Maintaining intraoperative normothermia: a meta-analysis of outcomes with costs

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Authors' objectives
The review addressed four specific questions:

1. Is the difference in adverse patient outcomes between normothermic and mildly hypothermic patient groups significant across studies and within studies?

2. What is the magnitude of the difference in adverse patients outcomes across studies?

3. What are the costs resulting form the difference in adverse patient outcomes?

4. Does a significant difference exist in effectiveness of modality for maintaining intraoperative normothermia?

Searching
Several search strategies were reported to have been used which included: standard medical on-line searches, the Cochrane Collaboration's optimal MEDLINE search strategy, manual library searches, consultation with medical topic specialist librarian, and appropriate topic journal searches. Reference sections and bibliographies of all retrieved articles and refereed proceedings (from professional organisations in which abstracts undergo blinded peer review) were examined for additional studies. Bibliographies received from well-known research authors in the field of hypothermia were also examined. Only studies published or abstracted in the English language between 1989 and 1997 were included

Study selection
Study designs of evaluations included in the review
Included studies were required to have a control group. Randomised controlled trials (RCTs) and controlled trials were included in the review.

Specific interventions included in the review
Mild intraoperative hypothermia, or a core temperature of 34 to 36 degrees centigrade compared to a maintained normothermia during the intraoperative period. The review did not included cases of extreme hypothermia. The post operative mean temperature for included participants in the hypothermic group ranged from 34 to 35.7 degrees centigrade and 35.3 to 36.7 degrees centigrade in participants in the normothermic group.

Warming modalities for maintaining intraoperative normothermia used by included studies to maintain patient temperature included air blanket, cotton blanket, space blanket, electric blanket, Bair Hugger (Augustine Medical Inc.) with or without a cotton blanket, forced air, circulating water or alcohol blanket, humidified air and passive warming.

Participants included in the review
Patients undergoing surgery. The type of surgery reported included abdominal (including aortic aneurysm repairs), vascular, thoracic, colon resection, maxilofacial, hip arthroplasy, pelvic or femoral osteotomy surgery posterior spinal fusion, hepatic cryosurgery, liver transplantation, lumbar laminectomy, knee arthroplasty and arthroscopic surgery. One study reported using a several hour experiment with no surgery. Where reported, mean age ranged from 14.7 to 74 years and mean duration of surgery ranged from 53 to 1,184 minutes. It was reported that the two patient groups did not differ for any other measure (e.g. age, body surface area, length of anaesthesia) other than temperature change.

Outcomes assessed in the review
Adverse health outcomes. The outcome measures reported by included studies were: the number of units of red blood cells, plasma, and platelets needed for transplantation; coagulotherapy; length of stay; intensive care unit time; rate of infection; incidence of myocardial infarction; probability of needing a transfusion; need for mechanical ventilation; and
mortality.

How were decisions on the relevance of primary studies made?
The authors do not state how the papers were selected for the review, or how many of the reviewers performed the selection.

Assessment of study quality
No systematic assessment of validity was undertaken. However, the authors noted that internal validity was addressed by controlling for differences in pre-existing conditions.

Data extraction
The authors do not state how the data were extracted for the review, or how many of the reviewers performed data extraction. The categories of data extracted for each study included: reference details, sample size, age, randomisation, type of surgery, duration of surgery, the warming device used and post operative temperature. For each adverse health outcome, the difference in rate of occurrence or effect size for each study was estimated.

Methods of synthesis
How were the studies combined?
A random-effects model was used to combine studies and pooled effect sizes were quoted with p-values. For the effectiveness of warming modalities, the difference in lowest temperature (degrees centigrade) expressed as a mean value was used as a measure of effect size. For normothermia vs hypothermia, the incidence of health adverse effects was used for dichotomous outcomes and the mean difference was reported for continuous adverse health outcomes.

How were differences between studies investigated?
No statistical test for heterogeneity was undertaken. However, the authors note that the studies covered a broad spectrum of clinical settings, practitioner training and specialities, patients groups, and geographical areas.

Results of the review
Twenty studies (which including 15 RCTs) with a total of 1,575 patients were included in the review.

Hypothermia vs normothermia:
The results showed that the difference in adverse patient outcomes between the normothermic and mildly hypothermic patients was significant across studies for all outcomes examined (p<0.05). The mean difference (standard deviation (SD)) for continuous adverse health outcomes included: red blood cells (5 studies, 859 patients) = 1.05 units (0.0315); plasma (1 study, 262 patients) = 1.10 units (0.0189); platelets (1 study, 262 patients) = 0.70 units (0.0189); length of stay (3 studies, 762 patients) 7.67 days (0.2059); intensive care unit time (2 studies, 462 patients) = 4.19 hours (0.1561).
The effect size (% (SD)) for the remaining adverse health outcomes included: Infection (2 studies, 258 patients) = 12.12 (3.66); myocardial infarction (2 studies, 562 patients) = 1.77 (0.78); transfused (2 studies, 237 patients) = 9.76 (3.12); ventilation (2 studies, 411 patients) = 6.42 (2.77); mortality (2 studies, 562 patients) = 3.31 (1.47).

Effectiveness of warming modalities:
A significant difference in effectiveness between warming modalities for maintaining intra operative normothermia was found. For all studies combined (1,575 patients), the lowest core temperature reached was, on average, 1.5 degrees centigrade warmer for the forced air group. Forced air warming was more effective than all other methods studies for maintaining intraoperative patient temperature (p<0.05). The alternative methods included passive warming or no treatment (9 studies, 779 patients; difference = 1.24 degrees centigrade), circulating water blanket (1 study, 99 patients; difference = 1.70 degrees centigrade), humidified air (1 study, 36 patients; difference = 0.70 degrees centigrade), space blanket (2 studies, 44 patients; difference = 0.90 degrees centigrade), and methods unspecified, such as warmed operating rooms (7 studies, 648 patients; difference = 1.20 degrees centigrade).
Cost information
Yes. The authors concluded that hypothermia averaging only 1.5 degrees centigrade less than normal resulted in cumulative adverse outcomes adding between $2,500 and $7,000 per surgical patients to hospitalisation costs across a variety of surgical procedures.

Authors' conclusions
Patients whose temperatures have been maintained at normal levels during the intraoperative period experience fewer adverse outcomes, and their overall hospital costs are lower. Intra operative normothermia is maintained more effectively with the use of forced air warming.

CRD commentary
The review included a clearly stated objective and reported some inclusion/exclusion criteria. The on-line databases searched were not specified and the search terms used and the years searched were not reported. It is therefore not possible to assess the completeness of the search strategy. Only studies published in the English language between 1989 and 1997 were included and therefore publication bias cannot be ruled out. Information about the methodology of the review process (such as how decisions on the relevancy of primary studies were made, whether more than one reviewer conducted data extraction and how discrepancies were resolved) were not reported. The quality or validity of the included studies was not systematically assessed. Some relevant details of primary studies were presented in table format, however, the data in one table did not match the findings. Despite acknowledging heterogeneity between studies the authors deemed it appropriate to pool the data using a random-effects method. The 95% confidence intervals of pooled effects were not reported, only the P values.

The authors' conclusions seem to follow from the results, but should be treated with caution owing to the above limitations.

Implications of the review for practice and research
Practice: The authors do not report any implications for practice.

Research: The authors state that further research is required to evaluate the effect of temperature change on the patients in terms of final end points or outcomes such as probability of transfusion, use of blood products, probability of myocardial infarction, and length of hospital stay. They also note that further research that measures patient comfort and satisfaction and their possible significant effect on costs and outcomes is required, as well as more research to provide complete and accurate cost information and to link patients comfort with the cost of outcomes.

Bibliographic details

PubMedID
10488289

Other publications of related interest

Indexing Status
Subject indexing assigned by NLM

MeSH
Cost Savings; Cost-Benefit Analysis; Hospital Costs /statistics & numerical data; Humans; Hypothermia /complications
AccessionNumber
11999005369

Date bibliographic record published
31/03/2001

Date abstract record published
31/03/2001

Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.