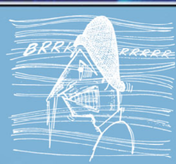
Terrific
Tuesday
Training



Hypothermia

Keith Conover, M.D., FACEP, FASRC

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http://www.conovers.org/ftp/ASRC-Hypothermia-Presentation.pdf

What Will We Cover?

- Basic stuff
- Intermediate stuff
- No advanced stuff unless there are specific questions

3

Science and Physiology

- Key concepts:
  - Homeotherms and Poikilotherms
  - Heat balance
  - Heat heat loss and heat production

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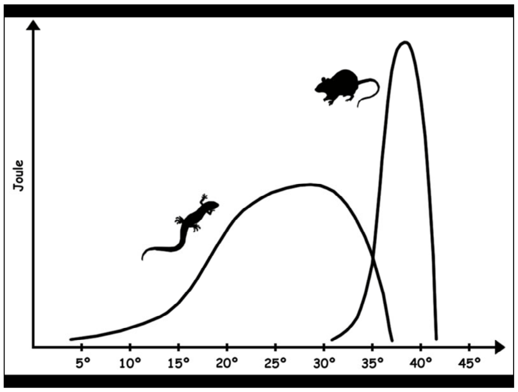
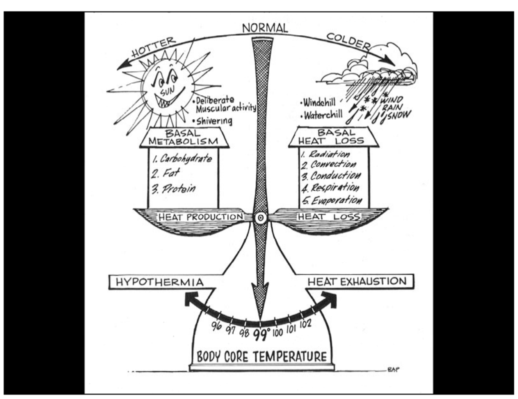


Humans are *homeotherms* ("warm blooded" although that's a misnomer, as you can see from the graph). That means our body's organ systems and tiny cellular mechanisms only work properly within a narrow temperature range, but we put a lot of time and effort into staying within that range where we are very, very efficient animals. That's unlike lizards, which are poikilotherms (AKA "cold-blooded" but that's a misnomer, too). They can function in a much wider range of body temperature, but they aren't nearly as good at keeping their temperature at the level where they function well.

Public domain via Wikimedia Commons, courtesy user Petter Bøckman.

Which is why they fall out of trees when it gets cold. And why I am a human speaking with a bunch of humans rather than a dinosaur speaking with a bunch of other dinosaurs. On the other hand, when our core temperature goes down, we call this hypothermia, and instead of just falling out of a tree, you may die.

Public domain, US National Weather Service.



But that also means that we need to put a lot of time and effort in keeping our body's core temperature within that narrow range. This brings up the concept of *heat balance*. We are constantly producing heat by basically burning the food we eat. It's like we all have tiny furnaces in our cells. Since we are producing heat all the time, we need to be able to get rid of that heat so we don't overheat and get heatstroke and die. But when it's cold out, we need to shut down some of those mechanisms at least partly. Let's now focus on the right side of this balance: the physical modes of heat loss.

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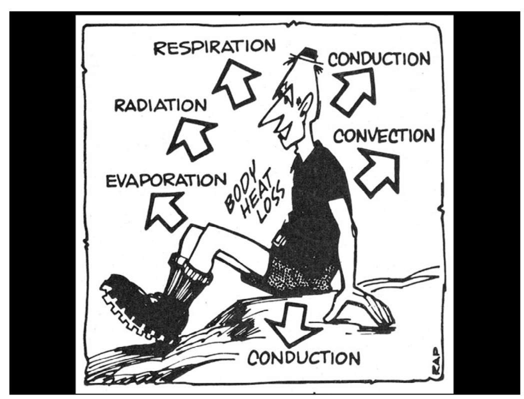

You need to know about the modes of heat loss so that you can control them. Cats and dogs laugh when we try to fluff up our so-called "fur" to stay warm and only get goose bumps. So we have to use our brains and what's in our pack to manage these. Physicists and engineers recognize a few different ways of heat loss.

- First is radiation: just like you can feel the heat radiating from a campfire, we radiate infrared radiation which cools us. Any clothing blocks infrared radiation, and shiny space blankets are no better than non-shiny clothing at infrared wavelengths.
- Second is *conduction*: direct transfer to something you're in direct contact with, such as sitting on a cold rock. The rock will gradually warm up as our butts cool, so this will limit the heat loss. My whole family carries inflatable sit pads in pockets on the outside of our packs when we are hiking. They keep our butts warm at lunch and also keeps out butts from getting wet and/or muddy. If someone gets injured, we can put all of our sit pads and the foam out our packs under them for insulation.
- We also radiate and conduct heat to the air around us. But it's a fluid gas that blows away and gets replaced with cold air again, so we call this *convection*. This is why that a windshell jacket can make such a difference in how warm you are when there's a stiff breeze.
- If we or our clothes are wet, and the air around us is less than 100% relative humidity, the water evaporates into the air, and this *evaporation* cools us.

- It's really a combination of evaporation and forced convection, but we lose heat every time we breathe in cold dry air and breathe out warm moist air, which is why you can sometimes see the moisture in your expired air condensing into little tiny clouds on a cold day. We call this heat loss via *respiration*. A rebreathe flap or facemask or scarf across your nose and mouth will get damp and warm and humdify the air you breathe in, limiting respiration heat loss. In terms of warmth per weight and bulk, an insulated facemask is one of the best warm clothing to have in a pocket or in your pack.

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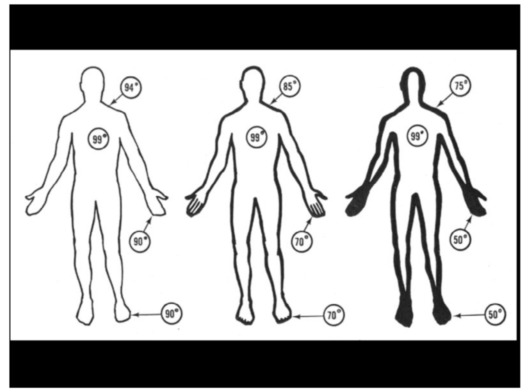

I have started talking about *core temperature* without defining it. As far as *thermoregulation* – what you do to keep your core at a near-constant temperature – and hypothermia, your core is those organs that are essential for life. These are your parts that, if you amputate them – like someone cuts off your head – you're dead. This means the internal organs in your torso, because you can amputate an arm or a leg and still survive. Most particularly, this means your heart and your brain. If either one stops functioning, you're dead.

This diagram shows on the left you in a room temperature room. The two figures on the right represent one of the ways you thermoregulate: letting your *periphery* – your outsides, those parts of you that are not your core – cool down. This can be an effective way to protect your core temperature.

This brings up the concept of *heat debt*. In the winter, you climb into your really nice warm sleeping bag (if you can afford it, a down bag from Feathered Friends or Western Mountaineering), on your nice warm sleeping pad (if you can afford it, the latest Therm-a-Rest Xtherm pad with the WingValve valve and the little Micro Pump that fits in the palm of your hand and inflates the pad for you). And despite having this really great insulation all around you, it still takes an hour for your feet to warm up, right? That's because the amount of energy you must use to warm up that black periphery on the right is the equivalent of a reasonable-size dinner. We should note that even though you need a lot of energy to warm up your periphery, your core temperature is still normal. We call this state heat debt.

When you're out on a search and rescue operation, or just hiking or climbing or caving in a relatively cold environment, you *want* to develop a bit of heat debt. That way, it takes longer to overheat once your start heading up a long hill or carrying a litter. But you need to monitor your heat debt and make sure it doesn't get too great.

So: when you're out in the cold, monitoring your heat debt is an excellent idea. Be aware that your hands and feet (and arms and legs) are getting cold. Are you getting deeper into debt? Or climbing out of debt? And how fast is this happening? Monitoring and managing your heat debt will help prevent overheating and getting your layers wet from sweat. (And thus wet and cold later on.) Or, from getting close to hypothermia.

There is also a standard winter hiking and climbing mantra: *dress cold*. If you're just getting out of your nice warm car to head up a long hill, dress lightly, compared with if you are just going to be standing around. That allows you to get a bit of heat debt before all the heat of your exertion heading uphill makes you too hot.

Why? Look at the three figures on the screen. The figure on the left can take a lot of cold stress before becoming hypothermic. The one on the right can't. So: **MONITOR AND MANAGE YOUR HEAT DEBT!**

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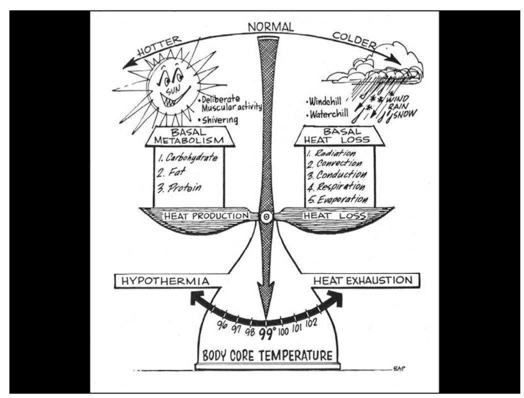

Now let's focus on the left side: heat production.

- Food in your belly gets absorbed and "burned": turned into sugar which your cells use as their food.
- However, if you have no food in your belly, you'll have to depend on your reserves: *glycogen*, also known as animal starch, stored in your liver and muscles. You can break this down into its individual components, which are sugar. And sugar, as in blood sugar, is what powers your body and thus generates heat, from ongoing processes or from muscular exertion, whether from SAR tasks or from shivering. But once your glycogen reserves are gone, you don't have a source of energy to burn to create more heat. You can break down your body's protein to produce blood sugar, but the process doesn't work fast enough to produce much in the way of blood sugar.
- Which is why anyone who is hypothermic and can eat NEEDS FOOD! Warm food is great, but cold food is better than nothing.
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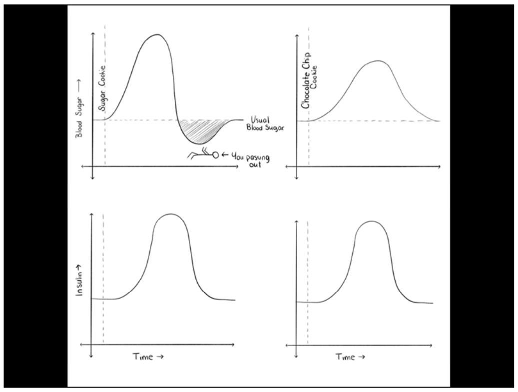
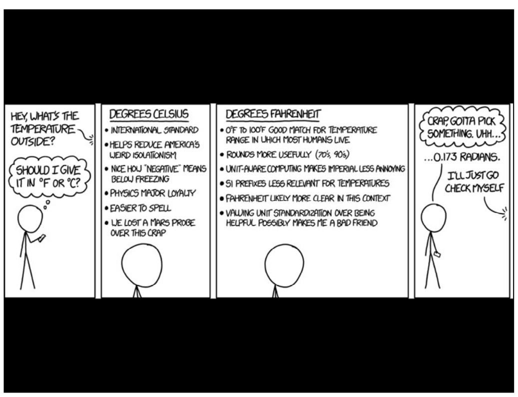


We should say something about *high-glycemic vs low-glycemia foods*.

- Especially if your glycogen is depleted, and you eat a sugar cookie, we call that a "quick energy food." You get a big burst of blood sugar.
- But a sugar cookie is also called a "high-glycemic food." That means that it gives you a burst of sugar and energy, but your body's not design for such a big load of sugar. Insulin, the hormone that pushes blood glucose into cells, either to burn or to convert into glycogen, is slow to respond to such a big, fast surge of sugar. So a couple of hours later, your blood sugar drops below the usual bottom limit of normal. So you get *hypoglycemic* (low blood sugar.) You get shaky, lightheaded, sweaty, and have trouble concentrating (bad things on a SAR mission). You may even pass out. Or get very hypothermic, even if it's not that cold out.
- The solution: eat a chocolate chip cookie instead. The extra fat in the chocolate chips slows your absorption of the sugar, so that you get a more sustained if not as high a sugar surge. That means your blood sugar doesn't bottom out a few hours later. Or, you can use the old standby of gorp, which according to the Intercollegiate Outing Club Association, is one part Virginia peanuts, one part M&Ms, and one part raisins, by number. The raisins have *glucose* (which can be directly absorbed into your blood to produce blood sugar, unlike table sugar = sucrose which has to be digested. Glucose is great for quick energy. The M&Ms and peanuts have enough fat to slow absorption and provide sustained energy. The peanuts also have protein to help support your body's damage control systems, which are always working. The *theobromine* in chocolate also stimulates your brown fat to generate heat which will also keep you warmer.
- By Laurel Victoria Conover, used with permission



A quick side note since I showed slides with 99° F on them. We all talk about your core temperature being about 99° F or perhaps 98.6° F if we don't round up, 37° C. That's what normal body temperature was a hundred years ago. But now, normal human body core temperature is now 97.5° F (36.4° C). That's an average and some bodies run at a bit higher or lower temperature.

Courtesy of xkcd.com

What do you do when you're faced with someone, search subject or team member, who has been exposed to cold, and shows signs of cold stress?

Well, first, let's consider what might be signs of cold stress or early hypothermia in your teammate Sarah.

People talk about the "umbles". These are:

- Stumbles: Sarah loses control over her movement, moves more slowly, and seems to have stiffness in the arms and legs; she's just not walking all that well.
- Mumbles: Sarah's speech sounds like she's drunk, even though you know she's not had any alcohol or drugs: slurred, slowed, or incoherent speech, sleepiness or confusion
- Fumbles: slow reaction time, dropping objects, poor coordination
- Grumbles: change in behavior, expressing a negative attitude

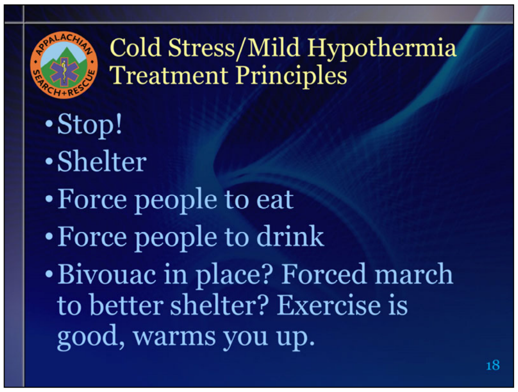
This is sunrise, in autumn, from Bear Rocks along the eastern edge of Dolly Sods Wilderness, West Virginia.

Back one October in the 1970s, my college roommate led a backpacking trip to Dolly Sods. We started out Saturday morning at Bear Rocks, along the eastern side of the 4000-foot plateau that is Dolly Sods.

We headed west towards Cabin Mountain at the western edge of the plateau. We crossed Alpine meadows scattered with blueberry bushes. It was 60°, sunny, with blue sky and birds singing. Many were dressed appropriately in shorts and T-shirts.

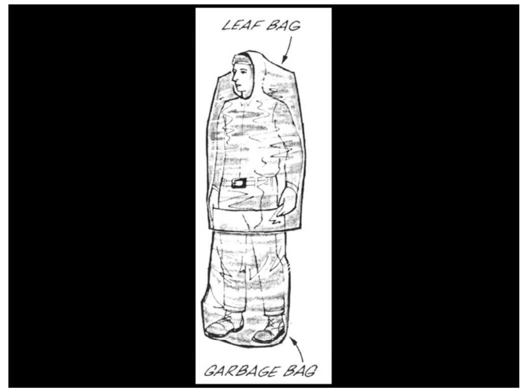
The few white puffy clouds that had been ahead to the west became darker and taller and rushed towards us. The wind picked up and soon became a stiff breeze. We could see rain heading towards us. Those of us who were experienced took off our packs and put on warmer clothing and raingear. And the temperature dropped 20 degrees in a matter of minutes. At which point we discovered some of the members of our group (a) didn't even have long pants and (b) didn't have adequate raingear.

We pulled out the Outing Club's 4-person tent and set it up with a central pole but without proper tieouts. We pushed all of the unprepared members of the group into the tent. All of them. Have you ever seen a possum with babies in her pouch, all squirming around? It sort of looked like that. We then sorted through our packs for spare warm gear. And remember, this was before leaf bags or Gore-Tex or cellphones were a thing.) We the pulled out the unprepared people, one by one, fitted them with our extra clothing, forced them to drink some water and eat some gorp, and then did a very quick-and-dirty packing job with the tent. We then did a forced march to a hunters' cabin I knew of, a couple of miles away – much closer than the cars – at the ***western*** edge of the plateau, feeding and watering and encouraging some miserable people alont the way. The cabin had room for all of us. There was frost everywhere all day as we hiked back to Bear Rocks.



And this is still a model of what you should do in such a situation. Let's enumerate.

- Stop! Recognize that you're in a hypothermia emergency.
- Seek or make temporary shelter.
- Force people to eat even if they don't want to: food in the belly will stoke your furnace and prevent hypothermia.
- Force people to drink even if they don't want to. Dehydration from cold can make you less fit for surviving the night or a forced march.
- Decide whether to bivouac in place or do a forced march to a more sheltered location.



And this is why the ASRC pack check list requires you to have ***FIVE*** large plastic leaf bags.

This shows how you can step into one, pull another over your head and rip a hole for your face, and shelter in place. Or more likely, give some of the leaf bags to underprepared members of your team, such as firefighters without SAR training. One member of the ASRC's Blue Ridge Mountain Rescue Group credits his leaf bags for saving his life when he got caught overnight above timberline in New Hampshire's Presidential Range.

If you have to do a forced march, you can put one over someone's head and rip holes for the face and the arms. It's better than nothing. You can also open the closed end of another leaf bag and tie it around waist to make a sort of formal-length rain skirt.

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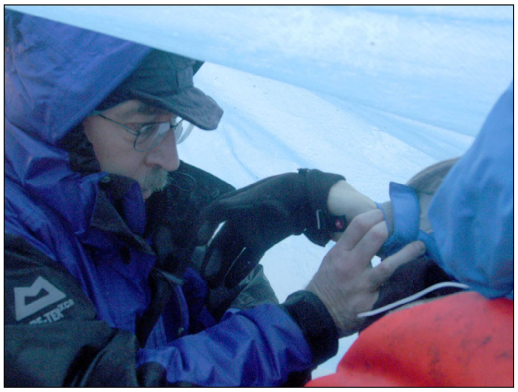
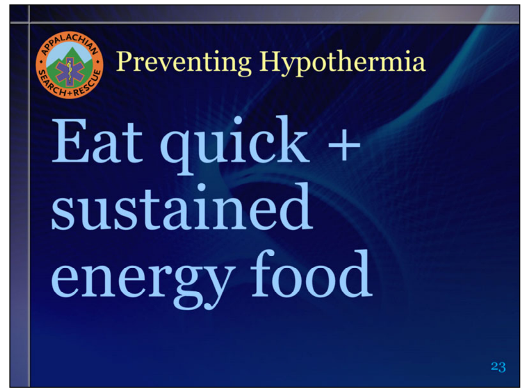
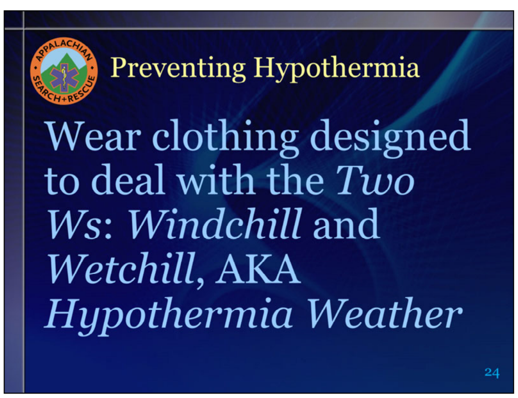
Even better for sheltering in place is if you have a bothy bag: an ultralight tent where your heads are the tent pole and your butts are the tent stakes. Here are two people huddled in a small bothy bag, sharing their body warmth. Note the vent on the top right.

Here are people setting large bothy bags over multiple simulated patients during a Wilderness EMT class in Scotland's Cairngorm Mountains.

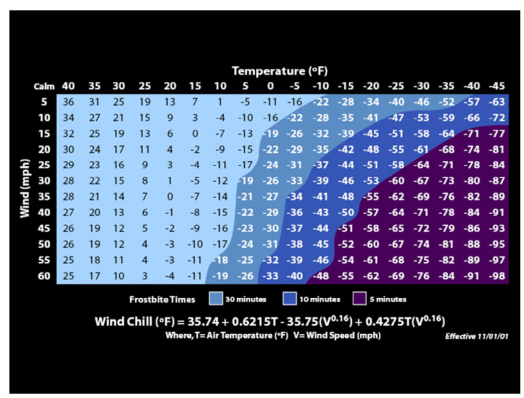


Here is an interior view, checking a patient's pulse.





Check the weather app on your phone. My favorite is WeatherBug. Look at the Doppler weather map to see if there's rain or snow heading your way. Check the wind speed. Check the forecast for the day or days you'll be out in the field. Convection from wind and evaporation from rain and decreased effectiveness of your midlayers and baselayers really increases the danger of hypothermia, which is why we call temperatures near freezing with wind and rain *hypothermia weather*: it's harder to stay dry in hypothermia weather than in colder weather with snow instead of rain.



Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

Wind Chill (°F) = $35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

This wind chill chart that everyone shows? This is better than most in that it says at the bottom of the chart that it shows the danger of *frostbite* on exposed skin, not the danger of *hypothermia*. Wind also markedly increases your danger of hypothermia, but it depends much more on how much, what and how recently you've eaten, your exertion level, your heat debt, and the clothing you are wearing. The "feels like" temperature that WeatherBug and many other weather apps provide, on the other hand, do give some idea of how cold you will feel, in hypothermia terms, for when it's cold out. When it's hot out, that "feels like" temperature figures in the humidity.

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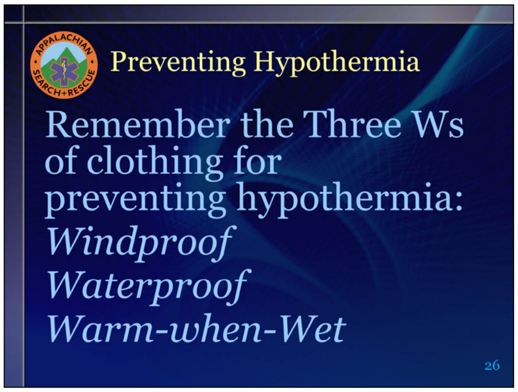
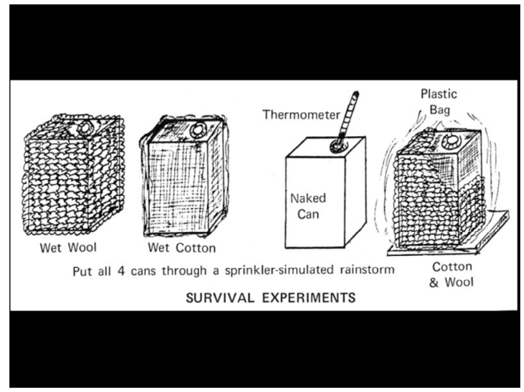


Windproof and waterproof are pretty explanatory, although it's worth mentioning that on cold dry days, you will stay warmer with a highly-breathable windshell or softshell jacket than in a "hardshell" waterproof-breathable jacket. Why? Because waterproof-breathable jackets only breathe – and by this we mean letting some of your sweat, or the insensible perspiration that we give off all of the time, evaporate through them – when your midlayers under it are already damp, with a high vapor pressure. And damp midlayers don't insulate as well.



Warm-when-wet needs a bit more explanation. Different fabrics retain different amounts of insulating value when wet. This thought experiment (though you can do it in real life if you wish).illustrates this. You put hot water of equal temperature in the cans; you put them in a *shady*, breezy spot. You wait for a while and then measure the temperature in each can. The naked can and the wet cotton can are about the same temperature, the coldest. The wet wool and the wet cotton and wool in a plastic bag are much warmer. This shows a couple of things: first, the power of evaporation to cool you, second, the value of a shell garment, and finally:

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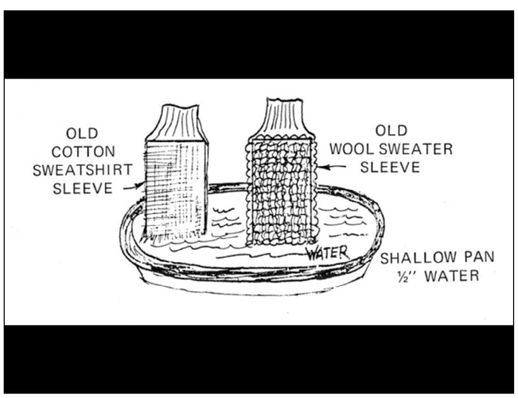

Why, as we say, cotton kills. If you do this experiment, the cotton sleeve is very heavy and cold to the touch, as the water in it conducts heat very well. The wool sleeve is a bit heavier than when it was dry, but still much warmer to the touch. (This is how I tell which of my wife's socks are wool and have to be hung up to dry, and which are cotton and go in the dryer.)

This is because, unlike wool or polyester fleece, cotton

(a) *wicks* (which is something we *like* in a baselayer material that doesn't retain much water) but

(b) it also holds onto – *absorbs* – lots of water. This is good in a bath towel, but bad in outdoor clothing especially in the wet-cold mid-Appalachians.

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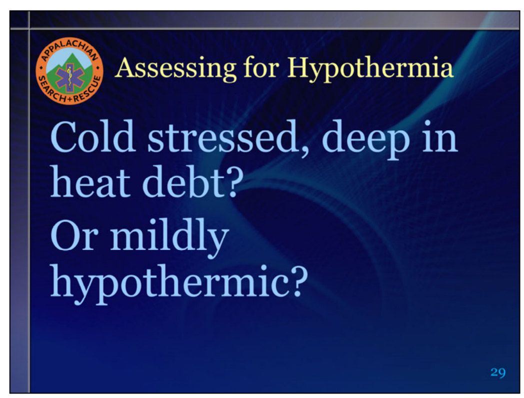
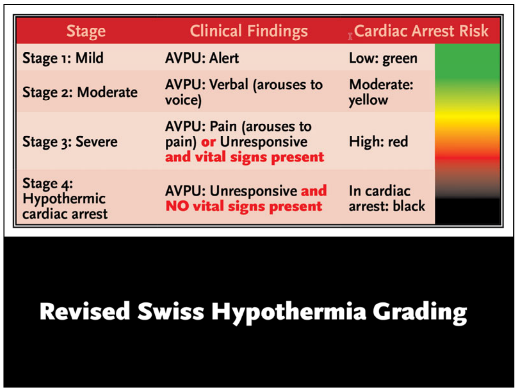


It doesn't matter as the treatment is the same: what we covered in that Dolly Sods story from 1972. Whether it's a team member or a search subject.

So how do we tell whether it's mild or moderate or severe hypothermia? There are lots of schemes for grading hypothermia, most of which are quite bogus. So you should use the:

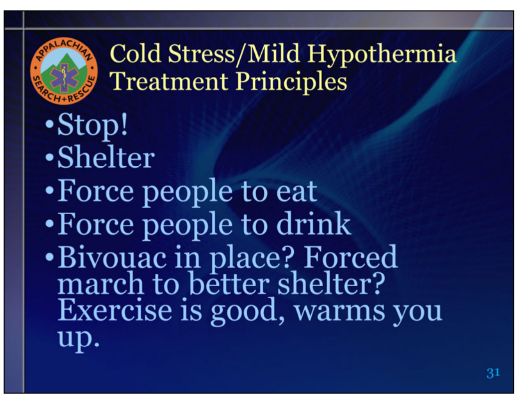


Stage	Clinical Findings	Cardiac Arrest Risk
Stage 1: Mild	AVPU: Alert	Low: green
Stage 2: Moderate	AVPU: Verbal (arouses to voice)	Moderate: yellow
Stage 3: Severe	AVPU: Pain (arouses to pain) **or** Unresponsive **and vital signs present**	High: red
Stage 4: Hypothermic cardiac arrest	AVPU: Unresponsive **and NO vital signs present**	In cardiac arrest: black

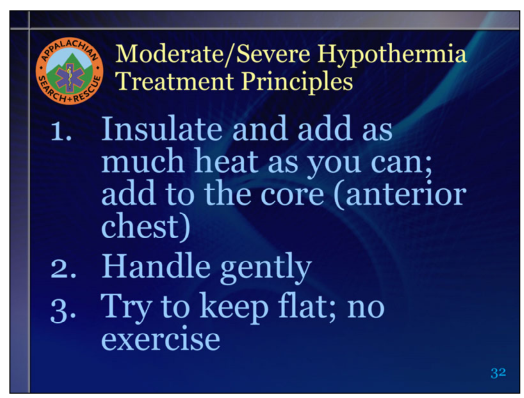
This is the latest and greatest system for assessing for severity of hypothermia ***in the field, without a thermometer***.

- These gradations are based on the risk of sudden cardiac arrest, whether from a minor bump (which is why we say "handle gently"), tilted head-up that worsens shock, or just because their heart is too cold.
- This uses the AVPU system – alert, verbal, pain or unresponsive – combined with checking a carotid pulse and checking for respirations. It's appropriate for everyone from wilderness first aid up to board-certified emergency physicians.
- A major part of the "revised" in this grading system was to remove shivering. Shivering does *not* correlate with core temperature. Some people *don't* shiver when they get hypothermic. Shivering is *useless* as a measure of hypothermia.
- I revised this graphic of the grading system by adding the "mild, moderate, severe, and hypothermic cardiac arrest" as they are ***so*** much easier to remember.
- The spectrum on the right indicates that there are not sharp boundaries between these levels
- These are graded by, in the appropriate setting, using the AVPU system of measuring responsiveness: Alert and responsive, arouses to voice (Verbal), arouses only to Pain, and Unresponsive, the last being combined with whether vital signs are present (breathing or pulse, even if very slow)

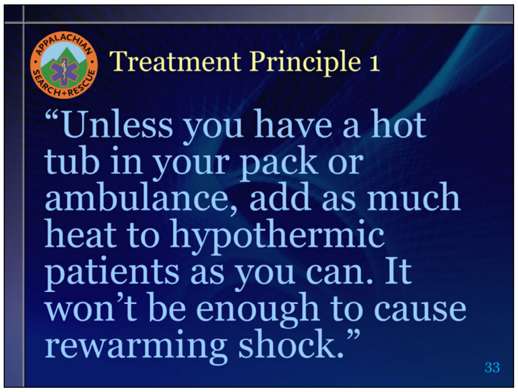
- Check for signs of life (pulse and, especially, respiration) for up to 1 minute.
- Other factors (e.g., intoxication, head injury, high altitude cerebral edema or low blood oxygen from high altitude pulmonary edema or chest injury) may also affect level of consciousness.
- Risk of cardiac arrest does not solely depend on core temperature but also varies depending on the patient's other medical conditions.



Again, for mild hypothermia or cold stress with a big heat debt, the principles are what we did during that Dolly Sods incident.



For principle #1: If you can remove wet clothes and replace with plenty of dry insulation, that's recommended. Remember to put insulation *under* as well as over patients.



We have to debunk the idea that you should *not* rewarm hypothermic patients in the field. The standard dictum has always been:

"Unless you have a hot tub in your pack or ambulance, add as much heat to hypothermic patients as you can. It won't be enough to cause rewarming shock."

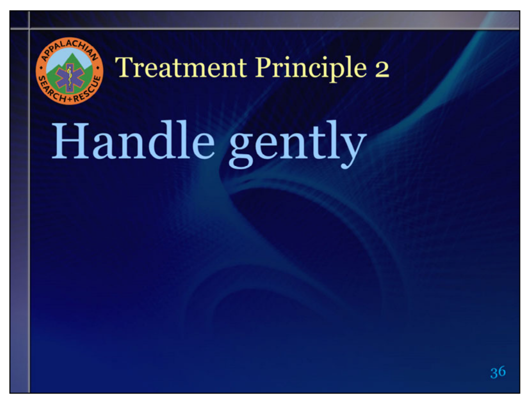
If you look at the back of your hand when it's warm, you can see the veins. They are dilated – full of blood – radiating heat. If you look at the back of your hand when it's cold, you can barely see the veins. They have constricted – gotten smaller – to conserve heat.

If you dump a moderately or severely hypothermic patient in a hot tub, you may cause rewarming shock. The heat on the skin, by reflex, dilates the veins (that means they get bigger), and suddenly there is not enough blood to go around. The patient is now in shock.

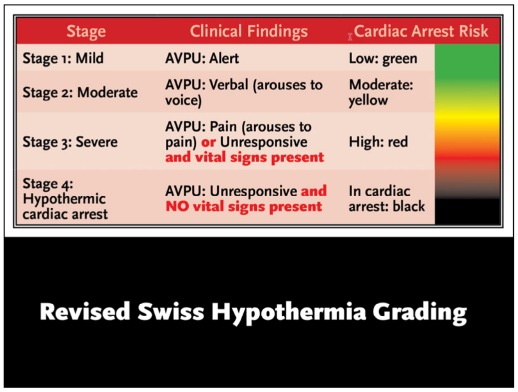
A corollary to this: you want to add heat to the core. And the best place to do this is on the anterior chest. We used to teach putting hot packs on the sides of the neck, the armpits and the groin, where big blood vessels are close to the skin. But we now know that the front of the chest works better, with the armpits if you've got extra

The mitten is for scale. This is my favorite keep-in-the-pack hot pack. It's from Chinook Medical, and it's a Ready Heat brand. Unlike the fragile packaging of the HotHands hot packs that you see everywhere, it's sealed in tough plastic that will last basically forever. And it fits nicely in the Camelbak pouch of your SAR pack. As with the HotHands, it's basically fine iron filings that, when exposed to air and moisture, rusts really fast. Both kinds tend to last for about 8 hours. This is the biggest part of my wilderness first aid kit: good hypothermia treatment. I have one in my SAR pack which is also my daypack for hiking.

This is the hot pack, opened. Note the hard-to-see white Velcro straps on the left and the Velcro patches on the right; it's designed to wrap around an IV bag. Look carefully at the fuzzy blue part: there are four large HotHands size hot packs embedded in the fuzzy blue part. This is perfect for putting on a hypothermic someone's chest, and the fuzzy blue stuff and Velcro can help keep it from sliding off.



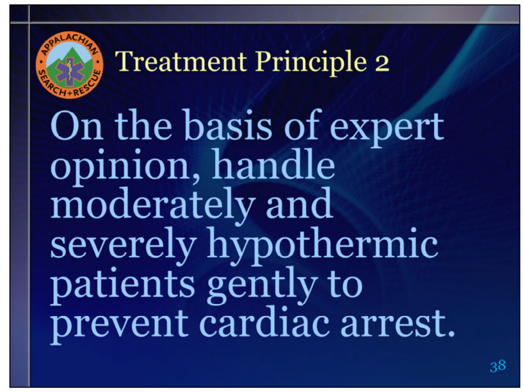
Why?



Stage	Clinical Findings	Cardiac Arrest Risk
Stage 1: Mild	AVPU: Alert	Low: green
Stage 2: Moderate	AVPU: Verbal (arouses to voice)	Moderate: yellow
Stage 3: Severe	AVPU: Pain (arouses to pain) or Unresponsive and vital signs present	High: red
Stage 4: Hypothermic cardiac arrest	AVPU: Unresponsive and NO vital signs present	In cardiac arrest: black

Because a cold heart is likely to go into ventricular fibrillation cardiac arrest. Just because. Or maybe because you bang the litter on a boulder when setting it down. Recently, I have heard some people pooh-poohing the idea that bumping a cold patient can send someone into cardiac arrest. Well, we know that if you hit someone in the chest with a baseball at just the right point after a heartbeat, you can send a *warm* person into ventricular fibrillation cardiac arrest. It's called commotio cordis. So it's reasonable to think that a *cold* heart will go into ventricular fibrillation with a less-severe shock. And now we've gotten into some advanced stuff that I originally didn't want to cover so I will just say that "On the basis of expert opinion, handle moderately and severely hypothermic patients gently to prevent cardiac arrest." Again, this is posted on my website with all of my planned comments in the speakers' notes.

Yes, hypothermic patients in cardiac arrest can survive longer periods of cardiac arrest with CPR than warm patients, but still, survival is better without cardiac arrest.

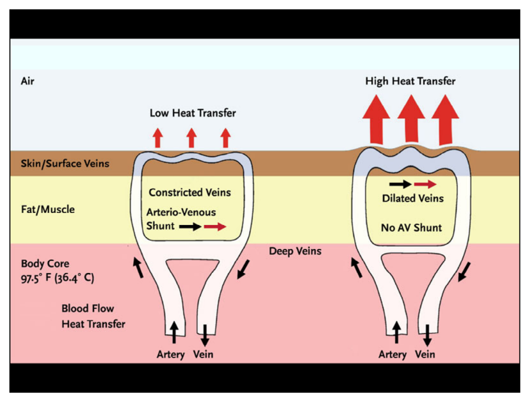


So there.

Remember that we learned that, for those who are cold-stressed or mildly hypothermic, to feed and water them and then get them up and have them exercise, like a forced march to better shelter.

That's a no-no for those who have moderate or severe hypothermia.

There are case reports of hypothermic patients being tilted head up for a rescue or being pulled out of the hydrostatic squeeze of being in water, and suddenly seizing or losing consciousness and then dying. This makes sense if you think about it. If you're dehydrated and lying flat, or your body is in water being squeezed by the water, there is enough blood going to your brain. But if you suddenly stand up, or suddenly get out of the water, there's not enough blood going to your brain. So you pass out. And/or have a seizure. And that seizure, if you're hypothermic, might send you into a ventricular fibrillation cardiac arrest.

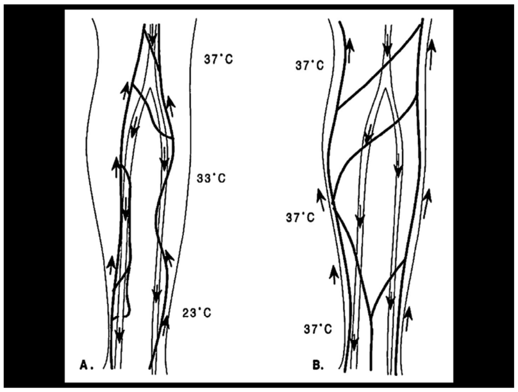


On the right is when you are warm and you can see the veins on the back of your hand carrying warm blood from your core to right under your skin to radiate away heat. On the left, you can see how your body responds to cold by keeping some blood flowing to your hands but mostly going through the deeper veins. This decreases the amount of space your blood vessels have for blood, which makes you kidneys pee out the excess fluid. This makes you relatively dehydrated. And when your kidneys get cold, they simply leak and you pee out water even if you're dehydrated.

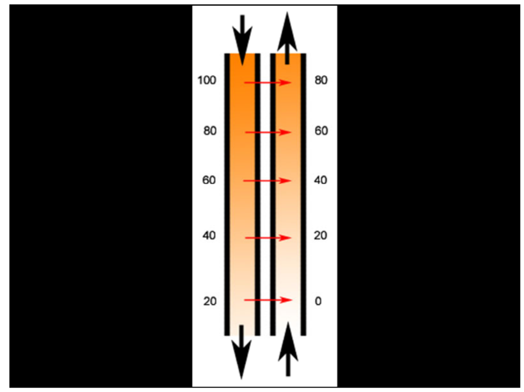
So, if you're hypothermic, you're probably dehydrated, and the more hypothermic, the more dehydrated. And being tilted, up, or trying to stand up, all of the blood goes to your toes rather than your brain. This tends to make you pass out. And maybe die.

So, that thing about getting up and exercising to get warm, like a forced march to better shelter? That doesn't apply to those with moderate or severe hypothermia until they're (a)_rewarmed, and (b) rehydrated and fed.

Graphic by Laurel Victoria Conover, used with permission. Inspired by a diagram in Davis, R.W. (2019). Metabolism and thermoregulation. Marine mammals, Springer: 57-87. https://link.springer.com/chapter/10.1007/978-3-319-98280-9_4



In that previous diagram, the veins right under the skin were short. In reality, they run the entire length of your arms and legs, as shown on the right in this figure. And if you look on the left, the deep veins run right next to the arteries. As a result…



This allows the heat to cross from artery to vein to keep heat in the core, while still providing blood to your arms and legs. This is called *countercurrent heat exchange*. This principle is used in air conditioning and heating as well. The black arrows are fluid flow, the red arrows are heat flow. For this diagram, your armpit is at the top and your hand is at the bottom. The temperature numbers are arbitrary in this generic diagram, your hands are not really going to be below freezing.

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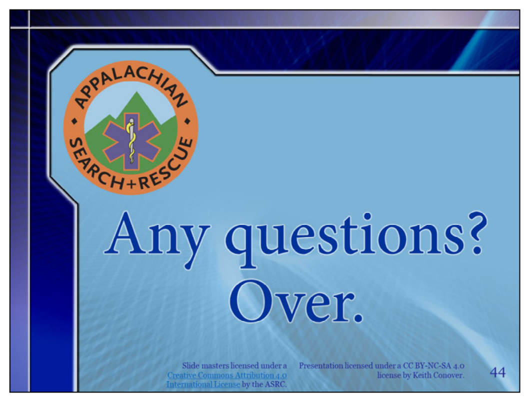
Revised Swiss Hypothermia Grading

We say "They're not dead until they're warm and dead." That's not really true, but severely hypothermic patients can survive cardiac arrest for a long time as long as they get some CPR. It's hard if not impossible to defibrillate a hypothermic heart with an AED or defibrillator, but if you keep warming the patient you may be able to do so and the patient might survive neurologically intact; it has happened, if not very often. When trying determine if there are vital signs, check for carotid or femoral pulse, and check for breathing; you can even hold a pair of sunglasses in front of the patient's mouth and nose to see if they fog. Check for a full minute. Why is this important? A severely hypothermic patient with a pulse, even a very slow one, is perfusing – getting blood to vital organs – better than if you perform external cardiac compression and thereby put the patient into a ventricular fibrillation cardiac arrest.



http://www.conovers.org/ftp/ASRC-Hypothermia-Presentation.pdf