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TITLE: Prevention of Post-cardiac Surgical Hypothermia

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Cardiac surgical patients often return from the operating room to the intensive care unit (ICU) with nasopharyngeal temperatures (NPT) at or even below 34°C. Shivering may occur in these hypothermic patients as neuromuscular blockade diminishes, and O<sub>2</sub> consumption may increase. Systemic blood pressure and vascular resistance may be elevated, increasing afterload. Impaired function of clotting mechanisms may lead to excessive bleeding. We first determined the incidence and time course of postoperative hypothermia in cardiac and vascular surgical patients. We next attempted to prevent intraoperative hypothermia by administering sodium nitroprusside (SNP) and increasing pump flows during the rewarming phase of cardiopulmonary bypass (CPB) as recently reported.<sup>1</sup> Our question was whether or not SNP-assisted rewarming provided any amelioration of post-cardiac surgical hypothermia.

#### Methods

Ninety-eight patients were studied. All had undergone cardiac or major vascular surgery and remained intubated on admission to the cardiac surgical ICU. NPT was measured with a calibrated thermistor probe placed in the posterior nasopharynx. Great toe temperature (GTT) was measured with another probe placed at the base of the left great toe. NPT and GTT were recorded on admission to the ICU and hourly thereafter until NPT reached 37°C or for at least 10 hours. Incidents of shivering in these patients were also noted.

Forty-six of the patients had undergone coronary artery bypass graft (CABG) procedures (Group I). Fifteen had valve replacement(s) (Group II). Thirteen were pediatric patients undergoing repair of congenital defects (Group III); and 14 had a non-cardiac vascular procedure (Group IV). Ten additional patients undergoing CABG with hypothermic CPB were administered SNP during rewarming on CPB (Group V) under the constraints of maintaining mean radial artery pressure > 70 mmHg and increasing pump flow until arterial inflow line pressure reached 250 mmHg.

#### Results

All groups (except Group IV) were rewarmed on bypass to NPT of ~ 37°C. Decreases in NPT prior to ICU admission were statistically significant in each group except the pediatric cardiac patients. Seventy-four percent of the patients in Groups I-IV had NPT's of < 35.5°C on ICU admission (27% had NPT's of < 34°C). Seven of 10 patients in Group V had NPT's of > 35.5°C on ICU admission and the other three had NPT's of > 34°C. Figure 1 depicts the time course of NPT in the ICU. Of those patients whose NPT reached 37°C in the 10-hour postoperative measuring period, the pediatric patients (Group III) took 1.1 ± .3 hours, followed by Group V (2.3 ± .2 hrs), Group I (3.4 ± .3 hrs), Group II (4.8 ± .7 hrs) and Group IV (5.2 ± .4 hrs). While each patient in Groups III and V reached a NPT of 37°C in the measuring period, 5% of Group I, 8% of Group II, and 31% of Group IV patients did not. GTT averaged ~ 6°C less than NPT in each patient group. The course of GTT

in the post-bypass period and in the ICU generally paralleled that of NPT. No relationship was seen between NPT or GTT and anesthetic technique or bypass time.

When the 10 CABG patients who received SNP and increased pump flows during rewarming (Group V) were compared with the 46 who did not (Group I), it was found that NPT at the time of ICU admission was significantly higher in Group V (35.7 ± .3°C) than in Group I (34.1 ± .2°C, *p* < .01). The time required to achieve NPT of 37°C in the ICU was correspondingly shorter (2.3 ± .2 hrs Group V vs. 3.4 ± .3 hrs Group I *p* < .01).

Shivering occurred in 14% (n=12) of the patients in Groups I-IV for an average of 1.8 ± .2 hrs per patient at an average of 35.2 ± .2°C. Incidence of shivering was unrelated to anesthetic agent. In contrast, no shivering was noted in Group V patients.

#### Conclusions

With standard rewarming techniques, 74% of the intubated patients admitted to the cardiac surgical ICU arrived with unacceptably low NPT's. Fourteen percent of these patients shivered postoperatively in the ICU with probable V<sub>O</sub><sub>2</sub> increases. This study shows that SNP-assisted rewarming, coupled with increased pump flows, resulted in higher NPT's on arrival in the ICU and that less time was required to return to normal NPT's. The problem of shivering was eliminated in this small group of patients. Shivering occurred in the others with NPT averaging 35.2 ± .2°C. Because of this we propose that a NPT of 35.5°C should be a minimal temperature goal at a time of admission to ICU. Pediatric cardiac surgical patients reach the ICU with acceptable NPT's, and SNP-assisted rewarming is not beneficial.

#### References

1. Noback CR, Tinker, JH: Heat dosage vs. distribution during rewarming on CP bypass. *Anesthesiology* 51: S134, 1979.

