



KEEPING THEM WARM

A randomised controlled trial of two passive perioperative warming methods

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Abbreviations:

- American Society of Anesthesiologists physical status classification (**ASA**)
- Body Mass Index (**BMI**)
- Inadvertent Perioperative Hypothermia (**IPH**)
- Lismore Base Hospital (**LBH**)
- National Institute for Health and Clinical Excellence (**NICE**)
- Postanaesthesia Recovery Unit (**PARU**)
- Temporal Artery (**TA**)

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Abstract

Aim

Inadvertent preoperative hypothermia (IPH) is a common problem for patients undergoing surgery. Heat redistribution from the body's core to the periphery after induction of anaesthesia is the major contributor to heat loss.

Both cotton and reflective blankets are currently in routine use in operating theatres for perioperative warming of patients undergoing short procedures. This study aimed to determine if thermal insulation with reflective blankets is more effective than cotton blankets in reducing the temperature gradient from the body's periphery to the core during the preoperative phase in adult patients undergoing short surgery and thus in reducing the intraoperative drop in core temperature.

Methods

A prospective randomized controlled trial was conducted in a regional base hospital operating theatre. Three hundred and twenty eight adult patients who underwent a short elective surgical procedure with general anaesthesia with anticipated surgery time less than one hour were randomly allocated to one of two groups, using a computer generated number table. One group received reflective blankets and the other cotton blankets. Eight patients were excluded from the study due to additional warming methods being used.

Up to eight temporal artery and two foot temperatures were measured during the perioperative period. Data was analysed using independent t-tests for continuous variables and chi-square tests for categorical variables.

Results

There was a significantly greater increase in foot temperature (0.64°C vs. 0.11°C , $p < 0.001$) and a significantly smaller reduction in temporal artery/foot temperature gradient (1.13°C vs. 1.64°C , $p < 0.001$) in the reflective blanket group compared to the cotton blanket group.

Conclusion

Reflective blankets provide a more effective alternative than cotton blankets to warm up patients' periphery and hence reduce core to peripheral temperature gradient preoperatively.

Implications

This study showed that surgical patients can be sufficiently warmed and maintain normothermia with reflective blankets for procedures under one hour. This could lead to a move away from using warmed cotton blankets and active warming for shorter procedures. Further, it provides a major advantage for day surgery procedures and smaller rural hospitals where mainly shorter procedures are performed.



Keywords: Hypothermia, Perioperative hypothermia, Prewarming methods, Inadvertent Perioperative Hypothermia, Randomised Controlled Trial



Executive Summary

Background

In 2010 a routine audit of patient temperatures in the postanesthesia recovery unit (PARU) at Lismore Base Operating (LBH) Theatres revealed that a large number of patients arrived hypothermic in recovery, that is with a body core temperatures below 36°C. As a consequence, key performance indicators for inadvertent postoperative hypothermia were not met and compared to peer hospitals, such as The Tweed and Wagga Wagga Hospitals, LBH had a much higher incidence of hypothermia.

This poor performance indicated that practices to maintain patient temperatures during the perioperative journey were not sufficient. Prior to this audit, warmed cotton blankets were used for short procedures and a combination of warm cotton blankets and forced air warming for longer operations. As a result of the 2010 audit, reflective blankets were introduced preoperatively in an attempt to use the patients own body heat to warm up the whole body. Anecdotally, the patients were warmer and fewer incidents of hypothermia were observed. However, as many nurses continued to use warmed cotton blankets, both blanket types were in use. It is not uncommon to use 3-5 warmed cotton blankets per patient during the operative journey. Warm cotton blankets have to be replaced frequently as they cool down and nurses have to spend additional time and motion retrieving the blankets. Internal costing at Lismore Base Hospital showed that washing a cotton blanket costs \$2.01 (without capital purchasing and warming costs) compared to \$0.80 for a reflective blanket.

The UK National Institute for Health and Clinical Excellence (NICE) in its guideline found that there is only weak evidence for the use of reflective modalities preoperatively to reduce the incidence of hypothermia. It questioned if thermal insulation applied preoperatively is better than usual care for patients undergoing short operations and recommended large randomized controlled trials with 100 patients in each arm with patients not at high risk of perioperative hypothermia and having anaesthesia for less than one hour.

The study

A randomized controlled trial was conducted at Lismore Base Hospital Perioperative Services to determine if reflective blankets are more effective than cotton blankets in keeping patients warm. Three hundred and twenty eight patients who had elective surgery that was expected to take less than one hour were randomly allocated to one of two interventions, reflective blankets or cotton blankets.

Multiple temperatures were taken to assess the effectiveness of either modality to warm up patients' extremities before surgery to reduce the effect of redistribution hypothermia after the onset of anaesthesia. The study also compared the number of patients arriving hypothermic in recovery.

Results

Out of 328 volunteers eight patients were excluded because active warming was used at the discretion of the anaesthetist during the intraoperative period. All remaining patients were passively warmed with either

a reflective (n=179) or a cotton blanket (n=141). The average surgery time was 32 minutes with 7% of the cases exceeding 65 minutes with the longest being 105 minutes.

There was an even distribution of patients between the two groups in regard to age, gender, Body Mass Index (BMI), American Society of Anesthesiologists physical status classification (ASA) and type of anaesthetic.

This study showed that insulation of patients with reflective blankets was significantly more effective than cotton blankets to increase the preoperative peripheral foot temperature; $t=-4.13$, $p<0.001$. A clinically significant mean increase of 0.64°C ($sd=0.98$) was observed in the reflective blanket group compared to 0.11°C ($sd=0.99$) in the cotton blanket group with an average 52 minutes preoperative intervention time.

Reflective blankets were also significantly more effective in reducing the temporal artery (core) to foot (periphery) temperature gradient, thus increasing the overall preoperative body heat content in the peripheral compartments (arms and legs); $t=-4.13$, $p<0.001$.

All patients arrived normothermic in PARU, apart from one patient (0.3%) in the reflective blanket group. This patient warmed up again to normal temperature during the stay in PARU without additional intervention.

Another important observation is that a significantly greater number of patients in the cotton blanket group requested additional warm blankets (40% cotton vs. 4% reflective group), $\chi^2=63.95$, $p<0.001$. This suggests that patients in the cotton blanket group felt cooler, which is supported by the only minimal increase of anaesthetic bay foot temperatures after intervention and the slight increase in temporal artery (TA) and foot temperature gradient, despite having extra warm blankets.

CONCLUSIONS AND RECOMMENDATIONS

Reflective blankets are significantly more effective in increasing patients' preoperative temperature and are able to maintain normal patient temperatures throughout the perioperative period in patients having elective surgery up to one hour duration.

The use of reflective blankets is a cost effective measure to prevent inadvertent perioperative hypothermia as compared to usual care with warmed cotton blankets and can provide significant savings. In smaller rural and remote facilities where mostly short elective operations are performed, it provides a superior method for keeping patients warm that does not require costly equipment, such as forced air warming devices.

Based on the findings of this research it is recommended to implement guidelines for perioperative temperature management that utilises reflective blankets for adult patients that undergo elective surgery up to one hour.

Introduction

The pace in operating theatres is very high, particularly with ever changing technological advancements and the need to provide safe care based on the best available evidence.

Too often perioperative staff only pay attention to highly advanced technology, but forget about utilising resources already available.

Inadvertent perioperative hypothermia is a very well known and thoroughly costed complication of anaesthesia and surgery (1-3). Operating theatres are cold places and the importance of keeping patients warm is often underestimated (1). Much research has focused on sophisticated active warming methods, such as forced air warming devices, circulating water garments and energy-transfer pads, which have been shown to make a difference in the outcome for patients (1, 4-6).

While active warming has proven benefits, many of these methods require a long exposure time (1, 5, 7). For shorter operation times alternative passive warming methods are often used. Little evidence is available that compares passive warming methods (1), particularly for shorter elective procedures. Where the exposure time for active heat transfer is not long enough, passive methods applied in the preparation phase, could provide an alternative.

The report describes a prospective randomised controlled trial to determine if thermal insulation with reflective blankets is more effective than cotton blankets in reducing the temperature gradient from the core to periphery preoperatively.



Background

Why is perioperative temperature management important?

Maintaining normal core temperature between 36.0°C and 37.5°C during the perioperative phase is important not only for patient comfort, but also for preventing complications as a result of hypothermia (1). Hypothermia is defined as a body core temperature below 36°C and mild hypothermia is 34°C to 36°C (1, 2). The UK National Institute for Health and Clinical Excellence (NICE) describes inadvertent perioperative hypothermia (IPH) as 'a common but preventable complication of perioperative procedures, which is associated with poor outcomes for patients (1). In most cases this occurs intraoperatively and during the immediate recovery period (1, 2, 8, 9). Preventing the complications of hypothermia can reduce the length of stay by 40% and postoperative surgical site infections by 64% (2, 3). This decrease in postanesthesia recovery unit (PARU) and hospital length of stay can reduce the cost of care by \$2,500 to \$7,000 (2, 3).

How common is hypothermia?

Despite an abundance of evidence and guidelines (1) to prevent the occurrence of IPH, Forbes et al (2009) (10) observed that 46% of patients undergoing abdominal surgery were hypothermic preoperatively and over one-third arrived cold to PARU. Others reported that 70% of all surgical patients experience some degree of hypothermia (4, 11).

What factors influence perioperative hypothermia?

All surgical patients are at risk of hypothermia as the intraoperative setting exposes the patient to several factors that contribute to heat loss (2, 9). After induction and within the first hour of a procedure core temperature tends to decrease between 1.0°C and 1.5°C due to redistribution of body heat from the core to the periphery (1). Inadvertent perioperative hypothermia occurs as a result of extrinsic factors such as low ambient room temperature, length and type of surgery, use of cold irrigation fluids and skin preparations (2, 9). However, the most significant factor is that the administration of general and regional anaesthesia compromises the patient's ability to regulate body temperature (1, 4). Other patient specific risks are young or advanced age, cachexia, pre-existing metabolic conditions or trauma (1, 2, 4, 9).

What are the complications associated with IPH?

Even mild perioperative hypothermia increases surgical site infections, prolongs surgical wound healing (10), reduces platelet functioning, increases intraoperative blood loss and may prolong the effects of general anaesthesia (1, 2, 4, 6). In pronounced hypothermia the incidence of ventricular tachycardia and morbid cardiac events triple (1, 2, 4, 6, 9). These complications can lead to the need for red blood cell, plasma or platelet administration; increased need for mechanical ventilation; and additional cardiac support. Furthermore, hypothermia contributes to infections by reducing tissue oxygenation, decreasing the body's ability for tissue healing, and impairing immune function (2, 4).

Inadvertent Perioperative Hypothermia also affects a patient's comfort and satisfaction. Patients frequently report discomfort because they feel "cold" after changing into the hospital gown and lying on the stretcher or hospital bed. This sensation can contribute to increased anxiety about various aspects of surgery (4, 12, 13).

A 2003 survey of perioperative and perianaesthesia nurses in the USA revealed that 71% reported the top comfort concern of patients was warmth and that being cold was the comfort issue most commonly expressed by patients (13). Feeling warm is an important factor in a patient's surgical experience. In fact, overall satisfaction with surgical care may hinge on the patient's sense of thermal comfort or discomfort (13). Feeling cold can trigger anxiety about the entire surgical experience. In a study by Wagner et al (2006), subjects using forced-air warming gowns had significantly lower reported anxiety compared with those warmed with blankets (7). It has to be noted though that patients thermal comfort report cannot be taken as an indication of hypothermia. Winslow et al (2012) found that over one third of patients stated they were "just right" when in fact their temperature was hypothermic (14).

Anaesthesia and physiological mechanisms

Human core temperature is well regulated and rarely differs from expected values by more than a few tenths of a degree (2, 6, 15). In distinct contrast to core temperature, peripheral tissue temperature can vary enormously by 2°C – 4°C (16). The body's thermoregulatory system permits such variation specifically to avoid initiating responses to each environmental change. As a result peripheral tissues lose heat in a cool environment and absorb heat in a warm one (11).

Anaesthetics, general and regional, are considered a primary cause of impaired thermoregulation and temperature control inducing hypothermia (1, 2, 4). This temperature drop can occur even during short procedures and has a significant impact on patient outcomes (1).

The degree of heat redistribution is influenced by the temperature gradient between the core and peripheral

compartments. The peripheral compartment includes upper and lower extremities and is expressed as mean skin temperature. The greater the temperature gradient between the two compartments the greater the core temperature drop after induction of anaesthesia (1, 17).

During general anaesthesia IPH develops in three phases:

- A rapid decrease in core temperature during the first hour of anaesthesia, resulting from an internal redistribution of body heat from core to periphery (15). General anaesthesia only slightly increases heat loss from the body's surface, but causes vasodilation. Anaesthetic agents reduce thermoregulatory vasoconstriction by increasing the hypothalamic trigger set-point (2, 8, 9, 16). During the first hour the core temperature can decrease by 1.6°C, of which 81% is attributed to redistribution and only 19% to environmental factors (8).
- A slower, linear decrease occurs in surgical cases from the second and subsequent hours. General anaesthesia reduces metabolic heat production by about 20%. Aided by radiation, convection, conduction and evaporation this causes heat loss to be greater than heat production (8, 18).
- Patient temperatures generally plateau around three to five hours into surgery as thermoregulatory vasoconstriction is triggered through the patient being sufficiently hypothermic (8, 9, 15, 18).

Although central thermoregulation remains intact during neuraxial anaesthesia, abnormal heat loss occurs because of the redistribution of heat from the core to the periphery, increased cutaneous blood flow resulting from a sympathetic block, reduced hormonal response to the surgical stimulation and impaired shivering in the area of the block (1, 16, 18).

Warming mechanisms and their actions

Interventions designed to prevent IPH are categorised as passive and active warming procedures. Passive

warming may include warmed cotton blankets, socks, head covering, limited skin exposure and increased ambient room temperature (1). Active warming includes therapies such as forced air convection warming systems, circulating water mattresses, warmed intravenous and irrigation fluids (1).

The extent of internal heat redistribution is proportional to the temperature gradient between the core and peripheral compartments. Consequently, warming patients before anaesthetic induction and thus reducing the core to periphery temperature gradient reduces heat redistribution (16).

Active warming:

While active intraoperative warming is considered an effective strategy to prevent IPH, its usefulness might be questioned for patients that are already hypothermic on arrival in the operating theatre (1, 5). Skin surface warming of patients who are already cold when arriving to the theatre will take considerable time to warm the core compartment (5, 7). One study demonstrated that commencing active warming intra-operatively for the first time, when core temperature has already decreased below 36°C, does not reverse or prevent further hypothermia (19).

Hindsholm et al (1992) found this process typically requires an active warming time exceeding two hours (15). However, for shorter procedures there is insufficient time for cutaneous heat transfer and active warming may only lead to increased skin blood flow, not to an increase in body heat content. If patients are exposed to a cold environment or surface, the heat loss through the periphery can be accelerated and patients may end up hypothermic in the PARU (11).

There are reported benefits from preoperative or pre-emptive warming (5). By increasing energy content in the peripheral thermal compartment through pre-warming, mean body temperature can be raised (11). Horn et al (2012) found that the core temperature of patients who were not pre-warmed declined more than with pre-warming, despite active warming during the surgical procedure. Even 10 minutes of

pre-warming was sufficient to prevent hypothermia. Longer periods of 20 or 30 minutes of pre-warming did not change the absolute core temperature profile, nor did it significantly reduce the proportion of postoperatively hypothermic patients (18).

In awake individuals, preoperative skin warming minimally alters core temperature, but it does increase body heat content and peripheral tissue temperature. Such pre-warming should minimize redistribution hypothermia during subsequent induction of anaesthesia (11, 20). However when the outer region of the body becomes warmer, vasodilation can lead to increased heat loss. To prevent this, adequate body covering is necessary (11, 15).

Passive warming methods:

It has been practice in many hospitals to cover patients with warmed cotton blankets to provide thermal comfort once they change into a cotton gown (11). Leeth et al (2010) found that when warm blankets are applied, comments such as "This is the best part of surgery" or "I look forward to the warm blankets" are often verbalized by patients (13).

However, as warmth dissipates within 5 – 10 minutes from warmed cotton blankets, they are frequently changed and in some cases five or more blankets are needed to maintain patient warmth during their perioperative journey (7, 13, 19). The cost of nursing time and motion with the continued use of warmed blankets and that of utilities to heat the blankets are difficult to measure, but is estimated to be significant (2).

Insulating with a reflective blanket protects the patient from the environment and reflects valuable heat back to the patient. Reflective blankets comprise metalized plastic sheeting which acts primarily by reducing the heat loss caused by radiation, but also by reducing convectional loss by minimizing draughts (15). At rest, 75% of the body's heat production is normally lost by radiation and convection from the body surface, thus minimising radiation heat loss during the perioperative period is essential (15). A clinically important reduction of heat loss can be achieved by using passive insulators,

which may be sufficient to keep patients normothermic depending on the skin surface area covered, ambient temperature and duration of surgery (21-23). Additional insulation by up to 30% is provided by using disposable surgical covers compared to sterile cloth drapes (24).

The UK National Institute for Health and Clinical Excellence guidelines do not specifically recommend pre-warming patients, but instead recommend regular temperature measurements. If the patient's core temperature falls below 36°C preoperatively, active warming should be commenced (1).

The NICE review found that there is only weak evidence for the use of reflective modalities preoperatively to reduce the incidence of hypothermia. The review questioned if thermal insulation applied preoperatively is better than usual care for patients undergoing short operations and recommended large randomized controlled trials with patients not at high risk of perioperative hypothermia and having anaesthesia for less than one hour (1). Therefore the aim of this study was to determine if thermal insulation with reflective blankets is more effective than cotton blankets in reducing the preoperative core to periphery temperature gradient.

Objectives

REFLECTIVE
BLANKETS

VS

COTTON
BLANKETS

The primary objectives of this study were to determine if thermal insulation with reflective blankets would be more effective than cotton blankets in:

1. Reducing the temperature gradient from the body's core to the periphery during the pre-operative phase;
2. Increasing the peripheral compartment heat content in adult patients undergoing surgery of one hour or less.

The secondary objective was to determine if improved peripheral warming reduced the degree of core temperature drop after the start of the anaesthetic.

Methods

Design

Prospective randomised controlled trial comparing reflective blankets with cotton blankets for preoperative warming of patients.

Outcomes

Primary Outcomes:

1. The difference between the foot and temporal artery temperatures in the admitting ward and anaesthetic bay in the two groups;
2. The preoperative change in foot temperature between the admitting ward and the anaesthetic bay in the two groups;
3. The average difference in temperature was then calculated for each group (reflective vs. cotton blankets) and compared using an independent sample t-test. The null hypothesis for this test was that there is no difference between the two groups.

Secondary Outcomes:

1. The 15 minute time interval at which the lowest intra-operative decrease in temperature occurred;
2. The proportion of people who arrived normothermic in PARU for each group;
3. The proportion of patients who requested additional warmed blankets.

Sample Size Consideration

The sample size calculation was based on an expected

treatment effect of 0.5°C on anaesthetic bay preoperative peripheral foot temperature. A type 1 error (alpha) of 0.05 for a two tailed test and a correlation coefficient of 0.8 for temperature measures taken within each individual was assumed. A sample size of 274 patients, divided into two groups, was estimated to provide 90% power. An additional 54 patients were recruited to the study to allow for a 20% buffer for withdrawal of patients who become ineligible. The total sample size was 328 patients.

Randomisation – sequence generation

Patients were randomly allocated to the two groups using a computer-generated procedure. A biostatistician, with no clinical involvement in the trial, created a computer generated randomization sequence using a Microsoft Excel spread sheet random number generator. Reflective blankets were allocated numbers between 0 – 0.5 and cotton blanket above 0.5 – 1. Consecutive numbers from 1 - 328 were then assigned to each intervention, following the randomly allocated sequence.

Randomisation – allocation concealment

The lead researcher prepared sequentially numbered, opaque envelopes, enclosed the particular intervention sheet for the allocated group to the assigned corresponding number and sealed the envelope.

Randomisation – Implementation

The admitting nurses assigned the envelopes in numerical sequence to the patients as they consented to

partake in the study. The nurses were unaware of the intervention concealed in the envelope to prevent selection bias. The envelopes were opened by the perioperative nurse preparing the patient for surgery.

Participants

Setting

The research was conducted at the Perioperative Services of Lismore Base Hospital (LBH), a 240 bed acute referral facility in the regional centre of Lismore in northern NSW, Australia.

Eligibility criteria

Inclusion criteria:

- Adult patient ≥ 18 years who underwent elective surgery where the estimated time of surgery was less than one hour;
- American Society of Anesthesiologists (ASA) classification ≤ 3 ;
- General anaesthesia or combined general/regional.

Exclusion criteria

- ASA ≥ 4 ;
- Surgery predicted longer than one hour;
- Predicted local/regional anaesthesia and sedation;
- Patients who did not consent for their data collected to be used for research purposes;
- Patients whose surgery was cancelled or postponed;
- Nurses not able to consent patients due to workload;
- Surgery to the head, e.g. dental, ear, nose and throat.

Withdrawal criteria:

- Patients where active warming was used during the procedure at the discretion of the anaesthetist.

Patient eligibility assessment

The study was conducted from February to July 2013. The lead researcher reviewed the list of patients scheduled for operation on a daily basis to identify subjects

who met the inclusion criteria for the study (APPENDIX 1). To estimate American Society of Anesthesiologists (ASA) Physical Status classification patients electronic medical records were consulted.

A list of the eligible patients was generated for the admission nurses for recruitment.

Recruitment and Consent

Patients were admitted as per routine procedure. The admitting nurses invited eligible patients to participate in the trial, provided them with a research information sheet (APPENDIX 2) and answered questions that the patient or their family had. When patients agreed to partake in the study the nurses obtained written consent (APPENDIX 3) to use de-identified patient data collected during the perioperative period. Following numerical order the nurses allocated a numbered sealed envelope to each patient. The sealed envelope, signed research consent form, a data collection form (APPENDIX 4) and a time counter were attached to the patient's notes. No identifying data was recorded on the data collection form.

If patients chose not to participate, normal procedures were followed. Patients declining to participate were not disadvantaged as both interventions are standard care and the perioperative nurses allocated either type of blanket.

Interventions

Patients were randomised into two groups:

1. The reflective blanket group, received a reflective blanket (MEDiflex, disposable emergency blanket, 140x210cm) close to the skin and one cotton sheet on top to contain the light weight reflective blanket.
2. Patients allocated to the cotton blanket group received a cotton sheet to the skin and a cotton blanket on top of the sheet.

In both groups the blankets were tucked around the patient, leaving only the head and at times their arms exposed, for the perioperative period including recovery. Body cover during surgery was adjusted depending on the requirements for the specific surgery the patient was undergoing. During surgery the patient was also

covered with sterile single use drapes. If patients stated that they felt cold and requested another blanket, a warmed cotton blanket was placed under the sheet or reflective blanket. In accordance with routine hospital practice all intravenous and irrigation fluids were warmed to 38°C. Room temperatures were on average 22.4°C in the anaesthetic bays and 20.7°C operating theatres.

Pre-operative holding area

Following consent, patients were brought to the preoperative holding area. While patients were being prepared for surgery the preoperative nurses changed the patients into a cotton gown and opened the sealed envelope. The nurse allocated either a reflective or a cotton blanket according to the instructions in the envelope and recorded patient data on the data collection form (APPENDIX 3). Temperatures were measured on either the right or left temporal artery and the right or left sole of the foot and recorded accordingly. The timer was started to record exposure time under passive warming. All other care was performed as per routine.

Anaesthetic Bay

The anaesthetic nurses admitted patients to the operative suite as usual. In the anaesthetic bay the patients were prepared as per routine for that particular operative procedure. The anaesthetic nurses recorded patient temperatures of the temporal artery and the sole of foot on the right or left side as indicated by the preadmission nurse as well as the time of exposure as indicated by the timer prior to the patient leaving the anaesthetic bay.

Operating Room

Immediately before induction of anaesthesia the countdown timer was reset by the anaesthetic nurse to alarm every 15 minutes to remind the staff to record the temporal artery temperature at the allocated site. Some nurses used the clock in the operating room to mark the time. The anaesthetic nurse also recorded the operating room temperature. During the operative procedure the patient was covered by the assigned passive warming modality as much as possible with respect taken to the particular operative area being exposed. In addition the patient was covered by disposable surgical drapes.

After completion of the procedure the patient was covered again with the allocated passive warming modality, leaving only the head exposed. If the blankets were soiled, they were replaced with a new one of the same type.

Post-Anaesthesia Recovery Unit (PARU)

Within five minutes of arriving in the PARU, the patient's respective temporal artery temperature was recorded. Normothermic patients were covered with their allocated modality. If patients expressed that they felt cold an extra warm cotton blanket was offered and recorded on the data collection forms. Before discharge from PARU the recovery nurses recorded the respective temporal artery temperature, any thermal intervention, the duration of the operation and time spent in PARU.

To guarantee correct duration of preoperative passive warming and timing of the intraoperative 15 minute interval temperatures, a countdown timer was used for each patient.

Data Collection

Up to eight patient temperatures were taken by nursing staff and recorded: on admission when changing into the operative cotton gown; in the anaesthetic bay just before commencement of anaesthesia; 15, 30, 45 and 60 minutes after commencement of general anaesthetic; in the immediate postoperative period (within five minutes of arrival to PARU); and prior to discharge from PARU. Temperatures in preadmission and the anaesthetic bay were measured on two sites, temporal artery (core) and sole of foot (periphery). All other temperatures were measured on the temporal artery only.

Variables recorded include: Type of surgery, method of anaesthesia i.e. general or combined general/regional, duration of exposure under blankets (time in bed and time of temperature measurement in anaesthetic bay), length of surgery time and time spent in PARU. Ambient temperature in the anaesthetic bay and the operating theatre were also recorded. Age of patient, gender, BMI, ASA grade and number of participants using additional warmed cotton blankets were recorded.

Instrument used

In order to measure temporal artery and peripheral foot temperature and avoid using several different temperature measuring devices, an infrared digital thermometer was used (16). The HubDic FS 700, Non-Contact Infrared Digital Thermometers is adjusted by 2°C to match core temperature and has an accuracy of $\pm 0.2^{\circ}\text{C}$ (36 ~ 39°C) and $\pm 0.3^{\circ}\text{C}$ (34 ~ 35.9°C, 39.1 ~ 42.5°C). No biomedical calibration is necessary as the thermometer calibrates automatically within 20 minutes of being in a new temperature environment. A thermometer was placed at each measuring station - preoperative area, anaesthetic bays, operating theatres and PARU.

Blood in the temporal artery is considered near core temperature and therefore the supervening skin temperature is also approximately core temperature if the measurement device is adjusted by 2°C. Even intense vasodilation associated with sweating and intense vasoconstriction resulting from shivering, do not alter forehead skin temperature (16). Barringer et al (2011) findings support the use of temporal artery thermometers for non-invasive temperature monitoring for adults undergoing elective surgery (25).

Data Analysis

The data collected was manually entered in an Excel spreadsheet by the lead researcher and only non-identifiable data was sent to the biostatisticians for further analysis. The statisticians were blinded to which intervention was assigned to each group.

Data was imported from Excel and analysed using SAS Enterprise Guide V5.1 and SPSS V21. Patients with out-of-protocol interventions during the operation (n=8, 4 from each intervention group) were excluded. Temperature difference variables were calculated by subtraction (preoperative core - foot, anaesthetic core - foot, foot anaesthetic - preoperative). BMI was categorised according to WHO definitions:

- 1 = Under 18.5 – underweight;
- 2 = 18.5 to 24.9 – healthy weight range;
- 3 = 25.0 to 29.9 – overweight;
- 4 = 30 and over – obese.

Characteristics of the patients and baseline temperatures were compared to confirm similitude of the two groups using independent t-test for continuous variables and chi-square tests for categorical variables. The data was grouped in pre-, intra- and post-operative and if data in either of these sections was incomplete others could still be analyzed.

For the comparisons of primary outcome (temperature differences) independent t-tests were used with equal or unequal variances as appropriate. While the temperature differences were not strictly normally distributed, t-tests were judged to be appropriate because of the Central Limit Theorem and the relatively large sample sizes (26). A p-value of less than 0.05 was indicative of a statistically significant difference between the reflective and cotton blankets and therefore allowed the null hypothesis to be rejected.

To assess for the lowest intraoperative decrease in TA temperature change scores were computed for each 15 minute time period during the intra-operative period for each individual and the largest change score indicates at which point in time the largest decrease in temperature occurred. An average for each 15 minute time period was computed and compared between the groups by using an independent samples t-test.

This outcome required multiple comparisons, which increased the chance of finding a spurious significant result. For that reason, a Holm-Bonferroni adjustment of the p-values were calculated and applied. This was calculated by multiplying the number of comparisons by the raw p-values to get the adjusted p-values.

The number of patients who were normothermic in each group and receiving extra warmed blankets in each group was compared using a Chi-squared test.

Ethical approval

Approval was given by the North Coast NSW Human Research Ethics Committee, No: LNR 048, on the 12th December 2012. The Site Specific Assessment, No: G086, was granted on the 18th December 2012.

Results

Patient Flow

422 eligible patients were identified during this period and invited to take part in the study. In total 94 patients did not take part and were excluded before randomisation. A number of cases (n=55) did not proceed mainly through changes in the operating schedule or due to overrun of lists. Admitting nurses reported that most patients not consenting for their data to be collected (n=11) were very anxious in anticipation of their procedure. Due to procedural and staffing reasons at the time, 28 eligible patients were not able to be invited to participate in the study (Figure 1).

Numbers Analysed

The sample (Table 1) included 328 patients of who 183 were randomised to receive a reflective blanket intervention and 145 a cotton blanket (Figure 1).

To measure for the primary outcome, data from 179 and 141 patients from the reflective and cotton blanket groups respectively was analysed. Four patients in each group were excluded as active warming was used during the intraoperative period.

A further five participants in the reflective blanket group (n=3 & n=2) and eight from cotton blanket group (n=5 & n=3) were withdrawn because of missing

intraoperative temperature measurements or an anaesthetic type other than general or general /regional combined was used. This left 174 patients and 133 for each group respectively.

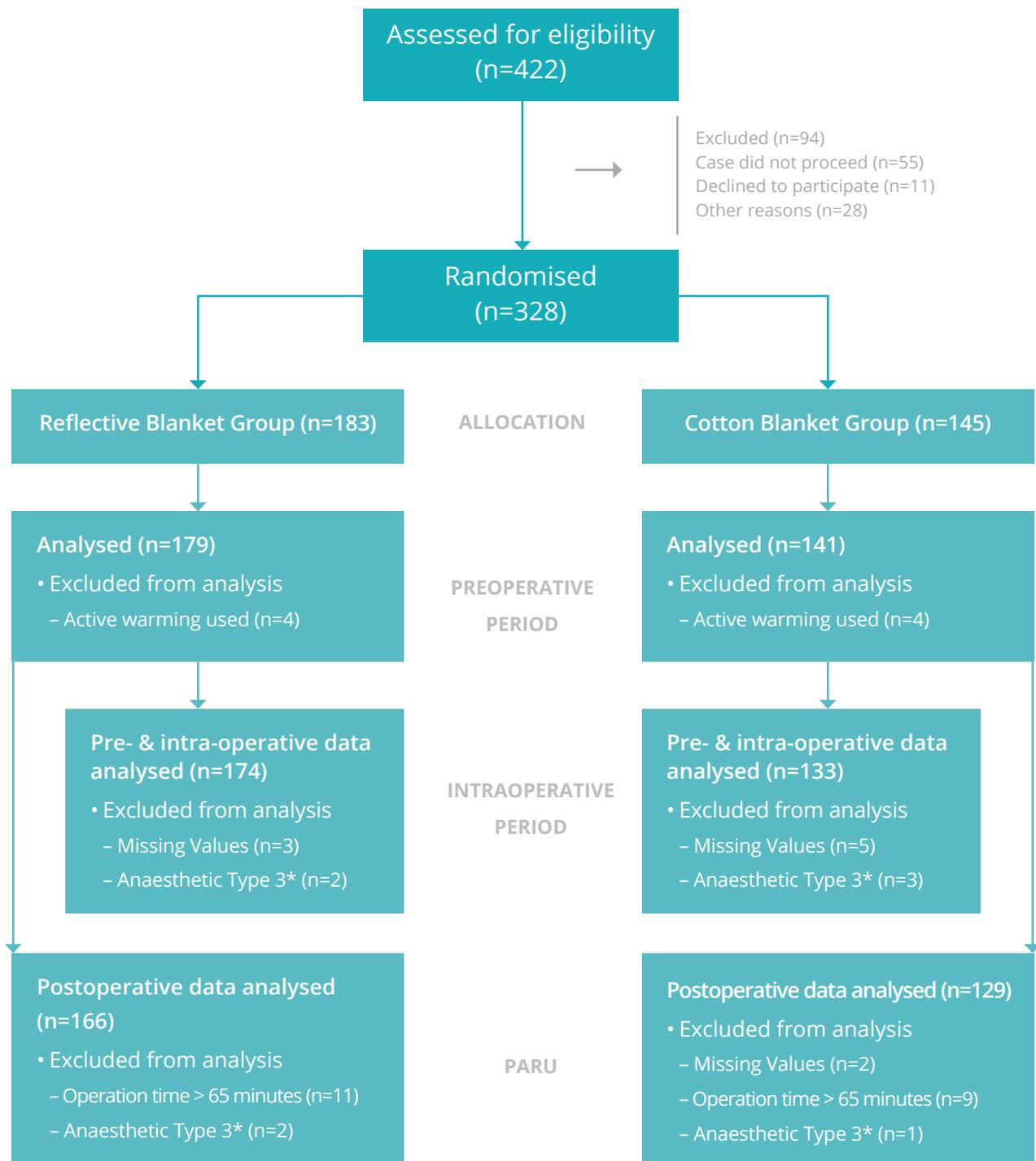
For the number of patients who were normothermic in PARU and who requested additional warmed blankets, 166 from the reflective and 129 from the cotton group were included. Another 11 and 8 participants were excluded (Figure 1) from each group if the operation time exceeded 65 minutes. Intraoperative temperatures up to 60 minutes for patients whose procedure went longer than 65 minutes were used.

Patient Baseline Data

There were no significant differences between the two groups in demographic and baseline characteristics (Table 1).

The average exposure to either blanket type preoperatively was 55 minutes for both groups. Although a great range in exposure time was observed from five to 297 minutes, due to quick day surgery procedure such as cystoscopies and long unexpected delays in the operating theatre. The median operation time for both intervention groups was 32 minutes.

Figure 1.
Patient Flow Chart
Perioperative Temperature Management



* Anaesthetic other than general or combined general/regional

Table 1.
Descriptive Information

Variable	Reflective Blanket (Group 1) (n= 179)	Cotton Blanket (Group 2) (n=141)	Total (n=320)	Comparison p-value
Socio-demographic				
Age: mean (sd)**	50.8 (16.9)	52.4 (17.4)	51.5(17.1)	p=0.411
Gender				p=0.331
Male: n (%)	73 (41 %)	50 (35 %)	123 (38%)	
Female: n (%)	106 (59 %)	91 (65 %)	197 (62%)	
Medical				
BMI*				p=0.374
Underweight	3 (2 %)	1 (1 %)	4 (1%)	
Normal weight	70 (39 %)	51 (36 %)	121 (38%)	
Overweight	53 (30 %)	53 (38 %)	106 (33%)	
Obese	50 (28 %)	36 (26 %)	86 (29 %)	
ASA score				p=0.221
1: n (%)	82 (46 %)	51 (36 %)	133 (42%)	
2: n (%)	70 (39 %)	65 (46 %)	135 (42%)	
3: n (%)	27 (15 %)	25 (18 %)	52 (16 %)	
Type of anaesthetic				p=0.663
General: n (%)	174 (97 %)	134 (95 %)	308 (96%)	
General + regional: n (%)	3 (2 %)	4 (3 %)	7 (2 %)	
Other: n (%)	2 (1 %)	3 (2 %)	5 (2 %)	
Measurement side of body				p=0.652
Right: n (%)	147 (82 %)	113 (80 %)	260 (81%)	
Left: n (%)	32 (18 %)	28 (20 %)	60 (19 %)	
Procedure				
Minutes with blanket intervention: mean (sd)**	51.9 (31.5)	58.1 (49.4)	54.6 (40.4)	p=0.186
Range of intervention times (min, max)**	(8, 157)	(5, 297)	(5, 297)	
Minutes of operation: mean (sd)	30.7 (22.5)	32.7 (23.2)	31.6 (22.8)	p= 0.439

* There were 3 people who had missing values for BMI, all from intervention Group 1.

** Independent t-test was used - all others χ^2 -test.

Preoperative Temperature Gradient

The foot temperature in both groups increased from the preoperative ward to the anaesthetic bay (Table 2). This increase was significantly greater for the reflective blanket group (0.64°C) than for the cotton blanket group (0.11°C). The temporal artery (TA) temperature increased only slightly in both groups (0.24°C and 0.22°C).

Table 2.

Mean Temperatures recorded for each group in °C

	Reflective Blanket (n= 179)*	Cotton Blanket (n=141)	Total (n=320)
Foot Temperature	Mean (sd)	Mean (sd)	
Preoperative Ward	34.80 (1.21)	34.80 (1.29)	
Anaesthetic Bay*	35.46 (0.85)	34.91 (1.26)	
Temporal Artery Temperature			
Preoperative Ward	36.35 (0.20)	36.33 (0.16)	
Anaesthetic Bay	36.59 (0.25)	36.55 (0.26)	
Temperature Comparisons			p-value
Change in foot temperature (anaesthetic bay minus preoperative ward) * Mean (sd)	0.64 (0.98)	0.11 (0.99)	p<0.001
Temperature differential in preoperative ward (temporal artery minus foot) Mean (sd)	1.55 (1.20)	1.52 (1.29)	p=0.853
Temperature differential in anaesthetic bay * (temporal artery minus foot) Mean (sd)	1.13 (0.85)	1.64 (1.26)	p<0.001

* There was one missing value for foot temperature in the anaesthetic bay in the reflective blanket group.

Lowest intraoperative TA temperature

There was no significant difference observed between the two groups in respect to lowest intraoperative temperature (Table 3 & Figure 2) or at what time point individual patients reached their lowest temperature (Table 4). As the duration of procedures varied, not every patient had temperatures taken at 15, 30, 45 and 60 minutes respectively. Even though a number of patients dropped below 36°C at some stage during the procedure, on arrival to PARU all but one returned to normal temperature.

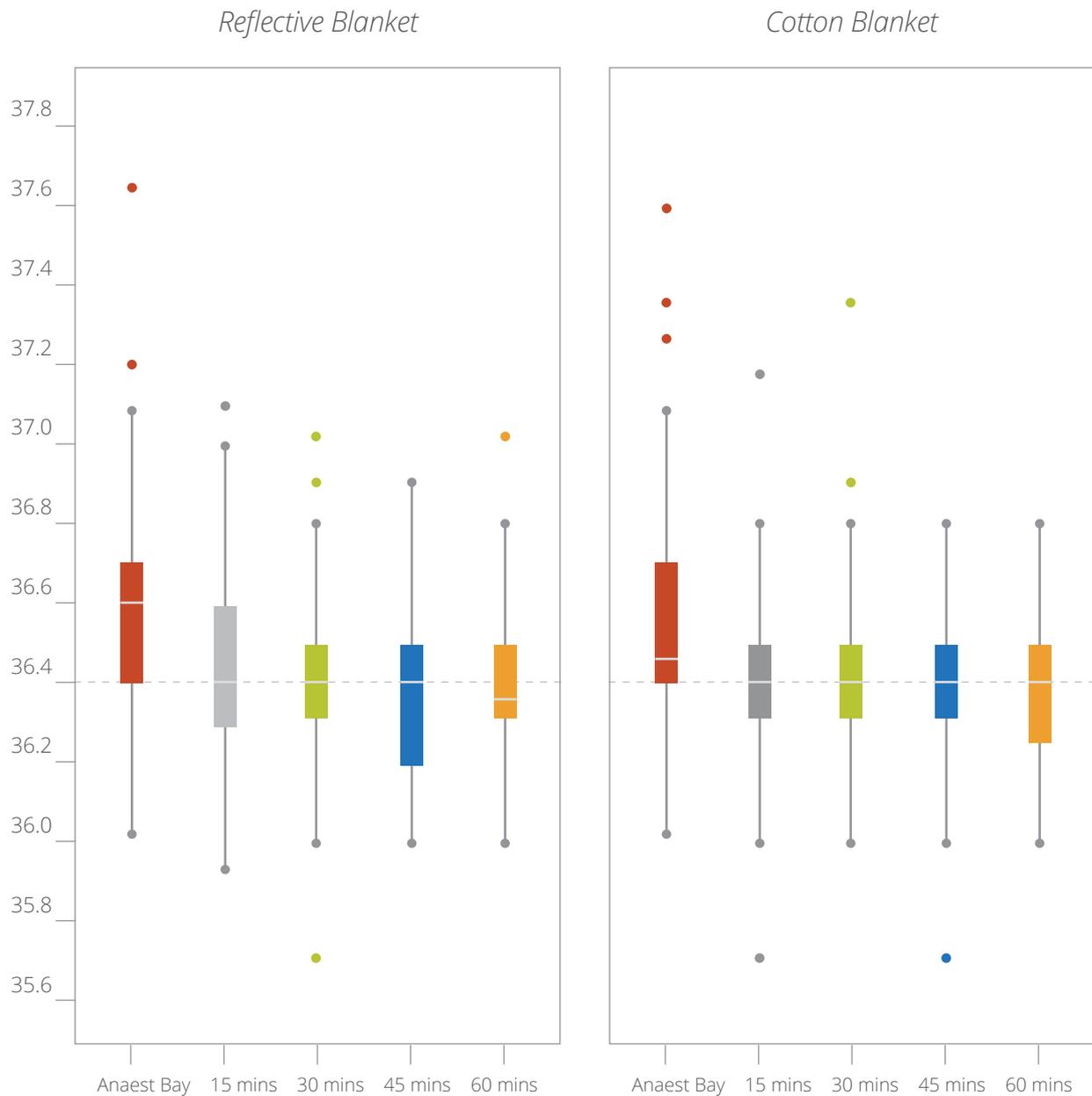
Table 3.

Intraoperative Temporal Artery Temperature in °C by group

	Reflective Blanket group	Cotton Blanket group	p-value
Anaesthetic Bay	(n=174)	(n=133)	
Mean (sd)	36.59 (0.2461)	36.55 (0.25)	p=0.152
Median (min, max)	36.60 (36.1, 37.6)	36.50 (36, 37.5)	
After 15 minutes	(n=174)	(n=133)	
Mean (sd)	36.44 (0.2185)	36.41 (0.1998)	p=0.183
Median (min, max)	36.40 (35.9, 37.1)	36.40 (35.7, 37.1)	
After 30 minutes	(n=108)	(n=84)	
Mean (sd)	36.41 (0.2146)	36.41 (0.2065)	p=0.955
Median (min, max)	36.40 (35.7, 37)	36.40 (36, 37.3)	
After 45 minutes	(n=60)	(n=49)	
Mean (sd)	36.39 (0.1928)	36.38 (0.2041)	p=0.785
Median (min, max)	36.40 (36, 36.9)	36.40 (35.7, 36.8)	
After 60 minutes	(n=34)	(n=24)	
Mean (sd)	36.40 (0.2216)	36.35 (0.2207)	p=0.4
Median (min, max)	36.35 (36, 37)	36.40 (35.9, 36.8)	

Figure 2.

Intraoperative temperature (°C) range for each group



The number of patients who were normothermic in PARU

There was no significant difference in the number of patients who were normothermic in PARU between the two intervention groups. Only one patient (0.3%) in the reflective patient group arrived with a temperature of 35.8°C whilst being normothermic during the 65 minutes long operation. Temporal artery temperature was taken again before discharge from PARU after 70 minutes and the patient warmed up to 36.1°C with no extra intervention.

Table 4.

Time of lowest intraoperative temperature by group

	Reflective Blanket: n (%)	Cotton Blanket: n (%)	p-value
Operating procedure up to 30 minutes duration			p=0.765
15 minutes	19 (39.6)	15 (42.9)	
30 minutes	29 (60.4)	20 (57.1)	
Operating procedure up to 45 minutes duration			p=0.414
15 minutes	7 (26.9)	11 (44.0)	
30 minutes	11 (42.3)	9 (36.0)	
45 minutes	8 (30.8)	5 (20.0)	
Operating procedure up to 60 minutes duration			p=0.667
15 minutes	16 (44.1)	7 (29.2)	
30 minutes	7 (20.6)	5 (20.8)	
45 minutes	6 (17.6)	6 (25.0)	
60 minutes	6 (17.6)	6 (25.0)	

Number of patients requesting additional warmed blankets

The number of patients given extra blankets was significantly greater in the cotton blanket group (40%) than in the reflective blanket group (4%); $\chi^2(1) = 63.95$, $p < 0.001$ (Table 5). Particularly preoperatively patients in the cotton blanket group requested additional warmed blankets despite their TA temperature being in the normal range.

Table 5.

Number of patients requesting extra warm blankets by group

Extra Warmed Blankets	Reflective Blanket	Cotton Blanket
Patients in preoperative ward	7/179 (4%)	56/141 (40%)
Patients in preoperative ward, excluding those with long operations > 65 minutes, and anaesthetic type 3*	5/166 (3%)	46/129 (36%)
Patients in recovery room, excluding those with long operations > 65 minutes, and anaesthetic type 3*	20/166 (12%)	21/129 (16%)

*Anaesthetic other than general or combined general/regional

Discussion

Interpretation

This study was the first randomised controlled trial to examine if reflective blankets were more effective in keeping patients periphery warm compared to cotton blankets. Three hundred and twenty eight low risk adult patients who underwent elective surgery with under one hour duration volunteered to partake in the trial. Only eight patients were excluded because active warming was used at the discretion of the anaesthetist during the intraoperative period. All remaining patients were passively warmed with either a reflective or a cotton blanket. The average surgery time was 32 minutes with 7% of the cases exceeding 65 minutes with the longest being 105 minutes.

The study showed that insulation of patients with reflective blankets was significantly more effective than cotton blankets to increase the preoperative peripheral foot temperature. A clinically significant mean increase of 0.64°C was observed with an average 52 minutes preoperative intervention time.

As expected the TA temperature (relative to core temperature) did not change in either group after intervention as core temperature is tightly regulated to maintain vital functions (2, 11). However in reducing the temporal artery (core) to foot (periphery) temperature gradient reflective blankets were more effective, thus increasing the overall preoperative body heat content in the peripheral compartments (arms and legs).

It is well researched and accepted that the magnitude of redistribution heat loss depends on the temperature

gradient between the core and the periphery (1, 17). The smaller the difference between the core and the periphery, the less significant drop in intraoperative core temperature is expected.

This however was not observed in this study. In each group all but one patient remained normothermic during the intraoperative period. This was despite the mean temperature differential between core and periphery in the reflective blanket group was reduced by 0.42°C. In the cotton group an increase of 0.12°C and a wider standard deviation was observed. This shows that patients' periphery in the cotton blanket group became even slightly colder.

The question arises if the use of the plastic drapes contributed to the less significant drop in core temperature that normally is anticipated with redistribution secondary to general anaesthesia. Disposable surgical plastic drapes were used during all operations and being plastic and impermeable, convection and evaporation was drastically reduced compared to sterilised cloth drapes used in the past (21, 23, 24).

All but one patient in the reflective blanket group (PARU TA temp. 35.8°C after 65 minutes surgery) arrived normothermic in PARU. This patient warmed up again to normal temperature during the stay in PARU without additional intervention.

Another important observation is that a significantly greater number of patients in the cotton blanket group requested additional warmed blankets (40% vs 4%), $\chi^2(1) = 63.95$, $p < 0.001$. This suggests that patients felt

cooler, which is supported by the only minimal increase of anaesthetic bay foot temperatures after intervention and the slight increase in TA and foot temperature gradient, despite having extra warm blankets. This finding correlates with other literature, which found that the heat of warmed cotton blankets dissipates quickly after removing them from the cupboard (7, 13, 19).

Additionally patients requested warmed blankets even though their core temperature was normal, which confirms that patients self-assessment is not a reliable indicator (14), but rather a comfort measure to aid against anxiety (11, 13).

Strengths and Limitations

The results of this study cannot be interpreted for patients with serious medical conditions, e.g. peripheral vascular disease, for patients undergoing major surgery or those requiring emergency procedures and

who might already arrive hypothermic to the operating theatre. This study only investigated temperature changes in a select study group of low risk volunteers undergoing elective surgery with durations of one hour or less. However, this study demonstrated that passive warming with reflective blankets provides an appropriate intervention to warm up and reduce the core to periphery temperature gradient preoperatively.

As pre- and post-operative temperatures were evaluated in awake patients, and as some of the procedures only lasted a short time the study was not able to directly measure core temperature. Temporal artery temperatures were measured as proxy for core with a device that was adjusted by 2°C as suggested by Sessler (2008) (16).

Conclusion

This study has demonstrated that reflective blankets are significantly more effective than cotton blankets in perioperative temperature management, as evidenced by increased peripheral foot temperatures and significantly decreased core to periphery temperature gradient. Patients using reflective blankets require significantly less additional warmed cotton blankets to feel warm than patients using normal cotton blankets.

Reflective blankets are able to maintain normothermia throughout the preoperative period and reduce the incidence of inadvertent perioperative hypothermia for patients undergoing short elective surgery up to one hour duration.

The study demonstrated that passive warming with reflective blankets is a realistic alternative to active warming in preventing inadvertent perioperative hypothermia and its complications in patients undergoing elective surgery up to one hour.

“ **Reflective blankets** are significantly **more effective** than cotton blankets in perioperative temperature management.



Recommendations

- Reflective blankets to replace warmed cotton blankets for all procedures up to one hour at LBH (approx. 50 % of all cases);
- Reflective blankets to be implemented at Ballina and Casino hospital for all procedures up to one hour;
- Staff in-services and education on 'Perioperative Temperature Management Guidelines';
- Audit compliance with guidelines every twelve months;

Suggestions for further research

To validate the findings of this study, it is suggested to replicate this trial in other institutions. Reflective blankets were shown to produce a clinically significant mean increase in peripheral temperature. It is questioned if this increase in peripheral heat load would also reduce the intraoperative redistribution heat loss in patients undergoing major surgery. Hence it is recommended to research the intraoperative temperature change in these patients in combination with intraoperative active warming.

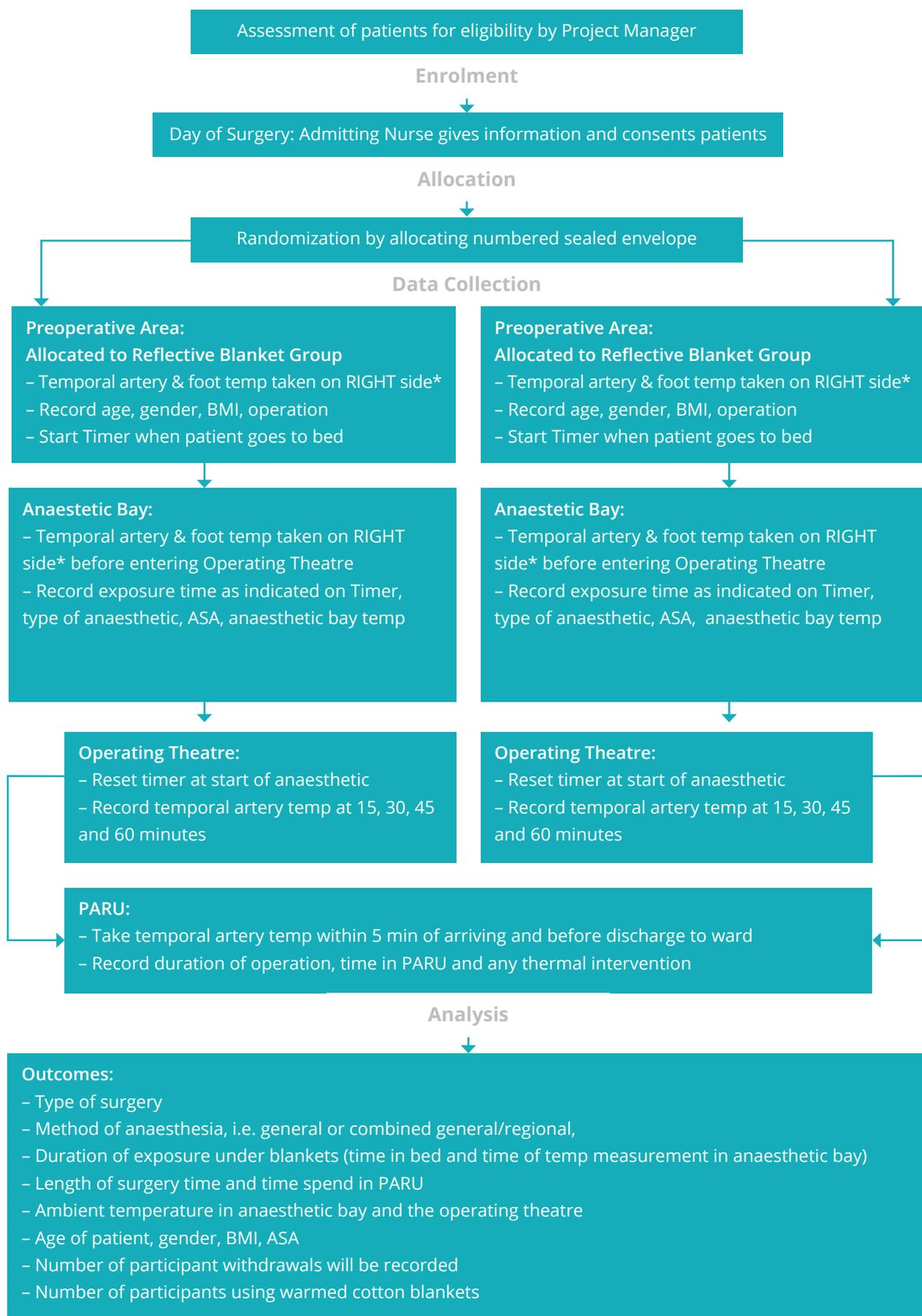
Patient reports of comfort or acceptance of the chosen warming modalities were outside of the scope of this study, but would be of interest for further studies.

References

1. National Institute for Health and Clinical Excellence. Inadvertent perioperative hypothermia: The management of inadvertent perioperative hypothermia in adults. Clinical Guideline 65, April 2008.
2. Mahoney CB, Odom J. Maintaining intraoperative normothermia: a meta-analysis of outcomes with costs. *AANA Journal*. 1999;67(2):155-63.
3. Kurz A, Sessler DI, Lenhardt R. Perioperative normothermia to reduce the incidence of surgical-wound infection and shorten hospitalization. Study of Wound Infection and Temperature Group. *New England Journal of Medicine*. 1996;334(19):1209-15.
4. Scott EM, Buckland R. A systematic review of intraoperative warming to prevent postoperative complications. *AORN Journal*. 2006;83(5):1090-104, 107-13.
5. Vanni SM, Braz JR, Modolo NS, Amorim RB, Rodrigues GR, Jr. Preoperative combined with intraoperative skin-surface warming avoids hypothermia caused by general anesthesia and surgery. *Journal of Clinical Anesthesia*. 2003;15(2):119-25.
6. Hirvonen E, Niskanen M. Thermal suits as an alternative way to keep patients warm preoperatively: a randomised trial. *European Journal of Anaesthesiology*. 2011;28(5):376-81.
7. Wagner D, Byrne M, Kolcaba K. Effects of comfort warming on preoperative patients. *AORN Journal*. 2006;84(3):427-48.
8. Kiekkas P, Karga M. Prewarming: preventing intraoperative hypothermia. *British Journal of Perioperative Nursing*. 2005;15(10):444, 6-7, 9-51.
9. Paulikas CA. Prevention of unplanned perioperative hypothermia. *AORN Journal*. 2008;88(3):358-65; quiz 65-8.
10. Forbes SS, Eskicioglu C, Nathens AB, Fenech DS, Laflamme C, McLean RF, et al. Evidence-based guidelines for prevention of perioperative hypothermia. *Journal of the American College of Surgeons*. 2009;209(4):492-503.e1.
11. Camus Y, Delva E, Sessler DI, Lienhart A. Pre-induction skin-surface warming minimizes intraoperative core hypothermia. *Journal of Clinical Anesthesia*. 1995;7(5):384-8.
12. Bitner J, Hilde L, Hall K, Duvendack T. A team approach to the prevention of unplanned postoperative hypothermia. *AORN Journal*. 2007;85(5):921-3, 5-9.
13. Leeth D, Mamaril M, Oman KS, Krumbach B. Normothermia and patient comfort: a comparative study in an outpatient surgery setting. *Journal of PeriAnesthesia Nursing*. 2010;25(3):146-51.
14. Winslow EH, Cooper SK, Haws DM, Balluck JP, Jones CM, Morse EC, et al. Unplanned perioperative hypothermia and agreement between oral, temporal artery, and bladder temperatures in adult major surgery patients. *Journal of PeriAnesthesia Nursing*. 2012;27(3):165-80.

15. Hindsholm KB, Bredahl C, Herlevsen P, Kruhoffer PK. Reflective blankets used for reduction of heat loss during regional anaesthesia. *British Journal of Anaesthesia*. 1992;68(5):531-3.
16. Sessler DI. Temperature monitoring and perioperative thermoregulation. *Anesthesiology*. 2008;109(2):318-38.
17. Diaz M, Becker DE. Thermoregulation: physiological and clinical considerations during sedation and general anesthesia. *Anesthesia Progress*. 2010;57(1):25-32; quiz 3-4.
18. Horn EP, Bein B, Bohm R, Steinfath M, Sahili N, Hocker J. The effect of short time periods of pre-operative warming in the prevention of peri-operative hypothermia. *Anaesthesia*. 2012;67(6):612-7.
19. Bujdoso PJ. Blanket warming: comfort and safety. *AORN Journal*. 2009;89(4):717-22.
20. Andrzejowski J, Hoyle J, Eapen G, Turnbull D. Effect of prewarming on post-induction core temperature and the incidence of inadvertent perioperative hypothermia in patients undergoing general anaesthesia. *British Journal of Anaesthesia*. 2008;101(5):627-31.
21. Sessler DI, McGuire J, Sessler AM. Perioperative thermal insulation. *Anesthesiology*. 1991;74(5):875-9.
22. Kurz AMD, Sessler DIMD, Narzt EMD, Lenhardt RMD, Lackner FMD. Morphometric Influences on Intraoperative Core Temperature Changes. *Anesthesia & Analgesia*. 1995;80(3):562-7.
23. Maglinger PEBS, Sessler DIMD, Lenhardt RMD. Cutaneous Heat Loss with Three Surgical Drapes, One Impervious to Moisture. *Anesthesia & Analgesia*. 2005;100(3):738-42.
24. Brauer A, Perl T, Uyanik Z, English MJ, Weyland W, Braun U. Perioperative thermal insulation: minimal clinically important differences? *British Journal of Anaesthesia*. 2004;92(6):836-40.
25. Barringer LB, Evans CW, Ingram LL, Tisdale PP, Watson SP, Janken JK. Agreement between temporal artery, oral, and axillary temperature measurements in the perioperative period. *Journal of PeriAnesthesia Nursing*. 2011;26(3):143-50.
26. Pagano M, Gauvreau K. *Principles of Biostatistics*. 2 ed. Belmont, California: Duxbury Press; 1999.

APPENDIX 1: Flow Chart Perioperative Temperature Management



*Unless RIGHT side is operative site or in case of missing limb use LEFT side

APPENDIX 2: *Perioperative Temperature Management Study*



Participant Information Sheet

You are invited to take part in a study on keeping patients warm during surgery. The following information is provided to help you make a decision about whether or not you would like to participate in the study.

This consent form may contain words that you do not understand. Please read the information carefully and ask the study staff to explain anything you do not understand.

Why are we doing the study?

We currently use two different types of blankets to keep patients warm before they go into theatre and during surgery. We would like to know which type of blanket works best.

What is involved?

As operating theatres often have a cool environment we keep patients warm with blankets. At the moment we use two different types of blankets – cotton blankets and reflective blankets. If you agree to participate in the study you will be randomly allocated one type of blanket. During your operation period we will measure different temperatures on your forehead and foot, which will also ensure that you are warm all the time. To take the temperatures we will use a non-touch thermometer. Other information we will collect for the purpose of this study is your age, gender, weight, height and the type and length of your operation. No other information to identify you will be collected. All information collected for the study is confidential and will not be used for any other purpose than the study and your immediate clinical care.

Participation is voluntary

Participation in the study is completely voluntary. If you do not wish to participate, your medical care will not be affected in any way. Also, if you choose not to participate in this study, it will not affect any future involvement that you may have with Northern NSW Local Health District Services.

Consent form

Once you understand what the study is about and if you agree to take part, you will be asked to sign the Consent Form. Signing the Consent Form indicates that you understand the information and that you give your consent to participate in the study.

Inquiries

If you have any questions, please feel free to speak with the Project Officer – Mr Michael Koenen on 0266202580. This Survey has been reviewed and approved by the North Coast NSW Ethics Committee. If you, at any stage have a complaint about the survey you may contact the North Coast NSW Ethics Committee, Research Ethics Officer on:

Research Ethics Officer
North Coast NSW Human Research Ethics Committee
PO Box 821
MURWILLUMBAH NSW 2484
Ph: 0266720269
Email: EthicsNCAHS@ncahs.health.nsw.gov.au

APPENDIX 3: *Informed Consent Perioperative Temperature Management Study*



I _____ (print name)

Have read the information contained in the information sheet. I have also had the opportunity to seek a verbal explanation of the study from the Project Officer and agree to participate in this Perioperative Temperature Management Study.

I understand that:

- Any information that is obtained in connection with this study is confidential
- I am free to withdraw my consent and to discontinue participation at any time without any problems
- I can contact Michael Koenen on 02 6620 2580, at any time if I have any questions to ask or comments to make.
- I understand that agreeing to participate in this study will not affect any relationship I may have in the future with NNSW LHD Services
- I can lodge a complaint about the study by contacting the Research Ethics Officer, North Coast NSW Human Research Ethics Committee, PO Box 821, MURWILLUMBAH NSW 2484, Ph: 02 6672 0269, Email: EthicsNCAHS@ncahs.health.nsw.gov.au
- I have read the information above and agree to participate in this study

Name (please print) _____

Signature _____ Date _____

APPENDIX 4: *Data Collection Form. Perioperative Temperature Study*

Case Number

Intervention: Reflective Blanket

Measurement Side (please circle):

Right Side

Left Side

Gender (please circle):

Male

Female

Patient Data:

Age

BMI

Type of Procedure:

(1) Preoperative Ward:

Admission Patient Temperature

Temporal Artery:

Sole of Foot:

Number of additional
warm cotton blankets used

(2) Anaesthetic Bay:

Room Temperature:

ASA:

Patient Temperature before Induction

Temporal Artery:

Sole of Foot:

Duration of exposure to intervention
(reflective or cotton blanket):

Type of Anaesthetic (please circle): General
General/regional

(3) Operating Theatre:

Room Temperature:

Temporal Artery at:

15 Minutes

30 Minutes

45 minutes

60 minutes

(4) Recovery Room:

Length of time in operation

Temporal Artery on admission to PARU:

Temporal Artery on discharge from PARU:

Time in PARU:

Number of additional
warm cotton blankets used



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Rural Research Capacity Building Program

Health Education and Training Institute: Rural and Remote Portfolio

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