The efficacy of an intraoperative cell saver during cardiac surgery: a meta-analysis of randomized trials
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CRD summary
This review concluded that use of intraoperative red blood cell salvage apparatus reduced exposure to allogeneic blood products or red blood cell transfusion for patients undergoing cardiac surgery compared with no cell salvage. There were no significant differences in postoperative complications. Given the poor quality of most included trials, a degree of caution might be required in interpreting these conclusions.

Authors' objectives
To assess the efficacy and safety of intraoperative cell salvage during cardiac surgery.

Searching
The following databases were searched without language restriction from inception to November 2008: MEDLINE, EMBASE, Cochrane Central Register of Controlled Trials (CENTRAL), DARE, NHS EED, Current Contents, and International Network of Agencies for Health Technology Assessment. Search terms were reported. Scientific meeting abstracts and relevant journals were handsearched. Reference lists of relevant publications were also screened.

Study selection
Randomised controlled trials (RCTs) that compared intraoperative cell saver use (blood cell-saving apparatus) with no cell saver use in adult patients undergoing cardiac surgery were eligible for inclusion. Trials in which a cell saver was used only in the postoperative period, or the cell saver blood was re-infused without washing, were excluded. Eligible trials had to report at least one relevant clinical outcome.

The primary outcome was the number of patients requiring any blood product transfusion. Secondary outcomes included: the number of patients requiring red blood cells, fresh frozen plasma or platelets transfusion; the volume of red blood cells, fresh frozen plasma, platelets, and total blood products transfused. Additional secondary outcomes included all-cause mortality, stroke, acute myocardial infarction, atrial fibrillation, renal failure, infections, and re-exploration for bleeding.

The included trials evaluated the following methods of cell saver: cardiotomy suction blood during cardiopulmonary bypass; shed blood; shed and residual cardiopulmonary bypass blood; and residual cardiopulmonary bypass volume. The included patients underwent either conventional coronary artery bypass or off-pump coronary artery bypass. The included trials were published between 1982 and 2008.

Two reviewers independently assessed studies for inclusion, with any disagreement resolved by consensus.

Assessment of study quality
The quality of trials was assessed using the Jadad scale, a 5-point scale evaluating randomisation, blinding, and completeness of the follow-up.

Two reviewers independently performed the validity assessment, with any disagreement resolved by consensus.

Data extraction
For dichotomous outcomes, event rates were extracted to enable the calculation of odds ratios (ORs) with 95% confidence intervals (CIs). For continuous variable, mean and standard deviation were extracted to enable the calculation of mean differences with 95% confidence intervals.

Two reviewers independently performed the data extraction, with any disagreement resolved by consensus.
Methods of synthesis
The trials were combined in a meta-analysis, using a random-effects model. Weighted mean differences (WMDs) and pooled odds ratios, with 95% confidence intervals, were calculated. Statistical heterogeneity was assessed using $I^2$ statistic.

Subgroup analyses were performed using a mixed-effect model. Subgroup analyses were conducted on the type of surgery (on-pump versus off-pump), as well as the method of cell saver used during operation (cardiotomy suction versus shed and/or residual pump blood).

Sensitivity analyses were conducted on trial quality (Jadad score of 3 or less versus Jadad score of more than 3).

Publication bias was visualised using a funnel plot.

Results of the review
Thirty-one RCTs (n=2,282 patients) were included in meta-analyses. The sample size ranged from 16 to 266. The median Jadad score was 2 points (ranging from 1 to 5).

Transfusion outcomes: Compared with no cell saver use during cardiac surgery, use of a cell saver apparatus was associated with a significant reduction in: patient exposure to any allogeneic blood product (OR 0.63, 95% CI 0.43 to 0.94; 14 RCTs); patient exposure to red blood cells (OR 0.60, 95% CI 0.39 to 0.92; 12 RCTs); the volume of total allogeneic blood products transfused per patient (WMD −256mL, 95% CI −416 to −95; six RCTs). Significant heterogeneity was observed in all these outcomes ($I^2>60\%$). There were no significant differences in the number of patients requiring fresh frozen plasma, and the number of patients requiring platelet transfusions between cell saver and no cell saver groups.

Clinical complications: No significant differences were found in hospital mortality, postoperative stroke or transient ischaemia attack, atrial fibrillation, renal dysfunction, infection, or the number of patients requiring reoperation for bleeding between the two groups. There was no significant heterogeneity in these outcomes.

Sensitivity analyses showed that trial quality significantly affected the results (p=0.03); higher quality trials reported more conservative effects in the reduction of patient exposure to red blood cells. There was no evidence of publication bias.

Subgroup analyses assessing the effects of surgery type and different methods of cell saver were also reported.

Authors' conclusions
The intraoperative use of red blood cell saver apparatus reduced exposure to allogeneic blood products and red blood cell transfusion for patients undergoing cardiac surgery, but did not increase the number of patients transfused fresh frozen plasma or platelets. There were no significant differences in postoperative complications between patients using and not using cell salvage.

CRD commentary
The review question and the inclusion criteria were clear. A number of relevant sources were searched. Efforts were made to find both published and unpublished studies without language restriction, minimising the possibility for both publication and language biases. Sufficient attempts were taken to minimise the errors and biases in the review process.

Relevant criteria were used to examine trial quality. Statistical heterogeneity was assessed and the authors presented a possible explanation for the substantial heterogeneity. Appropriate methods were used to pool the results.

This review was generally well conducted. However, given the poor quality of the majority of included trial, a degree of caution might be required in interpreting the authors' conclusions.

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

Research: The authors stated that further well-designed research with long-term follow-up is required to investigate the effect of cell saver on the early postoperative neurocognitive dysfunction in patients undergoing cardiac surgery.

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