

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

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Introduction. Hypothermia produces thermoregulatory vasoconstriction in patients anesthetized with halothane¹ and isoflurane,² but the response thresholds are $\approx 2.5^\circ\text{C}$ below normal. Both narcotics and N_2O inhibit thermoregulatory responses in animals.^{3,4} We tested the hypothesis that N_2O /fentanyl anesthesia would decrease the thermoregulatory threshold in humans. We also compared the decrease in cutaneous capillary (nutritional) blood flow to the decrease in arterio-venous 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/ N_2O and maintained with N_2O (70%), vecuronium, and fentanyl (a loading dose of 10 mcg/kg followed by an infusion of 4 mcg·kg⁻¹·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 $\geq 4^\circ\text{C}$ ¹ 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 washout⁵ and dynamic capillaroscopy.⁶

Results. The five patients actively warmed remained nearly-normothermic with a mean lowest esophageal temperature of $35.8 \pm 0.4^\circ\text{C}$. Skin-surface temperature gradients were $< 1^\circ\text{C}$ in all actively warmed patients, and became $\geq 4^\circ\text{C}$ in 6 of 10 hypothermic patients ($P < 0.05$) between 100 and 190 min following induction. The thermoregulatory threshold in the six hypothermic patients who vasoconstricted was $34.2 \pm 0.5^\circ\text{C}$ (SD) (fig. 1). The perfusion index and the skin-temperature gradient were correlated (regression equation: **Perfusion index = $-7.9 \cdot \text{Gradient} + 67$** ; $r^2 = 0.63$) (fig. 2).

Discussion. The thermoregulatory threshold during N_2O /fentanyl anesthesia, $34.2 \pm 0.2^\circ\text{C}$, was similar to that during halothane/oxygen, $34.4 \pm 0.2^\circ\text{C}$.¹ Vasoconstriction did not occur in four of 10 hypothermic patients given N_2O /fentanyl, but did in all hypothermic patients given halothane.¹ These four hypothermic patients probably reached a passive thermal steady state (constant core temperature without vasoconstriction).

Total digital skin blood flow is divided into arterio-venous shunt (thermoregulatory) and capillary (nutritional) components.^{7,8} Thermoregulatory vasoconstriction is thought to occur primarily in the cutaneous arterio-venous shunts,⁹ but we found that capillary flow also decreased significantly.

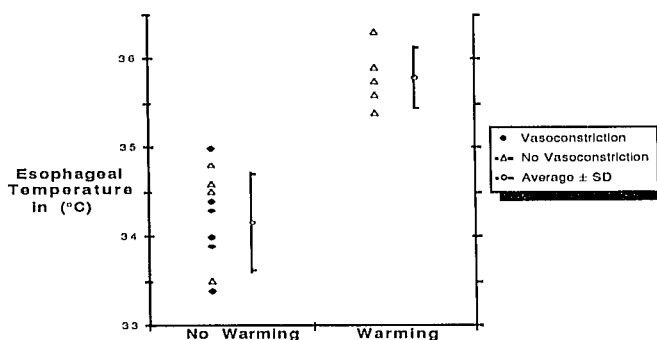


Figure 1. Significant vasoconstriction was observed in 6 of 10 elective kidney donors who became hypothermic (left side of figure). Vasoconstriction did not occur in 5 other patients maintained normothermic (right side of figure).

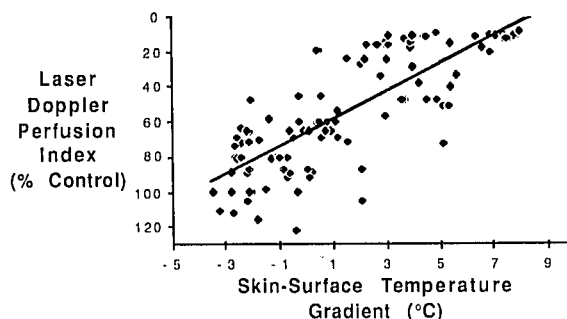


Figure 2. Skin-surface temperature gradient is plotted against the laser Doppler perfusion index (% control).

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