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Airway Heating Reduces Recovery Time (Cost) in Outpatients

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Patients who underwent relatively short (30–45 min) outpatient surgical procedures in our Day Surgery Unit (DSU) often complained of "feeling cold" postoperatively, and actually were moderately hypothermic on arrival in the recovery room. Moreover, these patients seemed to have a prolonged recovery room stay. In a busy ambulatory surgery unit, any factor that delays patient discharge decreases efficiency and contributes to increased per-patient costs.

To confirm our clinical impressions and to determine whether simple measures might prevent perioperative hypothermia and its untoward effects even during short procedures, we examined the effect of heating and humidifying the inspired anesthetic gases on body temperature, recovery room stay, and patient comfort.

METHODS

With the approval of the institution's Committee on Studies Involving Human Beings, we studied 19 healthy women participating in an *in vitro* fertilization program. These patients were scheduled to undergo laparoscopy and ovum harvesting in an ambulatory surgery unit.

Patients were assigned randomly to receive either untreated inspired gas (control, n = 9) or to have the inspired gas humidified and maintained at 38–39° C at the Y connector of the anesthesia circle (n = 10). A two-stage heater/humidifier employing a heated wire in the inspiratory limb of the anesthesia circle (Fisher and Paykell)§ was activated immediately after induction of anesthesia. An electronic thermometer (FILAC)¶ was used to measure oral (sublingual) temperatures prior to induction of anesthesia, every 15 min during the surgical procedure, on arrival in the recovery room, and after the determination had been made that the patient was ready to be discharged from the ambulatory surgery unit. All patients were anesthetized with thiopental, nitrous oxide, oxygen, and isoflurane, with succinylcholine used to facilitate tracheal intubation. Fresh gas flow rates were not controlled, but review of the anesthesia records confirmed that there was no difference in fresh gas flow between the two groups. Ventilation was controlled manually, and both ventilation and depth of anesthesia were adjusted based on the clinical judgment of the anesthesiologist caring for the patient.

Ambient operating room and recovery room temperatures were recorded, but not controlled. Warming blankets were not used. The recovery room nursing staff was unaware of which treatment a patient had received. Nurses assessed patients for shivering, and noted whether patients complained of "feeling cold." Cotton blankets were provided to all patients in the recovery room. Recovery room nurses used the DSU's standard criteria for discharge which include alertness; orientation to time, place and person; ability to walk without assistance; ability to void; and normal vital signs. Body temperature was not a discharge criterion.

Statistical significance of differences in group means was determined using the *t* test and confirmed with the Mann-Whitney U Test,[1] a non-parametric equivalent of the *t* test. The U test is more appropriate for the sample sizes in this study, and is less likely to indicate significance than is the *t* test. Incidence data were compared using chi-square analysis with the Yates correction for small sample size. Statistical significance was accepted at the $P < 0.05$ level.

RESULTS

The two groups of patients were similar in age and weight. Ambient operating and recovery room temperature and anesthesia time (induction to extubation) also were similar (table 1).

Intraoperatively, oral temperature decreased gradually in both groups. Patients in the control group were significantly colder than the treated patients at 15, 30, and 45 min after tracheal intubation (table 2).

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§ Fisher and Paykell, c/o American Pharmaseal Company, Valencia, CA 91355, supplied the heater/humidifier units.

¶ FILAC Corp, Subsidiary of Cheesbrough-Ponds, Inc., Watertown, NY 13601, supplied the electronic thermometers.

The 0.5° C difference between groups in temperature on arrival in the recovery room was statistically significant ($P < 0.03$), and patients in the study group had significantly shorter recovery room stays ($P < 0.001$). Patients who had received heated, humidified inspired gas were ready for discharge in an average of 129 min (range, 107–183 min), while those who were anesthetized with room temperature gas were not ready for discharge until an average of 187 min (range, 150–218 min) after recovery room admission. There were no significant differences between groups in the incidence of adverse recovery room events, including nausea and vomiting, dizziness, shivering, or complaints of feeling cold (table 2).

Discussion

Heating and humidifying inspired gases maintained normothermia and reversed hypothermia in a study of adult male patients.[2] That study was performed under near-ideal conditions, with warming blankets, controlled operating room temperatures, and electrically heated blow-over humidifiers in the inspiratory limb of the anesthetic circle. Only men having major open surgical procedures (*e.g.*, major vascular, total hip, major abdominal) expected to last 3 h or longer were included.

Our study was performed in an ambulatory surgery setting in a "healthy" population undergoing one type of surgical procedure. Heating blankets were not employed, nor was room temperature controlled. We found that the heater/humidifier system appeared to have a major effect in the population we studied. Study patients were 0.5° C warmer on arrival in the recovery room, and stayed almost 1 h less than their control counterparts. Patients' temperatures in the recovery room were not recorded frequently enough to allow determination of speed of rewarming.

The requirement for repeated temperature measurement in outpatients necessitated the use of a technique that produced minimum discomfort to the patients and that was easily accepted by them. We could not justify the slight risk of tympanic membrane damage or auditory canal hemorrhage,[3] and, therefore, chose to avoid tympanic membrane thermometry. Repeated nasopharyngeal or rectal temperature determinations in alert outpatients were inappropriate. Oral temperatures are adequate indicators of core temperature.[4]

During the anesthetic, the temperature probe was placed under the tongue on the side of the mouth opposite the endotracheal tube to avoid artificially high temperatures from local heating by the warmed gases. Such an artifact would have been reflected in a large drop in temperature when tracheal extubation removed the heat source, but this was not detected in this study.

TABLE 1. Characteristics of Patient Population

	Control (n = 9)	Heated Humidified Inspired Gas (n = 10)
Age (yr)	33.8 ± 0.8	32.1 ± 1.0
Weight (kg)	54.2 ± 2.3	59.1 ± 3.0
O.R. temp (°C)	22.5 ± 0.5	23.0 ± 0.5
Rec room temp (°C)	23.4 ± 0.2	23.2 ± 0.3
Anes time (min)	66 ± 5	70 ± 6

Values are reported as mean ± SEM. Differences between group means are not statistically significant.

While a relatively small number of patients were included in our study, patients were randomly assigned to the treatment groups and recovery room nurses were blinded to each patient's group. Thus, potentially confounding variables were likely to be distributed equally between the groups. Our findings were verified with the more conservative Mann-Whitney U test, which is appropriate for determining the significance of differences between small independent samples.

In our DSU, patients are discharged directly from the recovery room. There is no step-down or post-recovery holding area. A post-anesthesia recovery score (PARS)[5] of 10 must be achieved before the patient may be considered for discharge. Subsequent determination of fitness for discharge depends on subjective judgment. In making that judgment, experienced nurses incorporate the unit's minimum discharge criteria and their own interactions with the patient. By blinding recovery room personnel to the treatment a given patient received, we allowed nurses to employ independent, unbi-

TABLE 2. Intraoperative and Postoperative Course

	Control (n = 9)	Heated Humidified Inspired Gas (n = 10)
Pt Temp (°C)		
Start Anesthesia	36.8 ± 0.2	36.7 ± 0.1
15 min	36.0 ± 0.1	36.2 ± 0.1*
30 min	35.9 ± 0.1	36.2 ± 0.1†
45 min§	35.8 ± 0.1	36.2 ± 0.1†
Admit to rec rm	35.4 ± 0.1	35.9 ± 0.1*
Rec rm disch.	36.7 ± 0.2	36.7 ± 0.1
Rec rm time (min)	187 ± 8	129 ± 7‡
Shiver	4/9	1/10
Complaint of feeling cold	3/9	4/10
Complaint of dizziness	4/9	3/10
Nausea	7/9	6/10
Vomiting	6/9	4/10

Values are reported as mean ± SEM.
* Significantly different from control group at $P < 0.03$.
† Significantly different from control group at $P < 0.01$.
‡ Significantly different from control group at $P < 0.001$.
§ Values at 45 min represent eight control and nine study group patients.

ased judgment about patients' readiness for discharge. No explicit discharge criteria beyond the unit's standard policies (PARS 10; orientation to time, place, and person; ability to walk without assistance; and ability to void) were incorporated in the study protocol. Blinding and random assignment of patients minimized the likelihood that recovery room nurses changed their usual procedures because of the study.

Recovery room stay may be prolonged by nausea and vomiting, dizziness, or the sedative effects of postoperative pain medication. The incidence of nausea and vomiting in the recovery room was not significantly different between the groups, nor was the administration of antiemetic medication. No sedative agents other than antiemetics were administered in the recovery room.

Simple heating and humidification of inspired gas in patients undergoing laparoscopic ovum retrieval was associated with a higher temperature on arrival in the recovery room and a 31% decrease in recovery room stay. This time saving can reduce the per-patient costs. An informal survey of area hospitals reveals the charge for recovery room care ranging between $58 and $182 per hour. Even at the low end of this range, the approximately $12 cost for one use of the heater/humidifier appears justified if 1 h of recovery time can be saved. Additionally, prolonged discharge times in an ambulatory unit with limited recovery room capacity may force delay of succeeding cases.

Methods of heat conservation and heat transfer, such as artificial noses, space blankets, warming blankets, and warmed iv fluids, have been suggested as potential aids in reducing heat loss in outpatients. This study has shown that the use of a relatively inexpensive heating system can eliminate almost an hour of recovery room time, and is one cost-effective approach to patient management in this outpatient population.

The balance among cost, convenience, and effectiveness of any intervention assumes particular importance in outpatient anesthesia, and should be addressed in the planning of future studies of clinical practices in this group of patients.

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Histaminoid Reaction from Vecuronium Priming: A Case Report

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Vecuronium apparently is free of cardiovascular and histamine-releasing properties.[1,2]‡§ However, three recent case reports claimed possible histamine release after vecuronium administration. Levery *et al.*[3] reported erythema in the face, neck, and upper extremities after 6 mg vecuronium iv; Clayton *et al.*[4] reported an erythemathous rash on the entire body following 0.1 mg/kg iv vecuronium administration on two separate occasions in the same patient, and, lastly, Spence *et al.*[5]

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