Editors note: At the 2001 ASM in Madang, PNG, the Principal Guest Speaker, Dr James Francis, gave a presentation on research related to physiological studies of crew survival in a crippled submarine. This has recently been published and the abstracts appear below. Dr Francis’s presentation vividly brought out the human element of this experiment in a way that scientific papers are unable to do. It is for moments like these that Society members are encouraged to attend the ASMs; some aspects of these meetings cannot be represented on the printed page.

Physiological responses to cold exposure in men: a disabled submarine study

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A disabled submarine (DISSUB) lacking power and/or environmental control will become cold, and the ambient air may become hypercapnic and hypoxic. This study examined if the combination of hypoxia, hypercapnia, and cold exposure would adversely affect thermoregulatory responses to acute cold exposure in survivors awaiting rescue. Seven male submariners (33 ± 6 yrs) completed a series of cold-air tests (CAT) that consisted of 20-min at Tair = 22°C, followed by a linear decline (1°C.min⁻¹) in Tair to 12°C, which was then held constant for an additional 150-min. CAT were performed under normoxic, normocapnic conditions (D0), acute hypoxia (D1, 16.75% O₂), after 4 days of chronic hypoxia, hypercapnia and cold (D5, 16.75% O₂, 2.5% CO₂, 4°C), and hypoxia-only again (D8, 16.75% O₂). The ΔTsk during CAT was larger (p <0.05) on D0 (-5.2°C), vs. D1 (-4.8°C), D5 (-4.5°C), and D8 (-4.4°C). The change (relative to 0-min) in metabolic heat production (ΔM) at 20-min of CAT was lower (p <0.05) on D1, D5, and D8, vs. D0, with no differences between D1, D5 and D8. ΔM was not different among trials at any time point after 20-min. The mean body temperature threshold for the onset of shivering was lower on D1 (35.08°C), D5 (34.85°C), and D8 (34.69°C), compared to D0 (36.01°C). Changes in heat storage did not differ among trials and rectal temperature was not different in D0 vs. D1, D5, and D8. Thus, mild hypoxia (16.75% FIO₂) impairs vasoconstrictor and initial shivering responses, but the addition of elevated FICO₂ and cold had no further effect. These thermoregulatory effector changes do not increase the risk for hypothermia in DISSUB survivors who are adequately clothed.

Key words

Hypercapnia, hypothermia, hypoxia, shivering, vasoconstriction


Subjective symptoms and postural control during a disabled submarine simulation

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To simulate conditions aboard a disabled submarine, 7 submariners were confined for 5 d to a normobaric environment of 16.75% O₂, 2.5% CO₂, 4°C, and 85% relative humidity (RH). After 2 control days and 1 d of hypoxia, the remaining environmental conditions were imposed for the next 5 d, followed by 1 additional day of just hypoxia. Daily morning symptoms were assessed using the Environmental Symptoms Questionnaire (ESQ). Postural stability was determined on 4 occasions using a computerized balance system: control period, after 2.7 and 4.7 d of steady-state test conditions, and after 5.7 d (with return to normal ambient temp, RH, and CO₂). Three balance tests were performed: eyes open, eyes closed, and a dynamic test. Postural stability deteriorated after 2.7 d (87% eyes open, p <0.001 and 26% eyes closed, p =