A1011

TITLE: PREVENTION OF HYPOTHERMIA BY SKIN WARMING DURING ABDOMINAL SURGERY IN LITHOTOMY POSITION

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Heat can be actively transferred to the body by warming the skin surface.[1] Skin warming of the lower limbs can prevent hypothermia during abdominal surgery in the supine position.[2] However, during abdominal surgery in the lithotomy position, the surface area available for skin warming is limited to upper thorax, head and right arm. We studied the efficiency of warming this limited skin surface to prevent hypothermia.

METHOD: After institutional approval and informed consent, 17 ASA class I-II adult patients scheduled for major colorectal surgery were studied. The patients were placed in lithotomy position, with a Mayo instruments table over the head. The operating room temperature was kept at ≈21°C, and patients were ventilated through a circle system at a low fresh gas flow. Eight randomized patients had no additional prevention of hypothermia (control group). In the other nine (warmed group), the close air environment under the disposable surgical draps covering the Mayo table was warmed using a ceramic heater (Chromex®, Le Mans, France). Core T (tympanic, then esophageal after induction of anesthesia) and four skin T were continuously recorded to calculate mean skin T and changes in total body heat content (ΔTBH, kJ), according to Ramanathan's [3] and Burton's [4] formulae. The warmed skin T was continuously monitored using a non-isolated thermistor probe placed on the uncovered, right shoulder. In the recovery room, all patients were covered with a warming blanket. The occurrence of shivering was recorded. Results (mean±SEM) were compared using ANOVA, t-test and chi square, as required.

RESULTS: The two groups did not differ in age, weight, duration of anesthesia (363±22 min), and operating room T (21.7±0.1°C). In the warmed group, the T of the warmed air environment was 41.5±0.5°C and the highest skin T was 40.0±0.5°C. Results are presented in the table and the figure. Obvious shivering occurred in 6 patients in the control group, vs one in the warmed group (p<0.05).

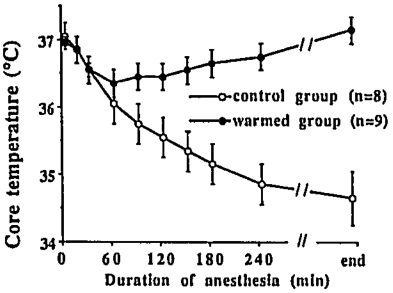
Results at the end of surgery:

	core T (°C)	mean skin T (°C)	intraop ΔTBH (kJ)
control group	34.6±0.4	32.4±0.4	- 434±55
warmed group	37.1±0.2*	34.7±0.4*	+ 161±54*

* p<0.0001 vs control group.

DISCUSSION: Normothermia can be maintained during abdominal surgery in lithotomy position, lasting up to 8 hrs, by actively warming the air environment surrounding the upper thorax, the head and the right arm. Provided that the warmed skin temperature is carefully monitored to avoid overheating, warming a skin surface area as small as ≈25% of body surface area can transfer enough heat to counterbalance heat loss during major abdominal surgery.

1. Anesthesiology 73:218,1990
2. Anesthesiology 71:A410,1989
3. J Appl Physiol 19:531,1964
4. J Nutr 9:261,1935



A1012

TITLE: NONINVASIVE CONTINUOUS MONITORING OF ARTERIAL BLOOD PRESSURE USING BIOIMPEDANCE

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There is a direct amplitude proportionality and shape similarity between the arterial blood pressure waveform (P-wave) and the corresponding electrical conductance waveform (C-wave), as measured by bioimpedance.

Bioimpedance signal Z is transformed into C-wave by C=1/Z. C-wave is mapped with high fidelity into a P-wave by 3-point calibration of the C-wave, so that the peak C_{MAX} of the C-wave (Figure 1) corresponds to systolic pressure P_S, the bottom C_{MIN}, to diastolic pressure P_D, and the mean value, C_{MEAN}, of the C-wave corresponds to the mean arterial pressure P_M.

The monitoring system (Fig. 3) consists of air pump (AP), inflatable cuff (IC) placed on the upper arm, pressure transducer (PT) connected to IC, bioimpedance monitor (BI), which continuously measures the Z and the dZ/dt signal coming from electrodes placed on the forearm. The cuff pressure (PC), Z and dZ/dt signals are continuously fed via analog/digital converter (A/D) into an 80286 microprocessor (CPU). For calibration, three consecutive C-waves, immediately preceding the inflation of the cuff, are stored in an array in the CPU memory. They are also used to obtain the average values of C_{MAX}, C_{MEAN}, and C_{MIN}. The cuff is then inflated until PC > P_S, so that the dZ/dt signal is flat. PC is then gradually lowered. P_S is determined as that PC for which the first blip occurs in the dZ/dt signal. When the peak of the dZ/dt signal reaches its maximum, P_M = PC, according to the oscillometric method of determination of mean arterial pressure. P_D is calculated in retrospect, by iteration, as that pressure corresponding to C_{MIN}, for which the integration of the three stored C-waves, tentatively calibrated using the above determined P_S, P_M, C_{MAX}, C_{MEAN}, and C_{MIN}, would exactly correspond to P_M. This procedure automatically determines the mapping coefficients A_0, A_1, A_2 in the calibration expression: $P = A_0 + A_1C + A_2C^2$, which is used to calculate P from C, point by point. After the initial calibration, the cuff is deflated, while the undisturbed signals are continuously displayed on the monitor's screen (S), together with the continuously updated values of P_S, P_M, P_D and heart rate. The simulated P-wave (Fig. 2) is virtually indistinguishable from the actually measured one using A-line.

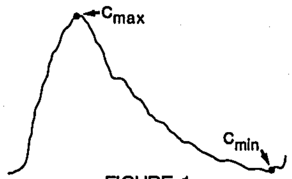

FIGURE 1

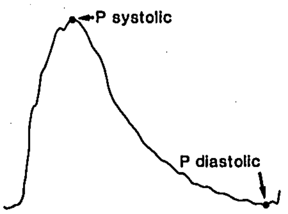

FIGURE 2

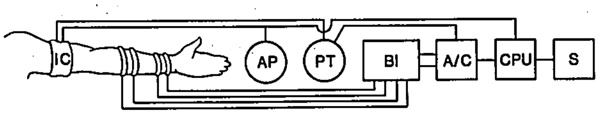

FIGURE 3