# ORTHOSTATIC INTOLERANCE DURING 63" HEAD-UP TILT FOLLOWING HOT BATH IMMERSION IS LONGER AFTER ETHANOL INGESTION.

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**INTRODUCTION:** The majority of hyperthermia-related deaths occur in hot tubs, spas and Jacuzzis (1). Alcohol ingestion was associated with most of these deaths (1,2). Exiting a hot bath can produce orthostatic intolerance (OI) and ethanol ingestion exacerbates this condition immediately following hot bath immersion (3). It is not known how long it takes for hyperthermia-induced OI to subside, and if this time is influenced by ethanol ingestion. Although ethanol is a known vasodilator, its influence on sweating is not clear. As well, the effects of ethanol on esophageal temperature ($T_{es}$) increase during immersion and $T_{es}$ decrease post-immersion have not been documented. To investigate the effects of ethanol on the duration of OI, sweating and rate of $T_{es}$ change, the present study subjected volunteers to 63" head-up tilt before and after 40°C bath immersion, with or without ethanol ingestion.

**METHODS:** 4 men and 3 women volunteers were instrumented for $T_{es}$, mean skin temperature, heart rate and forehead sweat rate ($E_{sw}$). Blood pressures were determined manually and mean arterial pressure *(MAP)* calculated. On 2 occasions, subjects were immersed in a warm bath (40°C) until $T_{es}$ increased to a maximum of 39.0°C. In the ethanol condition (ethanol), each subject ingested 1 ml ethanol per kg of body weight in 6 times the volume of orange juice. This resulted in an average blood alcohol concentration (measured by breath analysis) of (mean ± SE) 75.6 ± 7.0 mg %; this value was adjusted to correct $T_{es}$ increases (4). In the other condition (control) an equal volume of juice was ingested. OI was tested by 63" head-up tilt. Prior to immersion, subjects were given one 5 min tilt, bracketed by two 5 min periods of supine rest. Following immersion subjects were subjected to a series of at least 3 tilts (Fig. 1), starting after 5 min of supine rest, at 10 min intervals. Each tilt was scheduled to last 5 min but was terminated with the subjects verbal indications of imminent syncope and a pronounced blood pressure drop. Tilts continued until the subjects tolerated the entire 5 min period without OI; this was after the 3rd tilt in all cases in except 1 in the control condition.

**RESULTS:** During ethanol ingestion prior to immersion 3 of 7 subjects had a transient onset of sweating. One of these subjects is illustrated in Fig. 1 together with another subject that gave a typical response for other subjects who did not sweat during ethanol ingestion.

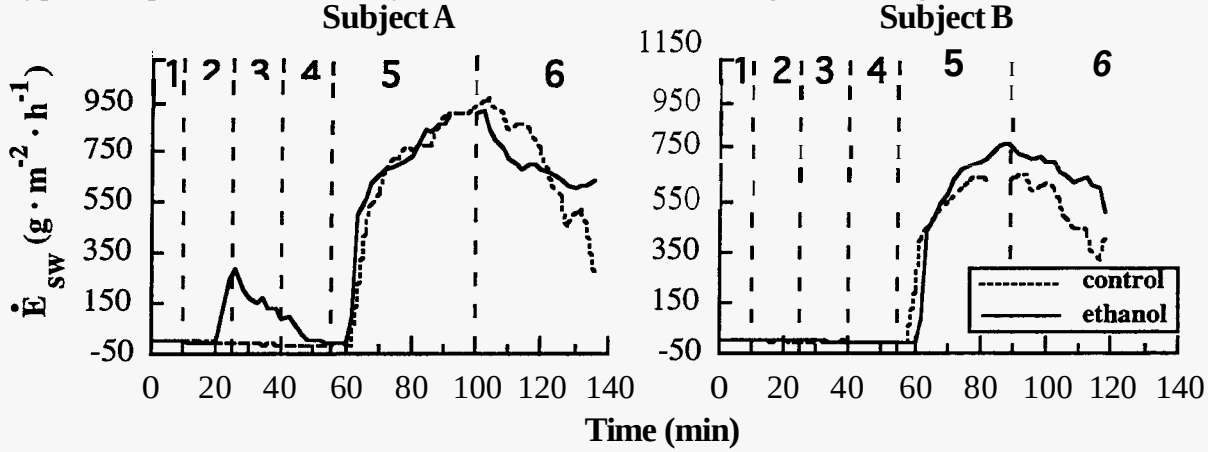


*Fig. 1. $E_{sw}$ for subjects A and B during: rest (1), a drink of juice or juice/ethanol (2), rest after drinking (3), normothermic tilting (4), 40°C bath immersion (5), and post-immersion tilting (6). Subject A sweated during and after ethanol ingestion in the normothermic condition. During and following immersion subject B gave the typical sweating response for the group .*

Rates of $T_{es}$ increase of 4.06 ± 0.35 °C·h$^{-1}$ during control vs 3.61 ± 0.21 °C·h$^{-1}$ during ethanol conditions were not significantly different. Post-immersion $T_{es}$ rates of decrease of 3.58 ± 0.12 °C·h$^{-1}$ during control and 3.52 ± 0.12 °C·h$^{-1}$ during ethanol conditions were also not

significantly different. Prior to immersion no OI was evident in either condition during head-up tilt. After immersion during the 1st tilt 5 of 7 subjects for the control and 4 of 7 for the ethanol conditions showed OI. For both the 2nd and 3rd control tilts 1 of 7 were intolerant, whereas for the ethanol condition 4 of 7 and 3 of 7 were intolerant. In the ethanol condition for the first 3 post immersion tilts females tolerated all tilts while males tolerated only 1 of 12 tilts. The tilt duration of 1st post-immersion tilt tolerated was 3.4 ± 0.5 min for the control and 2.9 ± 0.8 min for the ethanol condition **(NS).** The tilt duration endured for control vs ethanol conditions were significantly different for the 2nd **(4.8±** 0.2 min vs **3.4±** 0.7 min (P=0.005)), and 3rd (4.9 ± 0.1 min vs 3.7 ± 0.7 min (P=0.01)) post-immersion tilts. Mean arterial blood pressure was significantly lower in the ethanol condition for post immersion tilts 1 and 2. Control vs ethanol MAP values were 71.8 ± 4.5 vs 63.6 ± 3.4 mm Hg (P=0.01) for tilt 1 and 86.7 ± 4.4 vs 79.6 ± 2.3 mm Hg (P=0.02) for tilt 2. Tilt **3 MAP** values of 90.4 ± 4.9 for the control and 87.9 ± **3.0** mm Hg the ethanol conditions were not significantly different. Fig. **2** gives the MAP of a subject who had a prolonged orthostatic intolerance during post immersion tilting.

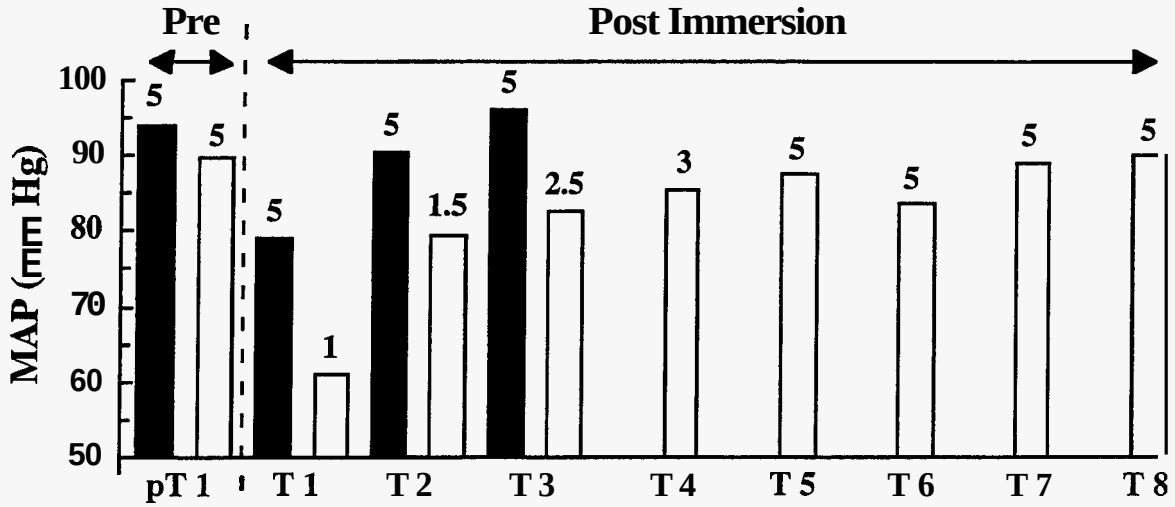


*Fig. 2. MAP during pre (pT1) and post **40°C** immersion head-up tilt (TI to T8) in control (black columns) and ethanol (white columns) trials. This subject showed **0 1for** 8 post-immersion tilts in the ethanol condition. The subject tolerated the prescribed 5 min from T5 to T8, but was not able stand without signs **of** syncope until T8 when **MAP** had returned to the preimmersion level. Above each column are the number of min the subject tolerated the tilt.*

During post-immersion tilting, the HR for control vs ethanol conditions for tilt 1 were 116.8 ± 6.3 b·min $^{-1}$ and 116.1± 12.2 b·min $^{-1}$ (NS), for tilt 2 were 91.3 ± 2.8 and 106.4 ± 7.4 b·min $^{-1}$ (P = 0.002), and for tilt 3 were 86.4 ± 2.9 **vs** 100.0 ± 4.9 b·min $^{-1}$ (P =0.0007).

**CONCLUSIONS:** Ingesting ethanol initiated sweating in 3 of 7 normothermic subjects. This suggests that ethanol could be a non-thermal factor influencing sweating. Despite this effect of ethanol, the rates of $T_{es}$ increase during 40°C immersion, and the rate of $T_{es}$ decrease following immersion, were not affected by ethanol ingestion. Following immersion ethanol: 1) increased the incidence of OI and decreased the time that a 63° head-up tilt was tolerated and *2)* increased *HR* and decreased MAP during the head-up tilt.

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