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Effect of postoperative immobilization after coronary artery bypass surgery

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Pulmonary complications, particularly atelectasis, occur frequently after coronary artery bypass (CAB) surgery. To determine the effect of early postoperative immobility on pulmonary complications, the authors randomly assigned 35 patients into two groups. One group remained in the supine position for the first 24 h. The second group had their body position systematically turned every 2 h for the first 24 h. Turning resulted in a significant decrease in postoperative fever ($p < 0.001$) and a 32% reduction in the duration of the stay in the Surgical Intensive Care Unit (SICU). Turning did not affect the patient's hemodynamic stability or arterial blood gas measurements. The authors conclude that systematic turning of CAB patients can reduce postoperative morbidity.

Despite substantial advances in intraoperative and postoperative management of patients undergoing CAB surgery, fever, hypoxemia, and atelectasis remain common problems during the early postoperative period.[1, 2] Radiographically demonstrable atelectasis has been reported to occur in 51–90% of these patients.[2–5] At this institution, a 2-month retrospective chart review showed that 84% of CAB patients were considered by the attending radiologist to have atelectasis within the first 72 h after surgery.

The postoperative care of CAB patients at this institution includes maintenance of a supine position for the initial 18–24 h after admission to the SICU. While not a universally accepted management modality, it was found that of the 18 university hospitals responding to a questionnaire on postoperative management of the CAB patient, 9 required 24 h of postoperative immobilization. Nine institutions routinely turned all patients during the first postoperative day. However, the method and frequency of turning varied. Currently, there are no controlled studies to determine whether beneficial effects results from turning patients after CAB surgery.

Immobilization of CAB patients may maintain cardiovascular stability, help ensure maintenance of intravascular access lines, and optimally utilize nursing personnel for sophisticated monitoring. However, immobilization may contribute to postoperative pulmonary complications.[6–9] In order to determine whether immobility or systematic turning is of clinical, physiological, or economic value after CAB surgery, 35 patients were randomly assigned to one of two groups (supine or turned) and closely followed during their first 72 h postoperatively. The findings suggest that turning CAB patients is beneficial.

MATERIALS AND METHODS

Patients scheduled for elective CAB (without aneurysectomy or valve replacement) were asked to participate in the study. Two h after surgery, patients who had given informed consent were evaluated for hemodynamic stability and admitted to the study if able to maintain a systolic blood pressure greater than 90 mm Hg without vasopressor therapy of intra-aortic balloon assistance. Patients were then stratified by sex and the number of bypass grafts (>3 or <3) and randomly assigned to one of two groups by drawing from a hat. The control group received the current standard postoperative care which included an immobile, supine position for the first 24 h. The experimental group received identical medical and nursing care except that for the first 24 h after surgery, body position was systemically changed every 2 h between a supine and a left or right lateral posture at a 45° angle. The positioning angle was uniformly maintained with a foam wedge (Model 02077, Span-America, Inc., Greensville, SC) placed behind the patient's back for the 2-h periods (Fig. 1). Initial postoperative respiratory management for all CAB patients was identical, consisting of ventilatory assistance with a volume-cycled ventilator set for synchronized intermittent mandatory ventilation (SIMV) at a rate of 10/min, tidal volume of 12–15 ml/kg, peep of 5 cm H_2O, and F_{IO_2} adjusted to maintain the Pa_{O_2} at 85 torr or above. Weaning from the ventilator was accomplished over a 10- to 18-h period, based on reestablishment of ventilatory mechanics and arterial blood gas results. After the first 24 h in the SICU and after extubation, both groups of patients were instructed to take several deep inspirations through incentive spirometers every 4 h. Routine chest physiotherapy and intermittent positive pressure breathing after extubation were not employed.

Vital signs and pulmonary artery pressure, which were continuously monitored for the first 24 h, were recorded every 15 and 60 min, respectively. Temperature was

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FIG. 1. Schematic of lateral positioning angle maintained with foam wedge.

recorded every 1–2 h for the first 72 h. Pao_2 levels were obtained at least every 4 h during the first 24 h. Alveolar-arterial oxygen difference $P(A\text{-}a)O_2$ on 100% O_2 was obtained on admission to the SICU and 24 h postoperatively. The duration of endotracheal intubation and SICU stay was also recorded. Portable chest x-rays were obtained on admission to the unit and daily for the first 3 postoperative days. Two observers unaware of the group to which patients were assigned independently reviewed the chest radiographs and recorded evidence of lobar, segmental, or platelet-like atelectasis, pulmonary edema, pleural effusion, parenchymal infiltrates, or pneumothorax.

Nurses and housestaff physicians responsible for primary postopertive care in the unit were aware that a study was in progress, but were not informed of the dependent variables being studied. The investigators did not participate in management discussions or care of the patients in this study.

Data were analyzed using the unpaired Student's *t*-test and one way analysis of variance, where appropriate, with $p < 0.05$ considered significant.

The study was approved by the Joint Committee on Clinical Investigation of The Johns Hopkins University.

RESULTS

Thirty-five patients were studied, 18 in the control group and 17 in the experimental group. The two groups were similar in age, sex, and number of coronary artery grafts implanted (Table 1). They were also similar in smoking history, preoperative Pao_2 levels while breathing room air, anesthesia time, length of cardiopulmonary bypass, and intraoperative weight gain.

There was a marked difference between the two groups in the duration of postoperative fever. Control patients had a temperature above 38°C for 44.0 ± 11.4 h (mean ± SD) during the first 72 h after surgery. Patients in the experimental group experienced only 26.4 ± 14.1 h of fever during this period. The difference between the two groups was statistically significant ($p < 0.001$).

As shown in Figure 2, there was little difference in the number of febrile hours between the two groups during the 1st postoperative day. On the 2nd day, the control group experienced more hours of fever than on the 1st postoperative day, while the experimental group had a slight decrease. The most striking difference occurred on day 3, when the control group averaged 15 h of fever while the experimental group averaged only 3 h of fever. The difference between the two groups was statistically significant on the 2nd and 3rd postoperative days ($p < 0.05$ and 0.001, respectively).

There was also a 32% reduction in the time that turned patients stayed in the SICU. The control group spent 58.3 ± 27.7 h in the unit and the experimental group 39.7 ± 14.2 h ($p < 0.025$).

The length of endotracheal intubation, while less in the experimental group (14.4 ± 5.4 h) than in the control group (19.2 ± 8.7 h), was not statistically different ($0.10 > p > 0.05$).

TABLE 1. Patient characteristics

	Control (n = 18)	Experimental (n = 17)
Age (yr)	52 ± 10.*	52 ± 10
Sex		
Male	15	15
Female	3	2
Number of grafts	3.3 ± 0.97	3.0 ± 0.98
Cigarette pack-years	35 ± 27	37 ± 28
Preoperative Pao_2 (torr)	81 ± 8	85 ± 13
Anesthesia time (min)	325 ± 60	323 ± 62
Cardiopulmonary bypass time (min)	118 ± 32	120 ± 40
Intraoperative weight gain (kg)	2.2 ± 1.6	1.9 ± 1.6

* Mean ± SD.

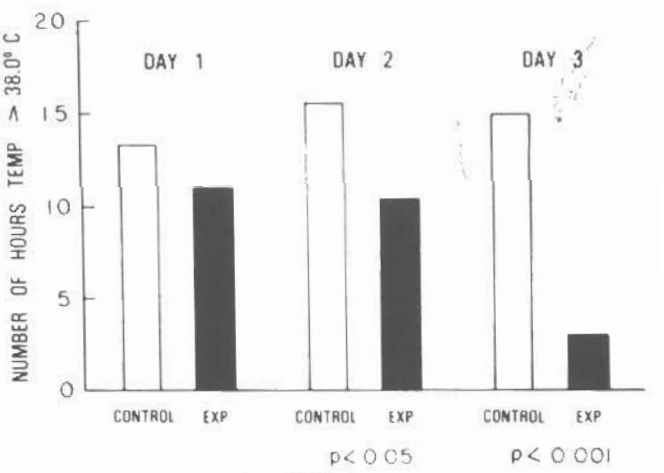

FIG. 2. Mean daily number febrile hours for control (immobilized) and experimental (turned) groups during the 72 h after CAB surgery. There is a statistically significant difference in hours of fever between immobilized and turned patients on day 2 (14.8 ± 6.4 vs 10.4 ± 7.0 h, $p < 0.05$) and day 3 (13.9 ± 7.3 vs 3.1 ± 4.7 h, $p < 0.001$).

There was no difference between the two groups in terms of x-ray abnormalities. The incidence of left lower atelectasis was 68% in the control group and 72% in the experimental group. Both groups received similar amounts of analgesic drugs. The control group received more antipyretic drugs during the first 72 h than the experimental group, but this did not prove to be statistically different.

Comparison of the $P(A\text{-}a)O_2$ on 100% O_2 upon admission to the SICU and 24 h later revealed no significant difference in the two groups (admission vs discharge: control 308 ± 75 vs 167 ± 73; turned 304 ± 92 vs 147 ± 43). PaO_2 levels during the first 24 h also did not differ between the two groups. Arterial blood gases were not uniformly available after 24 h. Pulse rate, respiratory rate, and blood pressure remained stable during turning. No complications could be directly attributed to changing position.

DISCUSSION

These data demonstrate that after CAB surgery, immobilized patients have significantly more hours of postoperative fever than patients systematically turned during the first 24 postoperative h. The hours of fever were maximal for the turned group on the 1st postoperative day and progressively improved during the next 2 days. In contrast, the control group's maximum febrile hours did not occur until the 2nd postoperative day, and fever persisted on day 3.

In addition to a decrease in postoperative fever, the duration of SICU stay was reduced by 32% for turned patients. While transfer criteria from the SICU to the intermediate care unit include many subjective and objective parameters, no nonrespiratory problems were identified in the medical records to account for the difference between the two groups. Although it is possible that the reduction in postoperative fever of the experimental group was a factor in the turned groups' earlier transfer, objective criteria for patient discharge are not reported in the chart.

The $P(A\text{-}a)O_2$ gradient for the two groups 24 h after surgery was similar. In retrospect, this was not surprising because there was little difference in radiographic or clinical findings at that time. Although pulmonary physical therapy has been reported to decrease PaO_2 during the first 24 h after cardiac surgery,[10] the authors found no change in $P(A\text{-}a)O_2$ or PaO_2 attributable to turning alone. Knowledge of alveolar-arterial gradient at 48 and 72 h, when fever differences were significant, might have shown better matching of ventilation perfusion ratios in the experimental group; however, the experimental design of this study did not include blood gas analysis on days 2 and 3.

Examinations of chest x-rays after CAB almost always revealed some abnormality. Left lower lobe atelectasis was frequently seen in both groups (68% in control, 72% in experimental) and is thought to be due to surgical manipulation.[1] Turning patients in the early postoperative period did not alter the qualitative or quantitative radiographic incidence of left lower lobe atelectasis or any other radiographic abnormality on days 1, 2, or 3 of this study. It is possible that the chest radiographic findings lag behind temperature changes in the experimental group or that the febrile response in the control group was unrelated to the observed chest x-ray abnormalities.

The mechanism for reduced postoperative fever in this study remains unclear but may be due to prevention of dependent pulmonary congestion resulting in less small airway obstruction, distal atelectasis, and inflammation.[11-19] Regardless of the pathogenesis of the postoperative CAB fever or the cause for the decrease in hours of fever in the experimental group, high body temperature may produce physiological changes which could be harmful to patients with ischemic heart disease.

During the time of this study, the number of CAB operations performed per day was limited by the number of available beds. Because the turned patients spend 32% less time in the SICU, beds were available sooner for new cases. SICU beds are not only short in supply, but are extremely expensive to maintain ($525/day in this unit). Currently, 360 CAB operations are being performed each year at this institution. By turning patients during the first 24 h after CAB surgery, a potential savings of $150,000/year can be estimated. If similar reductions in intensive care stay were to occur at other hospitals through early mobilization of their CAB patients, then financial savings produced by the simple process of turning patients in the early postoperative period would be substantial.

As the amount of high technology equipment has increased in ICUs, it has become more and more common to find critically ill patients immobilized. The data from this study indicate that immobility is detrimental to patient care and that a simple systematic turning regime can reduce postoperative morbidity.

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