Endurance Run.



Navigation bar of a Windows Internet Explorer browser. It includes a search bar with the URL <http://www.wser.org/participant-guide/#medical>, a search results field, and a menu with options: File, Edit, View, Favorites, Tools, Help. Below the menu is a tab titled "2013 Participant Guide - Western States Endurance Run". On the right side of the browser window, there are icons for Home, Print, Page, and a gear icon for settings.

MEDICAL AND OTHER RISKS

The Western States Endurance Run is one of the most physically challenging events in the world and participation in it presents numerous medical risks, many of which can be extremely serious or fatal.

Participation in this event is at the runner's own risk. Although Run Management has medical personnel at various points along the course, the inaccessibility of much of the trail will make it difficult or impossible for medical assistance to reach the runner immediately.

A brief medical examination is required of each entrant at pre-Run registration. Weight, blood pressure and pulse will be recorded and used as a baseline throughout the event. This will not be a complete physical and participants are encouraged to see their own physician prior to the Run. Runners should be knowledgeable about the stress effects attendant to participation in ultra events.

Runners' weights will be monitored throughout the race. Recent research suggests that modest (1-4 pounds) weight loss during prolonged exercise is physiologically normal. Excessive weight loss suggests dehydration. Weight gain suggests fluid retention and in some cases may be associated with a serious medical condition (hyponatremia). How the runner feels and looks and his or her mental status is more important to the medical staff than a number on a scale.

It is important for each entrant to recognize the potential physical and mental stresses which may evolve from participation in this Run. Runners may be subject to extremes of heat and cold, hypothermia, hyperthermia, dehydration, hypoglycemia, hyponatremia, disorientation and mental and physical exhaustion. Run Management and the medical staff strive to work with runners. They will do all they reasonably can to ensure "safe passage" to Auburn, but ultimately runners must understand their own limitations. This is one event where, as Dr. George Sheehan has said, it is better to follow the dictates of your body — not your ambitions! Adequate physical and mental conditioning prior to the Run is mandatory. If you have not been able to prepare properly, do not attempt to run!

Runners should appreciate the risks associated with participation in this event. Actions may have to be taken on your behalf under extreme time constraints and adverse circumstances. We will make reasonable efforts to give assistance whenever possible. Ultimately and primarily you are in charge, and you are likely to be solely responsible for creating your own crisis that we must then respond to. Be careful, be responsible, and do not exceed your own abilities and limitations. **IN THE EVENT THAT A RUNNER REQUIRES EMERGENCY EVACUATION BY GROUND or HELICOPTER-AMBULANCE, THE RUNNER ASSUMES ALL FINANCIAL OBLIGATIONS CONNECTED WITH THIS SERVICE. RUN MANAGEMENT IS NOT RESPONSIBLE FOR ANY DEBTS INCURRED.**

Some of the main risks of the Run, but certainly not all of them, are listed here. These should be understood and remembered by all runners, before and during the Run. Please understand that the information provided here is for informational purposes only and does not constitute a medical consultation. The Western States Endurance Run is a high-altitude, long-distance trail race. It is not a casual jog or a short-distance race. It is a serious event that requires a high level of fitness and preparation. Runners should consult with their physician before participating in the Western States Endurance Run.

PUBLICATIONS

The following scientific publications have resulted from studies at, or related to, the Western States Endurance Run.

2013

Hoffman MD, Fogard K, Winger J, Hew-Butler T, Stuempfle KJ. Characteristics of those with exercise-associated hyponatremia after a 161-km run. *Res Sports Med.* 2013;21:164-75 [View Abstract](#) [View Full Paper](#)

Winger J, Hoffman MD, Hew-Butler T, Stuempfle KJ, Dugas J, Fogard K, Dugas L. Physiology and hydration beliefs affect race behavior but not post-race sodium in 161-km ultramarathon finishers. *Int J Sports Physiol Perform.* 2013 Feb 14. [Epub ahead of print] [View Abstract](#)

Hoffman MD, Stuempfle KJ, Fogard K, Hew-Butler T, Winger J, Weiss RH. Urine dipstick analysis for identification of runners susceptible to acute kidney injury following an ultramarathon. *J Sports Sci.* 2013;31(1):20-31. [View Abstract](#) [View Full Paper](#)

Stuempfle KJ, Hoffman MD, Hew-Butler T. Gastrointestinal distress in ultramarathoners is associated with race diet. *Int J Sport Nutr Ex Metabol.* 2013;23:103-9. [View Abstract](#)

Hoffman MD, Hew-Butler T, Stuempfle KJ. Exercise-associated hyponatremia and hydration status in 161-km ultramarathons. *Med Sci Sports Exerc.* 2013;45:784-91. [View Abstract](#)

2012

Millet GY, Hoffman MD, Morin JB. Sacrificing economy to improve running performance—a reality in the ultramarathon? *J Appl Physiol.* 2012;113(3):507-9.

Hoffman MD, Fogard K. Demographic characteristics of 161-km ultramarathon runners. *Res Sports Med.* 2012;20:59-69. [View Abstract](#) [View Full Paper](#)

Hoffman MD, Ingwerson JL, Rogers IR, Stuempfle KJ, Hew-Butler T. Increasing creatine phosphokinase concentration at the 161-km Western States Endurance Run. *Wilderness Environ Med.* 2012;23:56-60. [View Abstract](#) [View Full Paper](#)

2011

Stuempfle KJ, Hoffman MD, Louise B, Weschler LB, Rogers IR, Hew-Butler T. Race diet of finishers and non-finishers in a 100 mile (161 km) mountain footrace. *J Am Col Nutr.* 2011;30(6):529-35. [View](#)

A group of runners is captured at the starting line of a 100-mile endurance race. They are wearing athletic gear and bibs, and are in various stages of starting their run. The background features a large banner with the event's name and location, and several red logos are visible on the banner. The scene is illuminated by bright lights, possibly from a stadium or event space.

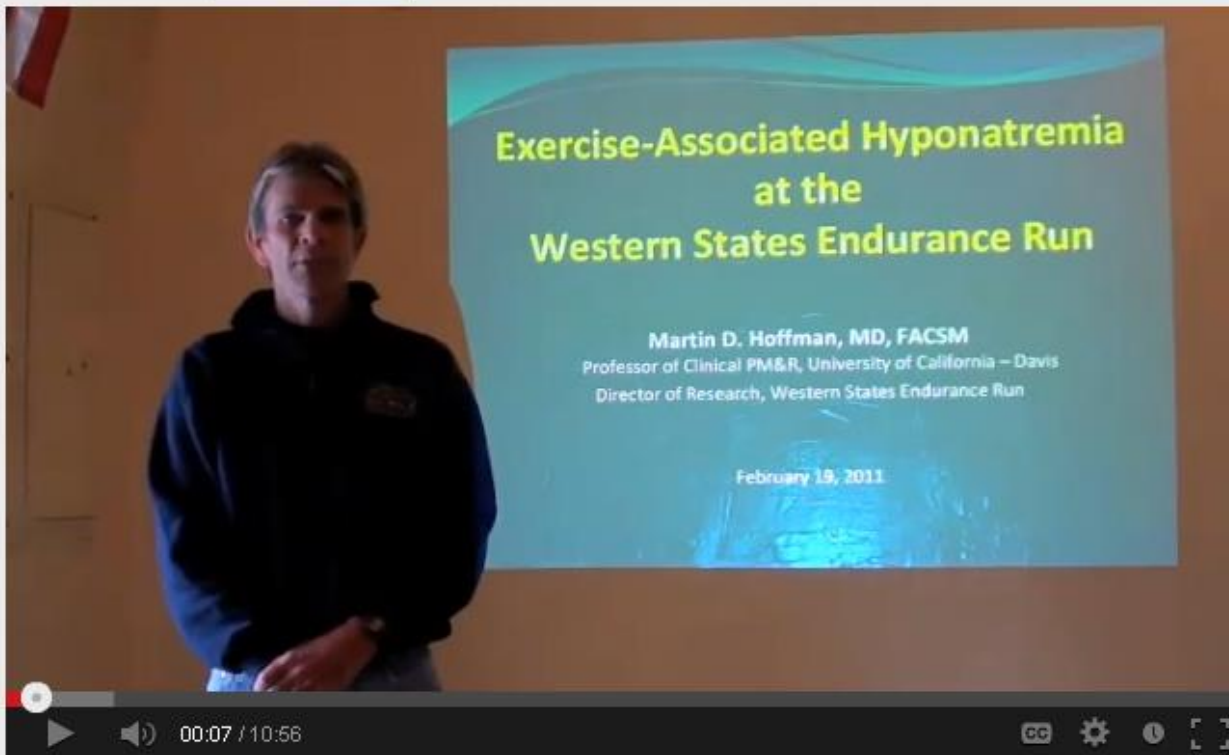
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**“I’ve done it this way for 30 years
...and haven’t killed anyone yet!”**

Western States Medical - Hyponatremia Part 1

wser100video

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334 views

Uploaded on Feb 23, 2011

No description available.

You are using an outdated browser, which YouTube no longer supports. Since some features on YouTube may not work, you are viewing a lightweight version of the video page. Go back to the regular page



Western States Medical - Hyponatremia Part 2

150 views
wser100video



Married To Medicine - S01E01

2,176 views
Jovo Jovic



Board Review: Hyponatremia

1,255 views
nephrologyondemand



Western States Medical Blisters

283 views
wser100video



Unbreakable: The Western States 100 - Journeyfi...

279,863 views
journeyfilm



“Our mission is to enhance the medical care at ultramarathon events around the world. This is achieved through provision of event medical services, education of medical providers, and ongoing research into the medical needs at these events.”

NATIONAL POST – John Stanton

June 1, 2011

Getting enough water is still the key hydration issue

Recent media reports have made the issue of fluids and hydration very confusing, which is too bad because it is actually a very straightforward issue.

During exercise, athletes should start drinking early and at regular intervals in an attempt to consume fluids at a rate sufficient to replace all the water lost through sweating (i.e., body weight loss), or consume the maximum amount that can be tolerated.



Welcome to Michigan Bluff
Medical Aid Station

Mile 55

What Color is Your Pee?



Coors Light™

GOOD



Pale Ale

Hydrate



IPA

Hydrate More



Guinness™

SEE MEDICAL!

My Recommendations Regarding Education

- Consider various approaches
 - Articles in magazines
 - Videos
 - Race information / website
 - Pre-race meetings
 - Scientific publications
- Focus on key issues
 - Hyponatremia
 - Blister management
 - Acute kidney injury