Pre-emptive use of the space blanket reduces shivering after general anaesthesia

D. Buggy and N. Hughes

SUMMARY
We have investigated the role of aluminized metal foil (space blanket, UN 320), used pre-emptively, in post-anaesthetic shivering and patients' subjective perception of cold after general anaesthesia of short duration. Sixty-eight ASA I and II patients undergoing orthopaedic and plastic surgery on the peripheries were allocated randomly to two groups: those in group 1 were wrapped (not less than 60% of body surface area) in the space blanket before induction of anaesthesia. In group 2 patients had standard surgical draping. In all subjects, anaesthesia was induced with fentanyl and propofol, and maintained with nitrous oxide and enflurane in oxygen, after a laryngeal mask airway was positioned. Patients were asked to grade their perception of cold on a visual analogue scale, before induction and on recovery. Skin (dorsum of hand) and core (nasopharyngeal) temperatures were recorded at 15-min intervals. Occurrence of shivering and cold scores were recorded by blinded observers. Groups were similar in age and gender; duration of anaesthesia was also similar (mean 41.6 (SEM 4.8) vs 47.5 (3.3) min, respectively). The incidences of shivering were 15% and 63% in groups 1 and 2, respectively (P < 0.001). Cold scores were 2.4 (0.4) and 5.7 (0.5), respectively (P < 0.001). Skin temperatures increased with increasing duration of anaesthesia in both groups but were greater at 15, 30 and 45 min in group 1 (33.38 (0.25) vs 31.56 (0.31), 34.46 (0.25) vs 32.45 (0.31) and 35.22 (0.36) vs 33.13 (0.34), respectively; P < 0.001 each comparison). Core temperature increased slightly in group 1 and decreased in group 2 (P = 0.11). We conclude that in spontaneously breathing patients, the use of a space blanket decreased the incidence of post-anaesthetic shivering and patients' perception of cold, and resulted in higher skin temperatures, even after relatively short general anaesthetics. (Br. J. Anaesth. 1994; 72: 393–396)

KEY WORDS

Post-anaesthetic shivering is a common problem with a reported incidence of 5–65% [1] in the recovery room and is very distressing for patients. Its severity depends on the duration of the procedure, gender and anaesthetic techniques involving spontaneous breathing [2]. A recent audit in our recovery room revealed that after general anaesthesia, 50% of patients recalled shivering and a feeling of intense cold as the most distressing memory of their anaesthetic management, even after relatively short procedures.

Moreover, post-anaesthetic shivering is associated with potentially harmful consequences, including increased oxygen consumption [3], carbon dioxide production, circulating catecholamines [4], cardiac output [5] and intraocular pressure [6], and decreased mixed venous oxygen saturation [7], lactic acidosis [4] and interference with monitoring [8]. Attempts to treat post-anaesthetic shivering have included a range of drugs [9–12], radiant heaters [13], increased ambient temperatures [14] and active warming blankets [15].

The space blanket (also termed reflective blanket and metallized plastic sheeting), is an ultra-thin aluminized plastic foil designed to reflect 80% of body heat. It has been used in patients subjected to artificial ventilation for prolonged surgery, with conflicting reports on its efficacy and safety [16, 17]. As radiation is one of the principal mechanisms of heat loss in the anaesthetized patient [18], the space blanket would be expected to minimize this, and the resultant shivering, especially in spontaneously breathing patients, whose duration of anaesthesia is short. To test this hypothesis, we have examined the role of the space blanket when used during general anaesthesia lasting approximately 80 min or less.

PATIENTS AND METHODS
The study was approved by the Ethics Committee of St James' Hospital. After obtaining informed consent, we studied 68 ASA I and II patients undergoing elective orthopaedic and plastic surgery on the limbs. Patients less than 14 yr of age and more than 80 yr, with a pyrexial illness or who required intraoperative blood transfusions were excluded, as were those whose operations exceeded 80-min duration or who required mechanical ventilation. Patients were allocated randomly to two groups: in group 1, patients were wrapped in the space blanket...
(UN 320) in the induction room, before induction of anaesthesia, such that at least 60% of body surface was covered. It was placed immediately next to the cotton gown and inside all surgical drapes. In group 2, patients were covered in the same routine surgical drapes as were used in group 1.

All patients were premedicated with oral temazepam or diazepam 10 mg. Peripheral skin temperature ($T_p$) was measured before induction at the dorsum of the hand by a thermistor (HP 21078A-204). Anaesthesia was induced with fentanyl 1 mcg kg$^{-1}$ and propofol 2 mg kg$^{-1}$, followed by placement of a laryngeal mask airway (LMA). Anaesthesia was maintained with 70% nitrous oxide and 1.5–2.5% enflurane in oxygen. A closed circle breathing system was used (Drager, Narkomed), with fresh gas flow 1.5 litre min$^{-1}$. Active humidification was not used.

After placement of the LMA, a nasopharyngeal temperature probe (Hewlett-Packard 21075A-7025) was positioned as an index of core temperature ($T_c$). Temperature values were recorded at 15-min intervals. Standard peroperative monitoring was used (ECG, non-invasive arterial pressure, oxygen, carbon dioxide and enflurane analysers).

Ambient temperature and relative humidity were strictly within the limits of 21.9–22.2°C and 59–61%, respectively, and airflow was maintained constant in each of the four operating theatres used. No patient included in the study received i.v. fluids during anaesthesia, as the anticipated duration was less than 1 h.

When patients awakened from anaesthesia, the space blanket was removed before transfer to recovery. Recovery room nursing staff, blind to the test groups, documented the occurrence of shivering, defined as readily detectable fasciculations and tremor of the jaw, neck, trunk and extremities lasting longer than 20 s.

On return of cognitive function, patients were asked if they had felt cold at any point since waking. They were asked to grade their perception of cold on a linear scale of 1–10, similar to the pain analogue score. A score of 1 indicated feeling pleasantly warm, 10 was "colder than you've ever felt before". This scale was explained to the patients before induction and a baseline preinduction value obtained.

Chi-square analysis (with Yates' correction) was applied to the 2×2 contingency table of shivering incidence. The Mann–Whitney U test and unpaired Student's $t$ test were applied to ordinal and interval data respectively, using Statsview 512.

**RESULTS**

Patients in both groups were similar in age, gender and duration of surgery (table I).

There was a highly significant reduction in the incidence of shivering in the space blanket group ($n = 5, 15\%$) compared with the control group ($n = 21, 63\%; P < 0.001$) (table II). Patients' perception of cold, recorded as the mean cold score in recovery, was significantly lower in the space blanket group (2.4 (0.4) vs 5.7 (0.5); $P < 0.001$) (table I).

There was no difference in initial core or peripheral temperatures between the groups, but patients in group 1 had higher skin temperatures at 15, 30 and 45 min, although control skin temperature also increased progressively during this time (fig. 1).

The net gain or loss of core temperature is shown in figure 2 and was expressed as the difference in initial and final measured core temperatures for each

<table>
<thead>
<tr>
<th>Table I. Patient characteristics (mean (range or SEM)).</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>32.2 (14–72)</td>
<td>37.8 (16–79)</td>
</tr>
<tr>
<td>% Male</td>
<td>76%</td>
<td>65%</td>
</tr>
<tr>
<td>Duration of anaesthesia (min)</td>
<td>41.6 (4.8)</td>
<td>47.5 (3.3)</td>
</tr>
<tr>
<td>Cold scores</td>
<td>2.4 (0.4)</td>
<td>5.7 (0.5)***</td>
</tr>
</tbody>
</table>

| Table II. Incidence of shivering in the two groups. P < 0.001 between groups. |
|-----------------------------------------------|---------|---------|
|                                               | Shivered | No shivering |
| Group 1 ($n = 34$)                            | 5       | 29      |
| Group 2 ($n = 34$)                            | 21      | 13      |

![Fig. 1. Mean (SD) peripheral temperatures in the space blanket (□) and control (●) groups.](image1)

![Fig. 2. Mean (SD) core temperatures in the space blanket (□) and control (●) groups.](image2)
patient \((T_o - T)\). The minus sign indicates a small nett temperature increase in the space blanket group in contrast with a nett loss of greater magnitude in the control group \(\text{fig. 2}\); however, this difference was not statistically significant. Temperature values are shown in table III.

### DISCUSSION

We have demonstrated that spontaneously breathing patients undergoing general anaesthesia, treated pre-emptively with a space blanket, had reduced post-anaesthetic shivering. This supports the findings of Bourke and colleagues [16] who found a 17% incidence of shivering in test patients and 55% in controls. Our study differs in that we used spontaneously breathing patients undergoing short procedures \(\text{mean (SEM) duration 44.6 (3.9) min}\), unlike their patients who underwent vascular surgery exceeding 2-h duration. No previous study has reported patients' subjective description of cold and shivering with the use of a space blanket.

In contrast, an earlier study of neurosurgical patients found that the space blanket was ineffective in preventing core hypothermia [17]. Although core temperature values in this study were similar to those in our study, skin temperature changes were not reported. Moreover, Radford and Thurlow's study could not assess post-anaesthetic shivering, as many patients were paralysed and their lungs were ventilated after operation. Dyde and Lunn [19] found that the space blanket maintained core \(\text{nasopharyngeal}\) and skin temperatures in patients undergoing thoracic surgery. However, they did not examine post-anaesthetic shivering and their controls were not comparable in terms of gender and duration of surgery.

Our study raises the intriguing question as to how the observed reduction in shivering was achieved by the space blanket without an accompanying significant increase in core temperature. Although the physiological basis for post-anaesthetic shivering after general anaesthesia is incompletely understood, it is believed generally that it is true thermogenic shivering, in response to intraoperative hypothermia, induced primarily by vasodilating anaesthetic volatile agents [1, 13, 15]. Heat loss under anaesthesia then occurs primarily by radiation and convection; evaporation and conduction have a minimal effect [18].

The thermogenic model of post-anaesthetic shivering implies a correlation between shivering and post-anaesthetic hypothermia; however, they correlate poorly [1, 20-22]. Perhaps the most persuasive evidence in support of the thermogenic theory is that the application of radiant heat was found to greatly diminish or abolish shivering [13, 21], while Lennon and colleagues found a forced air warming system effective [23]. However, a comparison of physical methods of treating established shivering after anaesthesia for cardiac surgery found direct radiant heaters and oesophageal heat exchangers less than satisfactory [24].

A study of patients undergoing regional anaesthesia for hip surgery found that peroperative total body heat loss was reduced significantly in patients wrapped in a space blanket, despite a significant decrease in core temperature, although the incidence of shivering was not reported [25]. Post-anaesthetic shivering may therefore be a response to heat loss, rather than core temperature. Hence minimizing radiation heat loss with the space blanket contributes to a reduction in shivering. The explanation for the higher skin temperature and hence lower core–peripheral temperature gradients in group 1 may be attributed to prevention of such radiation heat loss by the space blanket. The mechanism by which this contributes to the observed reduction in shivering is unknown.

The relatively large overall incidence of shivering in this study \(\text{39%}\) may be attributed partly to the anaesthetic technique of spontaneous breathing, where a greater heat redistributive effect to the skin is observed [2]. The preponderance of males \(\text{70%}\) and ASA I patients is known to be associated with post-anaesthetic shivering.

Typmpanic temperature reflects hypothalamic, and hence true core temperature [26]. While our core temperature monitor was nasopharyngeal, a comparative study of sites of core temperature monitoring during anaesthesia, using tympanic temperature as the gold standard, found that the precision and accuracy of measurements made in the nasopharynx and oesophagus were comparable and were recommended for peroperative use [27].

Most authors agree that prevention of post-operative shivering is desirable [1, 2, 16, 17, 28]. The use of drugs to treat established shivering has been questioned, as it suppresses physiological attempts to restore normothermia [24], while there are conflicting reports on the efficacy of physical methods [13, 23, 24]. These forms of technology are also expensive and cumbersome.

The space blanket, on the other hand, used pre-emptively, may reduce the incidence of post-anaesthetic shivering. This is a passive warming system and therefore cannot burn patients and the modern product is stated to be safe in the presence of diathermy. Following publication of Radford and Thurlow's results [17], several workers denounced the use of the space blanket pre-emptively in theatre as hazardous in association with diathermy [29].

In contrast, Bourke and colleagues insisted that no such risk existed with its use in association with electrocautery [16] and this concurs with advice from...
the manufacturers and distributors of space blanket UN 320. It is not radio-opaque, not subject to electrical or mechanical failures, is lightweight, clean, reusable, disposable and inexpensive.

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REFERENCES


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