Benefits and risks of maintaining normothermia during cardiopulmonary bypass in adult cardiac surgery: a systematic review

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CRD summary
This review concluded that maintaining normothermia during cardiopulmonary bypass surgery in adults was as safe as hypothermic surgery and associated with a reduced risk of allogeneic blood transfusion. The conclusions are likely to be reliable, but the impact of limitations in trial conduct, potential reporting biases and generalisability are difficult to predict.

Authors' objectives
To assess the relative effectiveness of maintaining normothermia compared to hypothermia during cardiopulmonary bypass in adult cardiac surgery.

Searching
MEDLINE, EMBASE and the Cochrane Central Register of Controlled Trials (CENTRAL) were searched without language restriction (to August 2009) using documented search terms. References and relevant websites were searched for additional studies.

Study selection
Eligible randomised controlled trials compared normothermia (systemic perfusion or core temperature above 34°C) with hypothermia (core 34°C or below), as an intra-operative temperature management strategy, during cardiopulmonary bypass in adult cardiac surgery. Studies of selective cooling or that compared temperature targets were excluded. The primary outcome was hospital mortality. Sixteen secondary outcomes were listed.

Thirty-seven of 44 studies only included patients who underwent coronary bypass surgery, remaining patients underwent valve surgery (two studies) or either coronary bypass surgery or valve surgery (five studies). Median time in surgery was 99 minutes. The targeted temperature difference was variable and ranged between 3 and 17°C. Most trials included in the review excluded patients who underwent emergency cardiac surgery and patients with concurrent significant medical diseases.

Two reviewers assessed study eligibility.

Assessment of study quality
Two reviewers assessed study validity; criteria assessed included allocation concealment, randomisation, blinding and inclusion and exclusion criteria.

Two reviewers assessed study validity.

Data extraction
Categorical outcomes were tabulated to allow calculation of relative risks (RR) and associated 95% confidence intervals (CI).

Two reviewers independently extracted data.

Methods of synthesis
Effects were pooled using an unspecified random-effects model. Heterogeneity was quantified using $I^2$. Meta-regression was used to assess the impact of temperature difference and bypass time on mortality. Sensitivity of results to exclusion of the largest trials and trials with unclear allocation concealment was assessed. Funnel plots and trim and fill sensitivity analyses were used to draw inferences about publication bias.

Results of the review
Forty-four randomised controlled trials (6,731 patients) were included. Only ten studies had adequate allocation concealment and only nine were double-blind. Full results were presented for hospital mortality, risk of allogeneic blood transfusion, stroke or focal neurological deficit and cardiovascular outcomes (see manuscript). Hospital mortality was not significantly different after normothermic (1.4%) or hypothermic (1.9%) cardiopulmonary bypass (RR 1.38, 95% CI 0.94 to 2.04). Restricting analysis to studies with a temperature differential 5°C or greater had no substantive impact on this result. Hypothermic bypass was associated with an increased risk of allogeneic red blood cell transfusion (RR 1.19, 95% CI 1.07 to 1.34) although only six publications reported this outcome. Other transfusion and bleeding outcomes also supported normothermic bypass whereas there was no difference for other reported outcomes including risk of stroke (RR 0.81, 95% CI 0.55 to 1.2) or cardiovascular outcomes. There was no evidence of funnel plot asymmetry.

**Cost information**
Total costs of post operative care were reported in one study and were lower in normothermic surgery ($2,660) than hypothermic surgery ($3,320).

**Authors’ conclusions**
Maintaining normothermia during cardiopulmonary bypass surgery in adults was as safe as hypothermic surgery and associated with a reduced risk of allogeneic blood transfusion.

**CRD commentary**
This review utilised appropriate methods to minimise bias in searching for studies and assessing their eligibility and validity. The methods of synthesis were appropriate. The internal validity of trial data resulted in some uncertainty. Trial sample sizes were variable, mortality event rates were low in some trials and few trials measured the risk of allogeneic blood transfusion. The reliability and generalisability of the results was difficult to assess particularly with respect to blood transfusion.

The conclusions reflect the evidence and appear to be reliable with the caveats that the impact of trial quality and reporting biases are unknown and the generalisability of results is unclear, particularly to higher risk populations.

**Implications of the review for practice and research**
**Practice:** The authors did not state any implications for practice.

**Research:** The authors stated that a large randomised study was needed to assess normothermic and hypothermic treatment in adult on-pump cardiac surgery survival rates.

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