Mountain Events in Hot Weather

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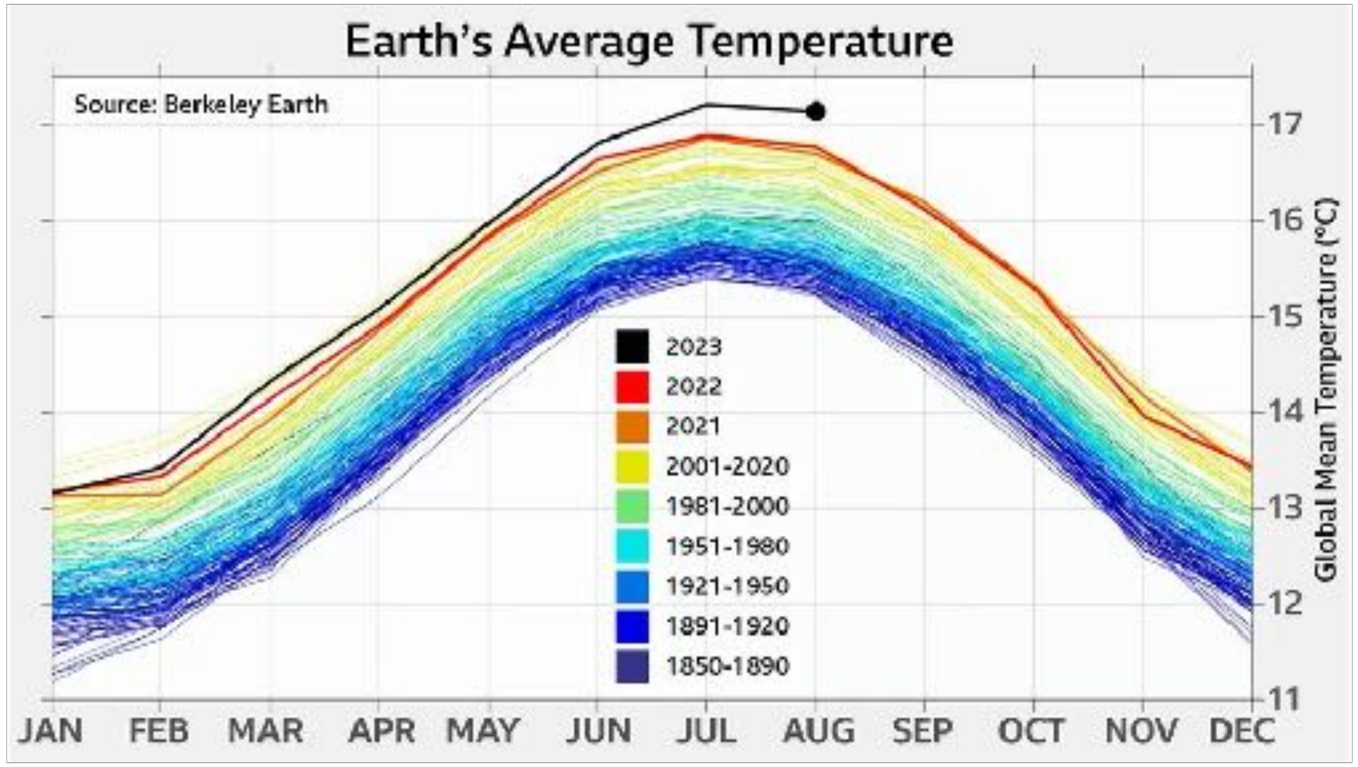
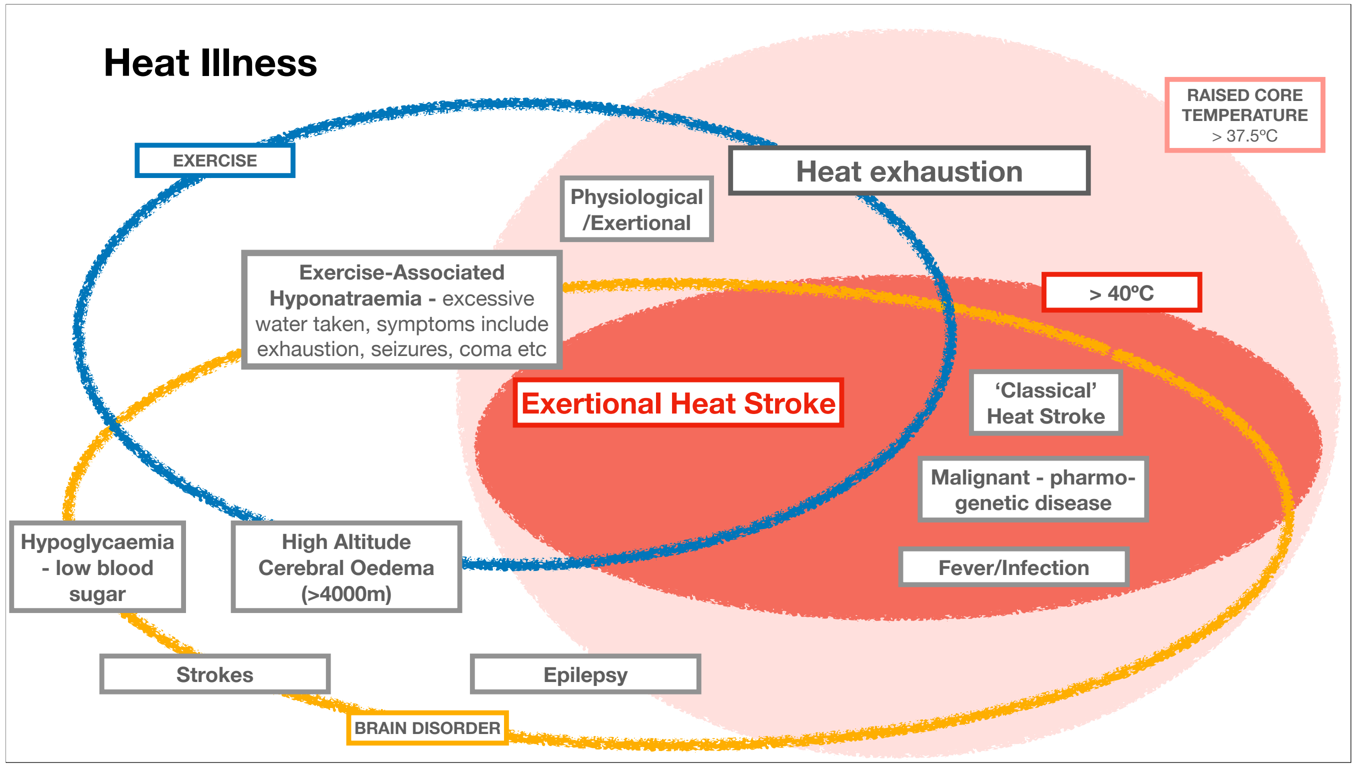
We have no conflicts of interest in relation to this subject

Good morning, In this presentation I would like to make the case that climate change will impact on the illness we see in mountain rescue.



This rainbow shows the Earth's average temperature from the end of the last mini-ice age, when major peaks in the Alps were first scaled, to the present day. What strikes me is the progression year on year. Of course, we are well aware, even in our lifetime, that glaciers are melting, seasons are changing and previously standard routes are now not feasible. This graph shows that in our lifetime the average temperature has risen by 1ºC. It is not unreasonable to expect that human heat illness will increase as I will demonstrate later.



Now be ready for a is a very busy slide. Heat illness develops when your core temperature increases above 37.5ºC; that's the pink and red areas shown here. This occurs not only from exposure to high environmental temperature, but also from heat generated from muscles during strenuous physical activity. So our diagram needs a blue circle for exercise. []
Where these circles cross we have the conditions to produce the common heat illnesses; [] heat exhaustion and Exertional Heat Stroke.
The difference between the two is that in Exertional Heat Stroke the patient invariably has a core temperature > 40ºC - they are in the red zone - and also have abnormal brain function; [] the orange circle. The brain disorder could be confusion, a reduced conscious level, seizures or coma. Ultimately death occurs if the condition isn't recognised early enough. In contrast, Heat exhaustion has none of these features. It presents with fatigue and headache in a person with a normal conscious level. The rest of the slide reminds us of the other heat illnesses [] and the other conditions that might be confused or coincide with heat illness [].
Before I leave this slide, I want to make a very important point. There is no reference to environmental temperature here at all.

This slide is of the Brecon Beacons in Wales. Most of us will think that this has no relevance to heat illness. We are conditioned to think that only hot places suffer from heat illness.
Not so. [] Here in 2013, 3 people died during a 26 km military training exercise. Their route, the standard clothing and kit they carried were sufficient on that day to tip the balance between heat generation and heat loss so that their core temperatures rose and rose. They died of Exertional Heat Stroke.

Ministry of Defence

JSP 539

HEAT ILLNESS AND COLD INJURY:

PREVENTION AND MANAGEMENT

Part 2: Guidance

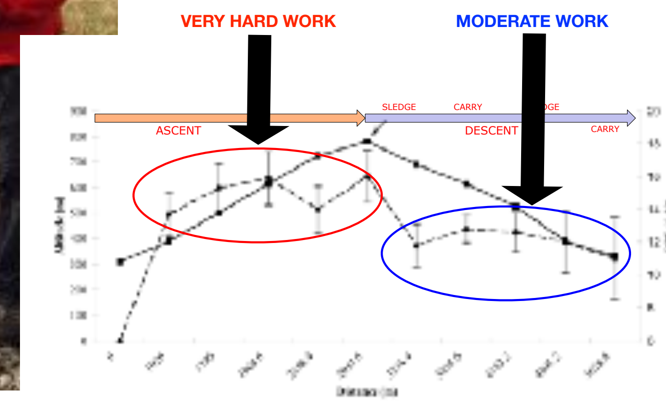
Table 1: not acclimatised, maximum continuous exercise durations and alternative work-rest schedules permitted for a 4-hour period when **wearing PT kit (shorts & t-shirt)**.

	Maximum Exercise Duration (Minutes)			
WBGT (°C)	**Easy Work**	**Moderate Work**	**Hard Work**	**Very Hard Work**
20 to 21.9	240	240	205 OR 30 work 30 rest	145 OR 20 work 40 rest
22 to 23.9	240	240	185 OR 30 work 30 rest	135 OR 20 work 40 rest
24 to 25.9	240	240	175 OR 30 work 30 rest	130 OR 20 work 40 rest
26 to 27.9	240	225 OR 50 work 10 rest	150 OR 30 work 30 rest	110 OR 20 work 40 rest
28 to 29.9	240	195 OR 40 work 20 rest	130 OR 20 work 40 rest	90 OR 20 work 40 rest
30 to 31.9	240	160 OR 30 work 30 rest	110 OR 20 work 40 rest	75 OR 20 work 40 rest
32 to 33.9	200 OR 40 work 20 rest	110 OR 30 work 30 rest	70 OR 20 work 40 rest	40 OR 10 work 50 rest
34 to 35.9	145 OR 40 work 20 rest	85 OR 20 work 40 rest	45 OR 10 work 50 rest	20 OR 10 work 50 rest
36 to 37.9	100 OR 30 work 30 rest	50 OR 20 work 40 rest	25 OR 10 work 50 rest	10
38 to 40	70 OR 20 work 40 rest	30 OR 10 work 50 rest	15	10

So, it’s not surprising that the military have introduced guidance and protocols to minimise the risk of heat stroke in their activities. This table shows the maximum work/rest periods at various military work loads being undertaken in different climatic conditions in shorts and t-shirts. Note that the temperature down the left side of the table is not your usual thermometer reading; it’s a Wet Bulb Globe temperature that takes into account air humidity and wind speed. This is a much better match to your potential to lose heat and thus not over heat.

Heat Illness in Rescuers

Physiological demands of mountain rescue work. Callender, Ellerton, MacDonald 2011



Do we have risk assessments covering this?

Now we already know that terrestrial rescuers have work loads comparable to soldiers. In 2011 we showed in the physiological study illustrated here that a carrying a stretcher uphill easily equates to very hard work as shown here in the red circle. Do we consider this in our risk assessments? Is it time that we prepare to look at the risk to ourselves more regularly and manage the risk of heat illness?

Great North Run, Newcastle, England

Exertional heat illness in half marathon runners: experiences of the Great North Run

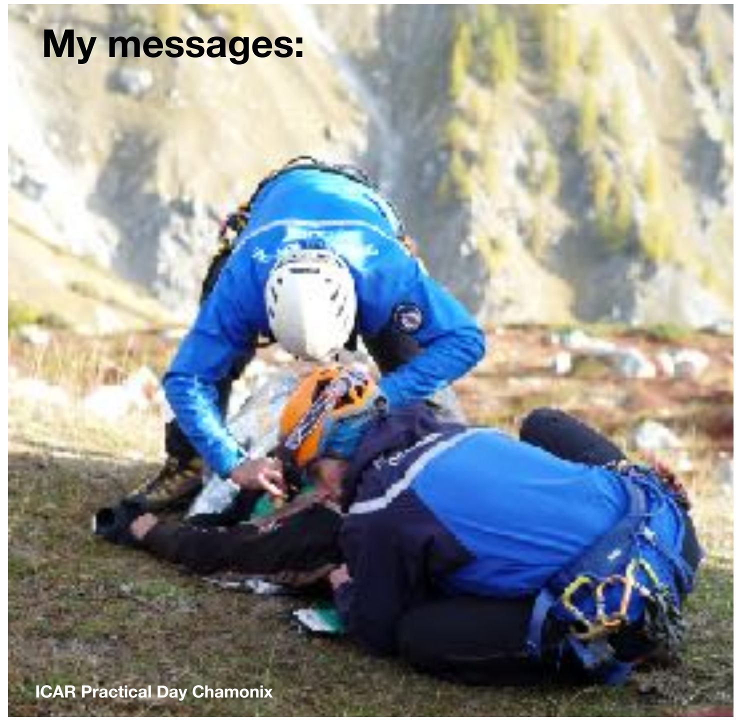
In 2009, 55 runners in similar male to female proportions were admitted to the Field Hospital with core temperatures >41°C. All but four were discharged home within 2 h. These were admitted to hospital and discharged within 24 h.

Nearly all patients with core temp >41°C had some cognitive dysfunction and delirium was common. This was transitory in the majority but,

Largest ½ marathon in the world - Over 1 millión participants in 42 editions

In total, there have been 14 deaths including 4 in one race in 2005 - from ‘over-exertion’

The Great North Run is the largest ½ marathon in the world. There has been over 1 million participants in its 42 editions . A total of 14 deaths have occurred during the race including 4 in 2005. At the inquest into these deaths, the coroner decided the cause of death was ‘over-exertion’. The temperature at the time of the race was about 18ºC, some 2ºC higher than the average for mid September.
In 2009 a study of the same race reported that 55 runners - about 0.1% of runners - were admitted to the field hospital with a core temperature of > 41ºC (rectal); nearly all had a reduced level of consciousness. The temperature at the time of the race was around 16 ºC. They were cooled quickly and there were no fatalities. Subsequently, medical facilities at the race weren greater increased.



Heat Illness is not always considered. False diagnoses including hypothermia have been made

Potentially harmful treatments maybe started

Any patient with impaired consciousness should have a core temperature taken asap

Both examples occurred at environmental temperatures of 18-20ºC - only a couple of degrees above the average for the location

1ºC rise in our lifetime. We will see more cases in the future

= more Heat Illness

To me, these two examples suggest a number of messages relevant to mountain rescue and particularly those incidents that involve participant exertion:[]
Firstly, heat illness was not considered initially and therefore appropriate management was not started. [] Indeed, we often hear that hypothermia is diagnosed and insulation is applied. [] I would like to plead that any patient with impaired consciousness has a temperature measurement taken as soon as possible.
[] Secondly, both the examples occurred on nice days where the temperature was 18 - 20ºC. This is only a couple of degrees above the average temperature for the location. If you recall that my first slide demonstrated an average increase of 1ºC in our lifetime. [] That fact would suggest to me that until we adapt, [] we will see many more cases of heat illness in the future.

So we need to look at our management of Exertional heat illness and learn from the experts like the person standing next to me. Over to you Darryl from New Mexico

The “usual” suspects for Exertional Heat Illnesses

Badwater 217km ultra - 49ºC
(WBGT 51ºC Dearth Valley, CA

Grand Canyon hike/run, AZ
(heat+exertion)

Bataan Memorial Death March
White Sands Missile Range, NM
(heat+clothes+conditioning)

Burning Man
“rave” (heat+sympathomimetics)
Black Rock Desert, NV

Under appreciated causes of Exertional Heat Illness

Fire, EMS, law enforcement/ military

Dry suit dive ("rescue")-water 10ºC

Confined space rescue: temperature 38ºC

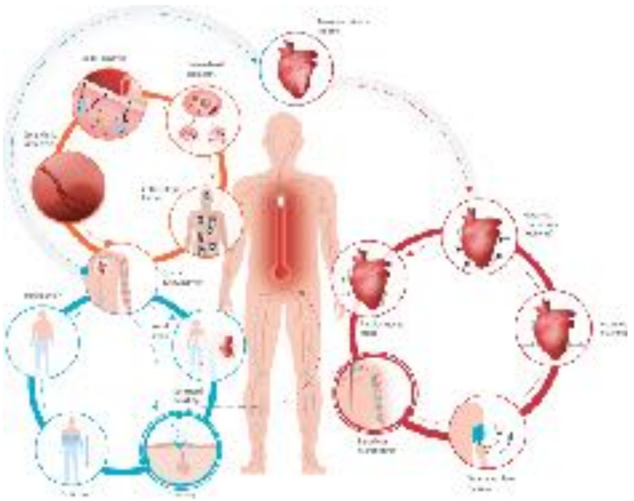
Mt Shishapangma - glacier area measured 32ºC before cloud cover

"Overdressing"

Heat Related Illness

- Heat oedema
- Heat rash
- Heat cramps
- Heat syncope
- Heat exhaustion
- Vague exhaustion
    - electrolytes, glycogen depletion

"Normothermia"



Heat Stroke:
40ºC + end organ

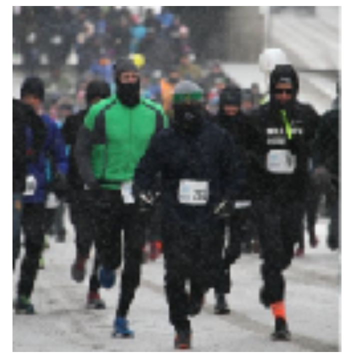
Was it Hypothermia or Hyperthermia?

A 12-yr profile of medical injury and illness for the Twin Cities Marathon

WILLIAM O. ROBERTS Roberts 2000

MinnHealth SportsCare, White Bear Lake, MN 55110; and Department of Family Practice and Community Health, University of Minnesota Medical School, Minneapolis, MN

- Average start temperature 5°C
- Average 4 hr temperatures 11°C
- -9 to 32°C; humidity 57-84%
- Windchill and WBGT adjusted
- ~80K runners, ~20 pts/1000



- 46 runners with temperatures 33-35°C
- Lowest: 33°C during “hottest” race
- 17 runners with rectal temperatures 40°C
- This was during “average” temperatures
- Uneventful recoveries

Core temperature measurement

“Applicable” to heat stroke and hypothermia

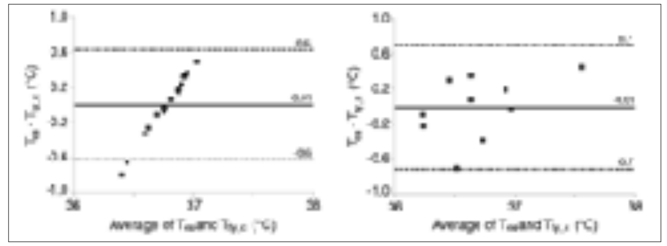
Oesophageal probe

Invasive bladder

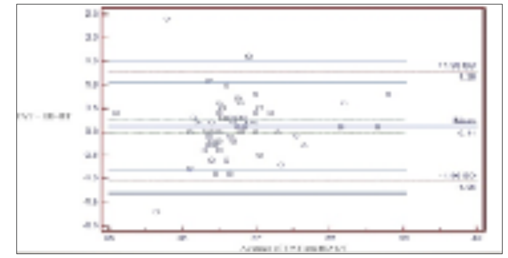
Rectal probe

Invasive (ECMO)

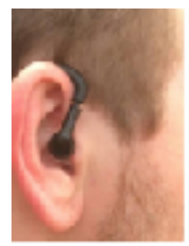
Less invasive: you choose!



Environment adversely affects; reproducibility and precision compared to oesophageal not reliable.
(Strapazzon 2015; Skiaa 2015)

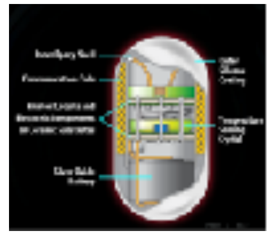


93% of mean differences (TAT vs ED DT within 1ºC; mean 0.1ºC, but variability/extremes
(Carleton 2012; Hsuan 2020; Azarkane 2022)

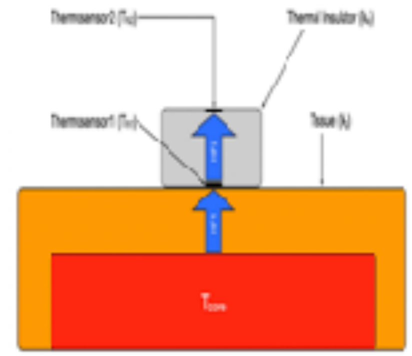


The future?

Telemetry enabled “pill” or the flux double sensor



Bongers 2015; Olcina 2019



Opatz 2013, Janke 2021; Savyon 2017; Masè 2022

Heat Exhaustion (exertional)

Too much at Burning Man - observe for drug interactions!

Cool water in a hot tent, White Sands NM

Likely normo-thermic

Normal mental status

Move to shade/cool area

Spray with cool/tepid water

Humidity: dry frequently

COLD water fan if humid

Fluids/electrolytes by mouth

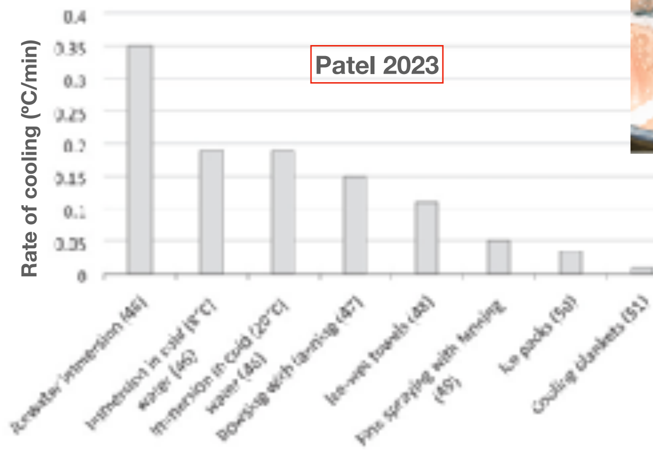
No IV, no laboratory tests

Insulate ground

Collapsed but alert, Badwater ultramarathon

Exertional Heat Stroke

Rapid cooling and transport!



Older patients intolerant to ice

Monitor; cool to < 39 C

Avoid antipyretics

Lab tests, admit

Shivering; rebound?

Ice bath (41°C patient)

“Taco” tarp; body bags

Thank you for listening

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