## Hot Worksites and Health: The Risky Business of Working in the Heat.

Dr. Sandra Dorman, PhD Centre for Research in Occupational Safety and Health



## Mine Rescue: Case Example



### **International Mine Rescue Competition (2016)**





### **International Mine Rescue Competition**

- Equivital Life monitor: n = 76 (Response Rate: 56.3%)
- Core temperature capsules: n = 57 (Response Rate: 42.2%)







## Subject Characteristics

	Total (n=76)	Captain (n=15)	Vice (n=15)	#2 (n=16)	#3 (n=15)	#4 (n=15)
Age (years)	36.5±0.70	37.5±1.73	35.2±1.55	35.4±1.01	36.0±1.16	38.5±2.17
Height (m)	1.8±0.01	1.8±0.02	1.8±0.02	1.8±0.02	1.7±0.02	1.8±0.02
Weight (kg)	87.5±1.65	90.4±4.29	94.4±3.87	82.8±3.13	83.0±3.74	87.0±2.92
BMI (kg∙m⁻²)	27.8±0.39	28.7±1.20	29.2±0.88	26.0±0.6	26.8±0.88	28.2±0.53
HR <sub>max predicted</sub> (bpm)	182±1	182±1	183±1	183±1	183±1	181±2
Estimated VO <sub>2 max</sub> (ml·min <sup>-1</sup> ·kg <sup>-1</sup> ) (n=70)	45.4±1	43.6±1.66	44.1±1.21	47.7±0.47	46.4±0.80	44.9±0.83



# Subject Characteristics

	Total	Captain	Vice	#2	#3	#4
	(n=76)	(n=15)	(n=15)	(n=16)	(n=15)	(n=15)
Age (years)	36.5±0.70	37.5±1.73	35.2±1.55	35.4±1.01	36.0±1.16	38.5±2.17

#### Average Resting Heart rate is 60-80 bpm;

A person's Maximum heart rate is considered to be the highest number of beats your heart can sustain. This can be estimated based on your Age using simple equations: (Fox: 220-age); (Tanaka: 208-0.7\*age). 80% of your maximum is considered to be HARD to VERY HARD and is not recommended to maintain for long periods.

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Estimated VO <sub>2 max</sub> (ml·min <sup>-1</sup> ·kg <sup>-1</sup> ) (n=70)	45.4±1	43.6±1.66	44.1±1.21	47.7±0.47	46.4±0.80	44.9±0.83

#### Task 1 – Casualty Care

Time: 40 mins

Ambient Conditions: Dry-Bulb Temperature (°C) = 25.7 Wet-Bulb Temperature (°C) = 22.0 Relative Humidity (%) = 72.4

#### Task 2 – Arduous Labour

Time: 22 mins

Ambient Conditions:

Dry-Bulb Temperature (°C) = 34.7Wet-Bulb Temperature (°C) = 24.7Relative Humidity (%) = 43.8

### Task 3 – Casualty Care

Time: 31 mins

Ambient Conditions: Dry-Bulb Temperature (°C) = 18.0 Wet-Bulb Temperature (°C) = 17.0 Relative Humidity (%) = 90.6

#### Task 4 – Arduous Lau

Time: 15 mins

#### **Ambient Conditions:**

Dry-Bulb Temperature (°C) = 18.0Wet-Bulb Temperature (°C) = 17.0Relative Humidity (%) = 90.6



# Physiological Measures



#### Measurements

- Heart rate (HR)
- Heart rate variability (HRV)
- Respiration rate (RR)
- Skin temperature (T<sub>skin</sub>)
- Core temperature (T<sub>core</sub>)

#### **Estimations**

- Energy expenditure (EE)
- Estimated maximal oxygen consumption (VO<sub>2 max</sub>)

### Mean Core Temperature

ROSH



Task





Task





The average man burns 2400-3000 kcal per day Or ~500kcal in 60 min of running.





# Implications



Current ACGIH standards cannot protect workers because:

- Some work cannot have time limits;
- Some work conditions fluctuate rapidly;
- Different workers respond differently to the same conditions;
- The same worker can respond differently, on different days, to the same conditions;
- Climate change is impacting more workplaces & workers; who currently don't enforce guidelines or who create their own.



# Personal Nonitoring P



# Why Monitor?

...because a worker's body response is modified by:

- age, sex, chronic disease, others
- medication use, fitness, acclimation, hydration state, others
- shift duration, illness, previous heat strain, others
- it becomes challenging to protect workers without assessing these physiological responses



# Why Monitor **P**

Meaningful heat stress protection is:

- Preventative;
- Rapid / real-time;
- Does not rely on secondary monitoring systems (e.g. check-in).





### Practical Considerations & Recommendations



## Resources



Konrad, Justin MHK; Gagnon, Dominique PhD; Serresse, Olivier PhD; Oddson, Bruce PhD; Leduc, Caleb MHK; Dorman, Sandra C. PhD Effect of a Simulated Mine Rescue on Physiological Variables and Heat Strain of Mine Rescue Workers, Journal of Occupational and Environmental Medicine: March 2019 - Volume 61 - Issue 3 - p 251-261 doi: 10.1097/JOM.0000000000001530



à l'Université Laurentienne

at Laurentian University

https://crosh.ca @CROSH CRSST

crosh@laurentian.ca



@crosh\_crsst



Centre for Research in Occupational Safety and Health