On immersion in cold water the ‘Cold Shock’ response (CSR, Tipton, 1989) can result in drowning and cardiac problems. During head-out immersion the incidence of cardiac arrhythmias in young, fit and healthy individuals is about 2%. This figure can rise to 81% during submersion with breath-holding (1) due, we believe, to coincidental stimulation of the parasympathetic nervous system (PNS, with face immersion and breath holding) and sympathetic nervous system (SNS, with anxiety and the CSR), resulting in cardiac arrhythmias (2). We have given the name ‘Autonomic Conflict’ to the coincidental stimulation of both divisions of the autonomic nervous system on submersion (3).

Autonomic conflict could occur in a range of activities including helicopter underwater escape training (HUET). The present study examined the electrocardiogram (ECG) of individuals undertaking HUET. Given the paucity of reported cardiac problems during HUET, it was hypothesised that either cardiac arrhythmias do not occur or, if they do, they are asymptomatic.

Methods
The experiment received ethical approval. Having given their informed consent and undertaken a medical with 12-lead ECG, 26 naïve male participants completed the study.

Participants were fitted with a three lead (V5) telemetric ECG system (Sharktooth, MIE Ltd, UK). They wore underclothing, a cotton overall and immersion dry suit. Skin temperature was measured on one participant on the chest, forearm, scapula and forehead (Grants Instruments, UK).

Each participant completed five HUET runs into water at 29.5°C, separated by a minimum of 10 minutes. Each run was standardized: after 3.5 minutes seated in the dunker it was rolled to an inverted, submerged position, this took 10s. Once inverted the participants made their escape, this took an average of 10s, during which they breath held. They then rested on their backs at the surface of the pool until 4.5 minutes had elapsed.

The ECG trace was examined by an experienced physiologist and, independently, by a clinician.

Results
The participants had raised heart rates prior to being submerged indicating sympathetic activation. Heart rate increased during the HUET submersion; this was probably more due to additional anxiety and physical effort than cold shock, as skin temperature did not fall significantly beneath the dry suit.

The participants demonstrated a range of cardiac arrhythmias the most prevalent being: bradycardia, premature junctional escape, ventricular ectopics and broad QRS with bundle branch block. 32 arrhythmias were observed in 21 different participants; only 6 of the arrhythmias occurred before submersion (breath holding).

Discussion
The concurrent stimulation of the SNS and PNS due to anxiety and submersion/breath holding, and the release of the stimulus to the PNS with the break of breath holding resulted in cardiac arrhythmias. The timing of the arrhythmias (normally just after the release of breath holding) is consistent with earlier findings (2).

These cardiac arrhythmias were asymptomatic and probably of little clinical significance especially in the young (< 40 years), fit participants tested. It remains to be seen if this is the case with older, less fit people in colder water.

References

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