## Re: Don't dive cold when you don't have to

The letter by Clarke et al[1] unfortunately misrepresents the work at the US Navy Experimental Diving Unit (NEDU) to which it refers,[2] and delivers a confused picture of the physiological impact of thermal status on decompression stress. A series of earlier reports outline the importance of thermal status. Being warm during a dive results in higher post-dive Doppler bubble scores.[3] Hot water suits are associated with a higher rate of decompression sickness (DCS) than passively insulated drysuits.[4] Post-dive cooling can prolong the risk window for developing symptoms of skin bends.[5]

The NEDU chamber study provided an elegant design to further assess the impact of thermal stress. Dives to 37 msw (120 fsw) were divided into descent/bottom and ascent/stop phases, prolonging the latter so that bottom times could be increased if results allowed without compromising the experimental structure. The water temperature was held at either 36$^{O}$C (97$^{O}$F; 'warm') or 27$^{O}$C (80$^{O}$F; 'cold'). The 'warm/cold' exposure, with a bottom time of 30 minutes, yielded a DCS rate of 22% (7/32 subject-exposures). The 'cold/warm' bottom time was increased to 70 minutes and still yielded a DCS rate of only 1.3% (2/158). Even if the effects are exaggerated by the prolonged ascent/stop phase, the dramatic results demand serious attention.

Contrary to the claim made by Clarke et al in their letter, the high temperature employed in the NEDU study could almost certainly be maintained at the skin by a number of active heating garments available to the diving public. Hot water suits are not required for the effect; and the 'cold' study temperature (better described as 'cool') is clearly well within the range experienced by divers.

The statement by Clarke et al that "*the Navy uses their extensive mathematical expertise to select the one dive profile that, in their estimation, is the most likely to identify a difference in decompression risk...*" is frankly baffling. Use of a single dive depth in no way invalidates the relevance to other dive profiles. Similarly, it is not reasonable to characterize skin temperatures lower than those produced in the study as "*venturing into the unknown*" and thereby invalidating the results.

Scientific method does encourage the confirmation of findings. This goal, however, does not diminish the value of singular, well-designed studies. The NEDU study is certainly one of these, most valuable in reminding divers that factors beyond the pressure-time profile will affect decompression risk.

Divers must have adequate thermal protection to function effectively (physically and cognitively) throughout a dive. However, excessive warming during the descent/bottom phase increases inert gas uptake and can compromise decompression safety. Practically, while it may be optimal for divers to be cool or cold during the descent/bottom phase, it is prudent to recommend a thermoneutral range and avoidance of any excessive warming. Being cool during the ascent/stop phase inhibits inert gas elimination and can compromise safety but sudden warming must be constrained to avoid reducing the gas solubility of superficial tissues that could promote localized bubble formation and symptoms of skin bends.

Active heating systems are attractive, but they have the potential to create the worst decompression stress condition; excessive heating during the descent/bottom phase and cooling during the ascent/stop phase if they fail part way through a dive. The risk is still elevated, though, if the systems work throughout a dive.[2,4] Gerth et al were able to increase the bottom time to 70 minutes for both the 'cold-warm' and 'warm-warm' conditions, but the rate of DCS was significantly lower for the 'cold-warm' condition (see above).[2] This lesson is relevant to any diving exposure.

Ultimately, divers need to be aware of the potential impact of thermal status. Thermal protection should preserve clear thinking and physical performance, but excessive manipulation should be avoided. For many, passive systems will provide adequate and appropriate protection. For those who need or choose active warming systems, thoughtful use is vital. Further research is required to quantify the hazards and be able to incorporate thermal status into decompression algorithms in a meaningful way.

### References


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**Key words**
Decompression sickness; hypothermia; risk factors; letters (to the Editor)