Title: The effect of warm I.V. solutions on the management of surgical hypothermia.

Authors: R.R. Papenburg M.D.C.M., M. English F.F.A.R.C.S., E. Foot D.V.M., E. Farias R.T., E.J. Hinchey F.R.C.S.(C).

Affiliation: Departments of Surgery and Anesthesiology, Montreal General Hospital, Montreal, Canada H3G 1A4

INTRODUCTION: In current anesthetic practice many maneuvers are employed to prevent, decrease, or reverse the hypothermia which occurs in patients undergoing major surgery. We have examined the efficiency of warmed intravenous fluids to rewarm various body sites in pigs undergoing a laparotomy.

METHODS: Five Yorkshire pigs of either sex were weighed, sedated with a mixture of ketamine-atropine-acepromazine, and their temperature was recorded. The pigs were then intubated, anesthetized with isoflurane and muscle relaxation maintained with pancuronium. A nasogastric tube with an esophageal temperature probe and stethoscope was inserted. A midline abdominal incision was made and remained open for the duration of the procedure. Central line catheters were inserted into the aorta via the femoral artery and the superior vena cava via the internal jugular vein. These catheters were then connected to a Med-Science circulation pump, set at 220cc/minute, and to an Abbott 50cc blood warming coil submersed in a water bath calibrated so that returning blood was 2-3°C above the animals preanesthetic temperature. Mon-a-therm thermocouples were implanted into the connecting tubing at the point of connection with the central line catheters. Thermocouples were then placed on abdominal skin, exposed bowel, within gluteal muscle, and intrahepatically.

RESULTS: The mean preanesthetic temperature was 39.2°C ±0.5°C and it took 2.5Hrs to prepare the animals before pump circulation was started. Prior to pump circulation all temperatures had decreased, with the core temperature falling the least to 37.3°C ±0.7°C. The maximum decrease in temperature was in the exposed bowel which dropped to 31.4°C ±1.5°C. Pump circulation was maintained until the intrahepatic temperature rose to ±0.5°C of the preanesthetic core temperature. This required a mean circulation time of 104 minutes (range 75 to 170 minutes). As a result of pump circulation both liver and esophageal temperatures were similar to the simultaneously measured core temperature whereas the exposed bowel temperature remained low (Table 1).

TABLE 1

SITE	TEMPERATURES (°C ± SD) PREPUMP	POSTPUMP	CHANGE(°C)
Core	37.3±0.7	39.3±0.8	2.0
Exp.Gut	31.4±1.5	31.9±3.6	0.5
Liver	37.2±0.7	39.2±0.8	2.0
Abdomen	35.1±1.4	36.5±1.3	1.4
Gluteal	36.5±0.5	38.1±0.7	1.6
Esophag	37.0±1.0	39.0±1.1	2.0

DISCUSSION: In surgical or trauma patients the management of hypothermia includes insulating/heating blankets, heated humidified ventilator gases, and heated intravenous fluids. We have evaluated the efficacy of heating the animals circulating blood to reverse surgical hypothermia in pigs. The mean externally supplied caloric requirement to effect a 2°C rise in core body temperature was 48.47 Kcal, or 2.53 Kcal/Kg body weight. To accomplish this a mean circulation volume of 22.9 L, or 1.2 L/Kg of body weight, was required. Based on this data a 70 Kg human might require 177.1 Kcal and 84 L to effect a similar rise in core body temperature. Warming one liter whole blood to 2°C above core temperature would increase its useful caloric content by only 1.74 Kcal.

CONCLUSION: The use of warmed infusion fluids to reverse or retard hypothermia in surgical patients is both inefficient and dependant on large volumes of fluids. The objective should not be to reverse those preoperative or intraoperative events leading to hypothermia, but rather the prevention of heat loss in all phases of the patient's management.