Thermal Protection for Divers

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Thermal strain and hydration

Thermal strain and hydration are interrelated and affect nearly every aspect of diving performance and undersea medicine

- Heat stress in the water magnifies water loss
- Cold stress in the water aggravates centralization of blood and increases water loss

PPE may improve some situations (dry suit in cold water) and worsen other (vulcanized rubber drysuit in warm water)

The effect of temperature on DCS

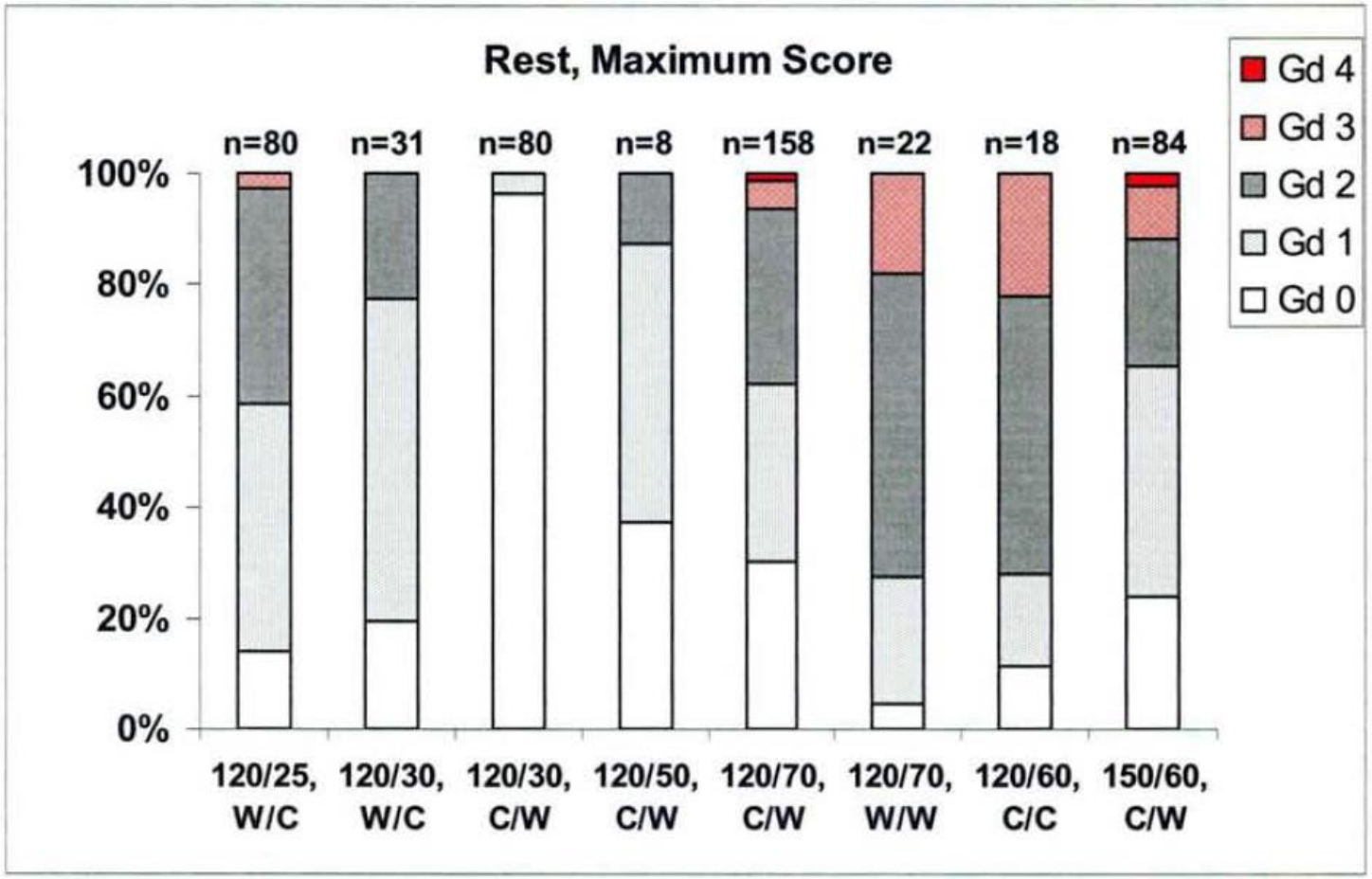
Table 5.
Summary of DCS Outcomes, 120 fsw Dives

Series	Thermal Condition Pair	Depth (fsw)/ Bottom Time (min)[a]	# DCS/ # Exposures	DCS Incidence (%, 95% C.L.)
1	C/W	120/30	0/80	0.0 (0.0–3.7)
3		120/50	0/8	0.0 (0.0–31.2)
4		120/70	2/158	1.3 (0.2–4.5)
2	W/C	120/30	7/32[r]	21.9 (9.3–40.0)
5		120/25	4/80	5.0 (1.4–12.3)
6	W/W	120/70	4/24[r]	16.7 (4.7–37.4)
7	C/C	120/60	4/18[r]	22.2 (6.4–47.7)
		Totals:	21/400	

[a] All dives decompressed with the 120 fsw/70 min U.S. Navy Standard Air schedule
[r] Testing stopped with attainment of reject criterion

Gerth et al. The influence of thermal exposure on diver susceptibility to decompression sickness. NEDU Technical Report 06-07. Panama City: Navy Experimental Diving Unit; 2007

The effect of temperature on DCS



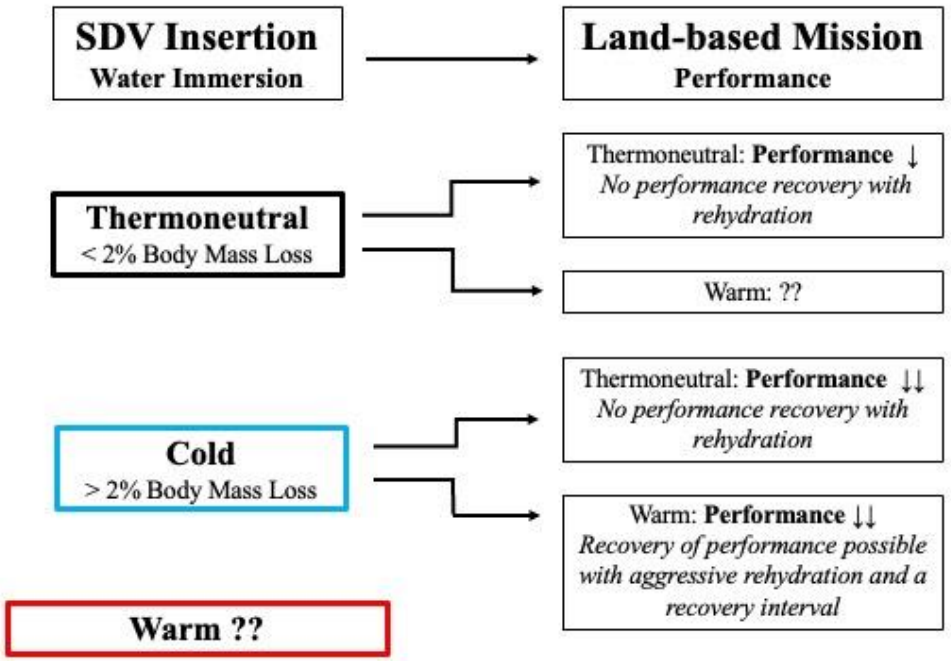
Gerth et al. The influence of thermal exposure on diver susceptibility to decompression sickness. NEDU Technical Report 06-07. Panama City: Navy Experimental Diving Unit; 2007

The effect of temperature on hydration and post immersion performance

Water immersion leads to hypohydration

Hydrostatic pressure on immersed tissues shifts fluid from the intracellular to the vascular compartment

- Initially expanding the plasma volume
- Translocates blood to the thorax
- Reflex Diuresis and natriuresis



Controlling thermal strain partially controls hydration

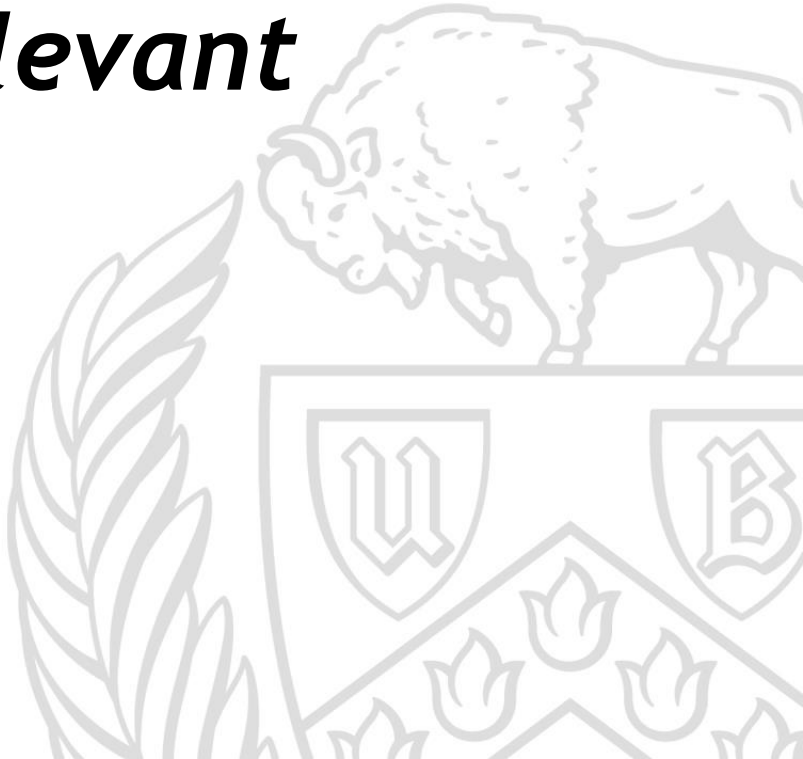
Manipulating skin temperature prevents both sweating and vasoconstriction

Controlling skin temperature can both offset metabolic heat in warm conditions and supplement body heat in cold conditions

Controlling body temperature could greatly reduce the incidence of decompression sickness

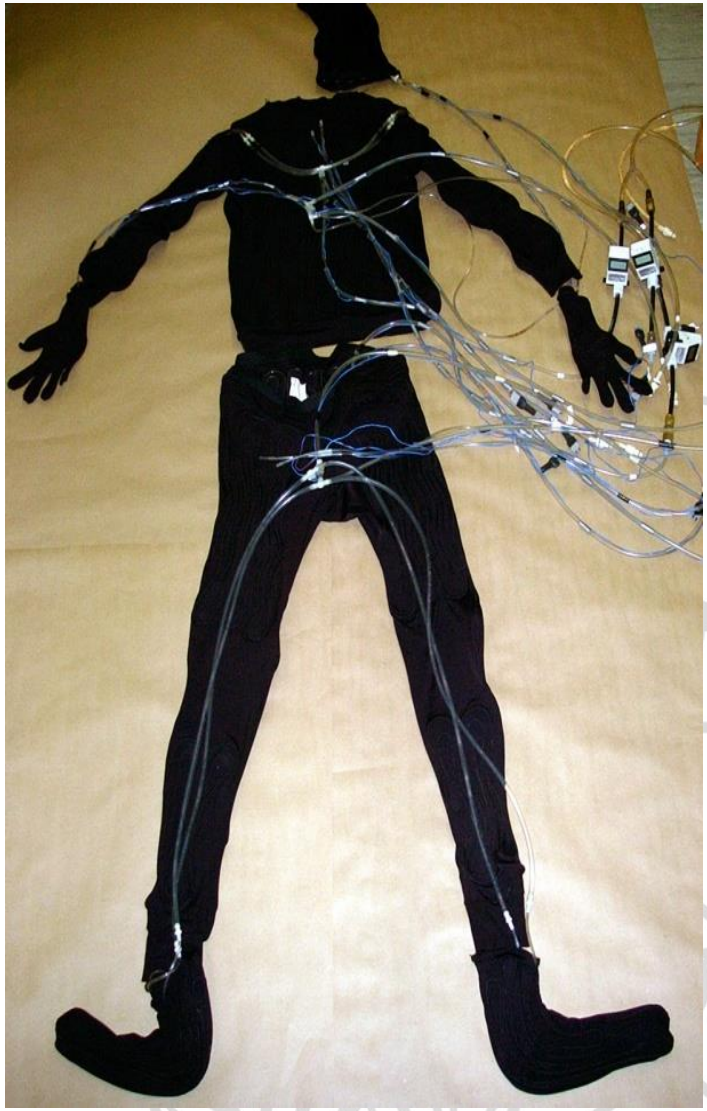
The giant step forward

Make the temperature of the ocean irrelevant

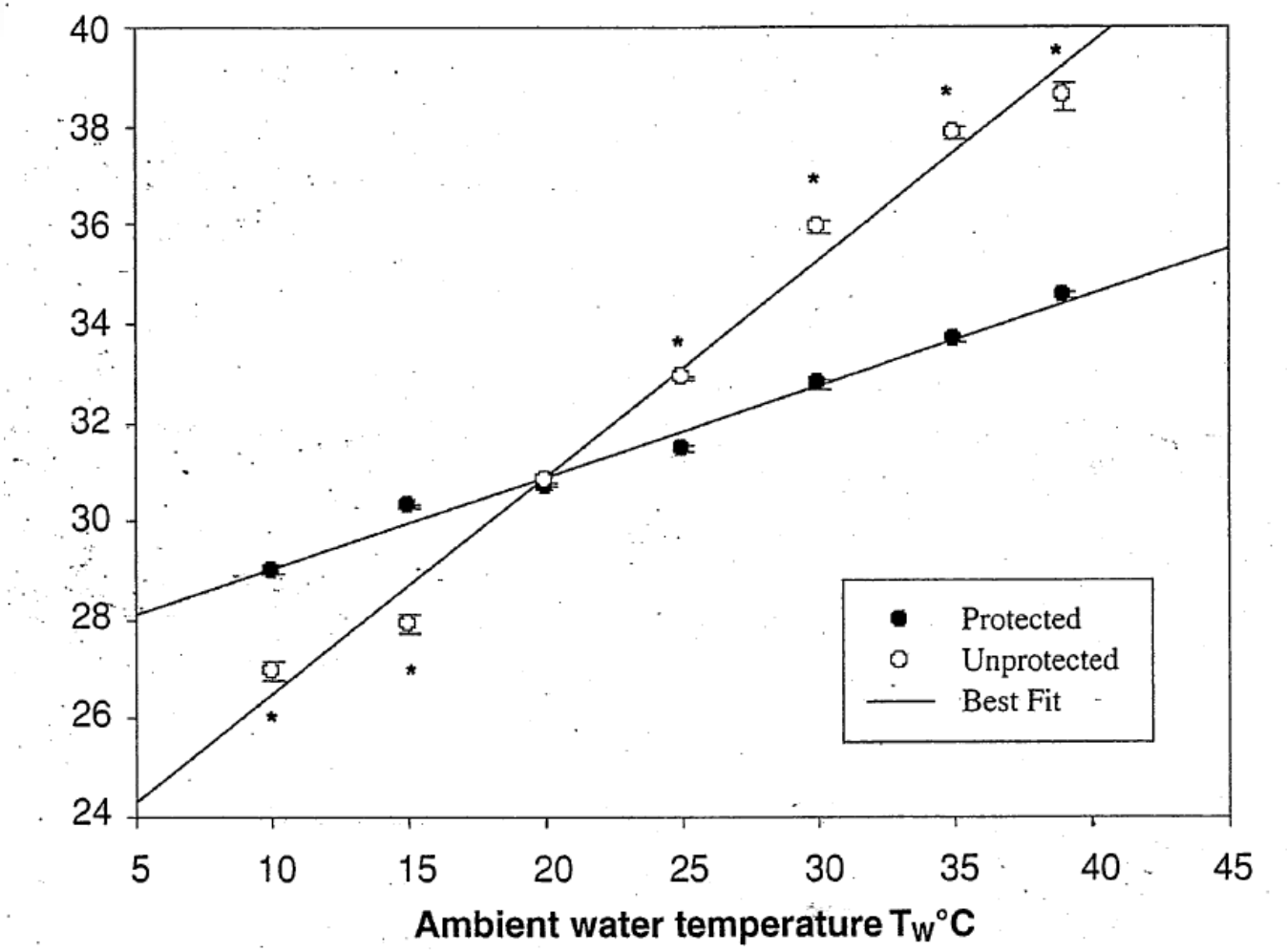


Diver Thermal Protection System (DTPS)

- Developed at CRESE more than 20 years ago
- Custom creation designed to clamp skin at a constant temperature



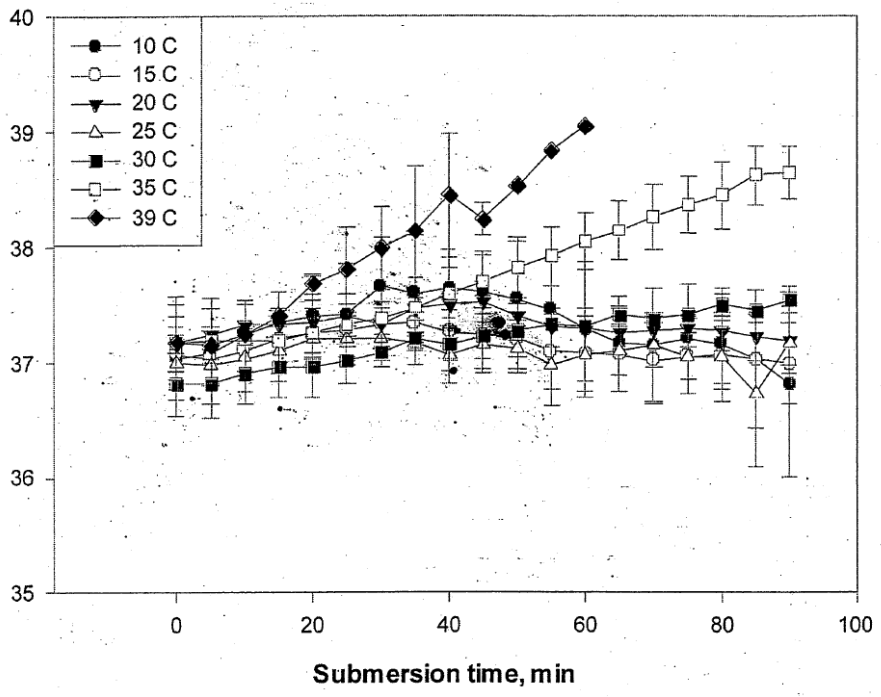
Skin temperature



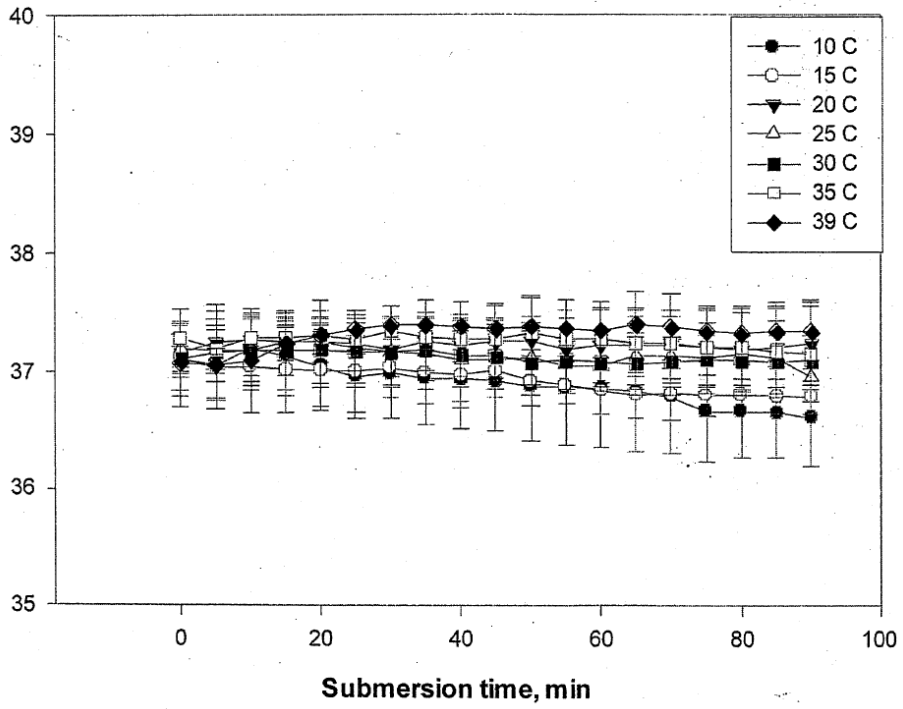
Pendergast and Mollendorf *UHMJ* 38(2): 127-136, 2011

Core temperature

Unprotected



Protected



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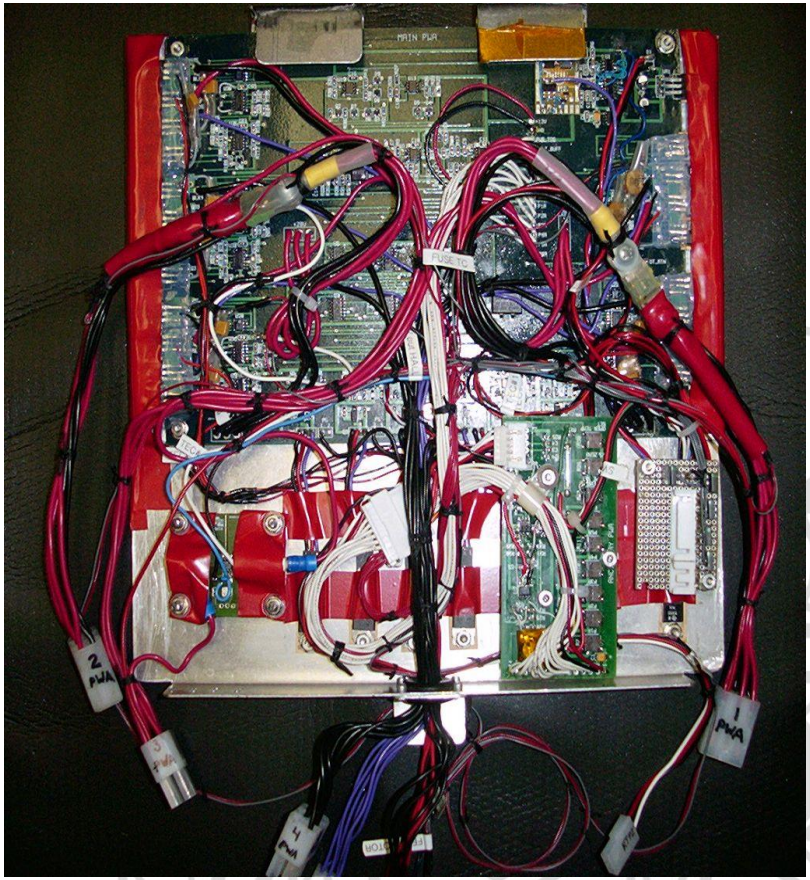
Circulating System

DTPS Controller



It is time to develop a next generation DTPS (DTPS2) for all types of diving (special warfare and Navy divers)

- The custom-built components of 20 years ago made it nearly impossible to commercialize DTPS
- Improvements in batteries and feedback monitoring make a fast-responding DTPS possible
- Create an automated feedback system that leverages what is known about the effect of thermal strain on diving.
- DTPS2 makes the ocean temperature and the diving garments irrelevant

Mare fortes adiuvat
- The sea favors the brave

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