TITLE: THE THERMOREGULATORY THRESHOLD IN HUMANS DURING NITROUS OXIDE/FENTANYL ANESTHESIA

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Introduction. Hypothermia produces thermoregulatory vasoconstriction in patients anesthetized with halothane and isoflurane, but the response thresholds are ≈ 2.5°C below normal. Both narcotics and N₂O inhibit thermoregulatory responses in animals. We tested the hypothesis that N₂O/fentanyl anesthesia would decrease the thermoregulatory threshold in humans. We also compared the decrease in cutaneous capillary (nutritional) blood flow to the decrease in arteriovenous shunt (thermoregulatory) flow.

Methods. With approval from our Committee on Human Research, we studied 15 unpremedicated patients electively donating a kidney. Anesthesia was induced with halothane/N₂O and maintained with N₂O (70%), vecuronium, and fentanyl (a loading dose of 10 mcg/kg followed by an infusion of 4 mcg/kg·h⁻¹). Patients were randomly assigned to receive no hypothermia precautions (n = 10) or additional warming measures including warm intravenous fluids and breathing circuit humidification (n = 5).

Constriction of thermoregulatory arterio-venous shunts was evaluated using skin-temperature gradients (fingertip surface temperature subtracted from forearm surface temperature). Significant vasoconstriction was prospectively defined as a skin temperature gradient ≥ 4°C, and the thermoregulatory threshold was defined as the esophageal temperature at which vasoconstriction occurred. Peripheral capillary vasoconstriction was evaluated using a Periflux 3 laser Doppler monitor which correlates well with 133Xe washout and dynamic capillaroscopy.

Results. The five patients actively warmed remained nearly-normothermic with a mean lowest esophageal temperature of 35.8 ± 0.4°C. Skin-surface temperature gradients were < 1°C in all actively warmed patients, and became ≥ 4°C in 6 of 10 hypothermic patients (P < 0.05) between 100 and 150 min following induction. The thermoregulatory threshold in the six hypothermic patients who vasoconstricted was 34.2 ± 0.5°C (SD) (fig. 1). The perfusion index and the skin-temperature gradient were correlated (regression equation: Perfusion index = -7.9 + 4 Gradient + 67; r² = 0.63) (fig. 2).

Discussion. The thermoregulatory threshold during N₂O/fentanyl anesthesia, 34.2 ± 0.2°C, was similar to that during halothane/oxygen, 34.4 ± 0.2°C. Vasoconstriction did not occur in four of 10 hypothermic patients given N₂O/fentanyl, but did in all hypothermic patients given halothane. These four hypothermic patients probably reached a passive thermal steady state (constant core temperature without vasoconstriction).

Total digital skin blood flow is divided into arteriovenous shunt (thermoregulatory) and capillary (nutritional) components. Thermoregulatory vasoconstriction is thought to occur primarily in the cutaneous arterio-venous shunts, but we found that capillary flow also decreased significantly.

Figure 1. Significant vasoconstriction was observed in 6 of 10 elective kidney donors who became hypothermic (left side of figure). Vasoconstriction did not occur in 5 other patients maintained normothermic (right side of figure).

Figure 2. Skin-surface temperature gradient is plotted against the laser Doppler perfusion index (% control).

References.