Safety, efficacy, and cost of intraoperative cell salvage and autotransfusion after off-pump coronary artery bypass surgery: a randomized trial

Record Status
This is a critical abstract of an economic evaluation that meets the criteria for inclusion on NHS EED. Each abstract contains a brief summary of the methods, the results and conclusions followed by a detailed critical assessment on the reliability of the study and the conclusions drawn.

Health technology
The use of intraoperative cell salvage and autotransfusion of washed salvaged red blood cells after first-time coronary artery bypass grafting (CABG) performed on the beating heart (off-pump coronary artery bypass surgery, OPCAB) was examined.

Type of intervention
Treatment.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised patients aged 18 years or older, who were undergoing non-emergency first-time CABG. The exclusion criteria included patients who are prevented from receiving blood and blood products according to a system of beliefs, and patients receiving preoperative warfarin, heparin, or other systemic anticoagulant drugs. Also excluded were patients with congenital or acquired platelet, red blood cell, or clotting disorders, and patients with ongoing or recurrent systemic sepsis.

Setting
The setting was a hospital. The economic study was carried out in the UK.

Dates to which data relate
The dates to which the effectiveness and resource use data referred were not reported. The price year might have been 2004.

Source of effectiveness data
The effectiveness evidence was derived from a single study.

Link between effectiveness and cost data
The costing was carried out prospectively on the same sample of patients as that used in the effectiveness study.

Study sample
Power calculations were performed in the preliminary phase of the study on the basis of prior studies. The calculations suggested that a sample of 40 patients in total would allow a 90% chance of detecting a standardised difference of more than 1 in laboratory measures of clotting pathway function and haematologic indices with 95% confidence. To allow for
possible dropouts, a total of 30 patients in each arm were recruited. A sample of 61 patients admitted at the authors’ institution was actually enrolled over a 16-month period. There were 30 patients (83% men) in the autotransfusion group and 31 patients (74% men) in the control group. The mean ages in the two groups were 62.3 (+/- 9.3) years (autotransfusion group) and 66.4 (+/- 7.6) years, respectively. It was not stated whether the patients were consecutively identified, or if some patients were excluded from the study sample or refused to participate.

**Study design**
This was a prospective, randomised clinical trial that was carried out at a single institution, the Bristol Heart Institute in Bristol, UK. The patients were assigned to one of the two groups in a 1:1 ratio using block randomisation. Allocations were generated by a card system and were concealed in sealed opaque envelopes. The length of follow-up was not explicitly stated, but the patients appear to have been followed until hospital discharge. No patient was lost to the follow-up assessment. Ten patients in the autotransfusion group had cells salvaged but had insufficient volume to merit processing (< 150 mL); although this blood was discarded, these patients were included in the analysis. No blinding of the outcome assessment was performed.

**Analysis of effectiveness**
The analysis of the clinical study was conducted on an intention to treat basis. The outcome measures used in the analysis were parameters of efficacy and safety, haematologic indices, and measures of coagulation pathway and platelet function. Safety and efficacy parameters included, for example:

- units of intraoperative homologous packed red blood cells, intra-operative platelets and intraoperative clotting products;
- intraoperative volume infused;
- in-hospital deaths;
- ventilation time;
- intensive therapy unit stay;
- high-dependency unit stay;
- rates of cardiovascular events; and
- the proportion of patients requiring transfusions.

Haematologic indices and measures of coagulation pathway and platelet function included, for example:

- haemoglobin,
- haematocrit,
- platelet count,
- prothrombin ratio,
- activated partial thromboplastin time, and
- fibrinogen.

The authors stated that study groups were well balanced at baseline in their demographic and clinical characteristics, apart from a higher frequency of unstable angina symptoms in the autotransfusion group. Chronic obstructive pulmonary disease appears to have been more common in the control group. The authors stated that all analyses were adjusted for baseline readings, and the results were reported with outliers excluded.
Effectiveness results
Patients in the autotransfusion group received a median of 236 mL (interquartile range, IQR: 206 - 342) of autotransfused red blood cells after surgery.

No statistically significant differences were observed in any of the parameters of efficacy and safety. However, there was a trend toward a reduction of exposure to homologous blood products in the autotransfusion group (17% versus 36%; odd ratio 0.36; p=0.095).

The postoperative haemoglobin concentration after 24 hours was significantly higher in the autotransfusion patients, 10.69 (+/- 0.20) g/dL versus 11.71 (+/- 0.21) g/dL (difference -1.02, 95% confidence interval, CI: -1.60 - -0.44; p=0.0007).

At 24 hours, the mean haematocrit level was significantly lower in the control group, 0.319 (+/- 0.006) L/L versus 0.350 (+/- 0.006) L/L (difference -0.031, 95% CI: -0.049 - 0.013; p=0.0008).

Differences in other parameters did not reach statistical significance.

Clinical conclusions
The authors stated that the two interventions led to almost similar outcomes. Only differences in postoperative haemoglobin concentration at 24 hours (higher in the autotransfusion group) and haematocrit levels at 24 hours (higher in the control group) were significantly different. The difference in exposure to homologous blood products although not statistically significant, could be clinically relevant.

Measure of benefits used in the economic analysis
The health outcomes were left disaggregated and no summary benefit measure was used in the economic evaluation. In effect, a cost-consequences analysis was performed.

Direct costs
The perspective adopted in the study was unclear. The health services in the economic analysis were operating room materials, bed occupancy (including nursing costs), transfusion products and the treatment of postoperative complications. Professional fees, preoperative costs, operating room and perfusionist staff costs, and drug costs were excluded. Overhead costs (hospital administration, building and maintenance) were also not considered. A detailed breakdown of the cost items was not reported, and the unit costs were not presented separately from the quantities of resources used. Those patients who were transferred to an intermediate care facility before home discharge were censored at the time of discharge from the cardiothoracic unit. The source of the cost data was not explicitly stated. Resource consumption was derived from the sample of patients included in the effectiveness study. Discounting was not relevant since the costs were incurred during a short timeframe. The period during which resource use was gathered was not reported. The price year was not explicitly reported, but it might have been 2004.

Statistical analysis of costs
The Mann-Whitney test was used to test the statistical significance of differences in the costs. The cost estimates were presented as mean and median values. CIs and IQRs were also reported.

Indirect Costs
The indirect costs were not included in the economic evaluation.

Currency
US dollars ($). The costs were initially assessed using UK pounds sterling () and then converted into US dollars using the exchange rate calculated as of June 2004.
Sensitivity analysis
Sensitivity analyses were not performed.

Estimated benefits used in the economic analysis
See the 'Effectiveness Results' section.

Cost results
The mean operation costs were $996.80 (median 1,030.00; IQR: 933.57 - 1,029.84) in the autotransfusion group and $876.50 (median 873.40; IQR: 873.40 - 873.40) in the control group. The median difference was -$156.40 (95% CI: -156.40 - -137.60; p=0.0001) in favour of the control group.

No statistically significant difference was observed in terms of bed occupancy and nursing costs, complication costs, or transfusion costs.

The mean total costs were $10,100.34 (median 9,244.00; IQR: 7,603.50 - 11,373.43) in the autotransfusion group and $8,938.60 (median 8,423.00; IQR: 6,869.92 - 9,370.18) in the control group. The median difference was -$1,015.9 (95% CI: -2,260.00 - 206.10; p=0.12) in favour of the control group.

Synthesis of costs and benefits
The costs and benefits were not combined because a cost-consequences analysis was performed.

Authors' conclusions
The use of intraoperative cell salvage and autotransfusion in off-pump coronary artery bypass (OPCAB) surgery was associated with modest clinical benefits. It did not increase the risk to patients and did not significantly increase the costs in comparison with homologous blood transfusion.

CRD COMMENTARY - Selection of comparators
The selection of the comparators was clear and was justified by the authors. A detailed description of the two strategies was given. You should decide whether they are valid comparators in your own setting.

Validity of estimate of measure of effectiveness
The effectiveness evidence came from a clinical trial, which was appropriate for the study question. Some details on the method of randomisation and sample selection were provided. It was unclear whether consecutive patients were enrolled. The inclusion and exclusion criteria were reported, and the study sample appears to have been representative of the patient population, although the evidence came from a single centre. As a result of the randomisation procedure, the study groups were quite comparable at baseline. This enhances the robustness of the comparison. Further, the use of intention to treat analysis and power calculations ensures a high internal validity. However, the comparison was not masked, which might have introduced some potential for assessment bias. The impact of the intervention on the patients' health was assessed using intermediate outcome measures. Quality of life issues were not considered in the analysis.

Validity of estimate of measure of benefit
No summary benefit measure was used in the analysis because a cost-consequences analysis was conducted. Please refer to the comments in the 'Validity of estimate of measure of effectiveness' field (above).

Validity of estimate of costs
The perspective adopted in the study was unclear. Only the direct medical costs were included in the analysis, and the authors did not justify the exclusion of some categories of costs. No information on the source of the data and the price year was provided. In addition, the unit costs and quantities of resources used were not reported. This limits the possibility of replicating the analysis in other settings and time periods. Statistical analyses of the costs were undertaken, but the cost estimates were specific to the study setting. The costs were estimated in the UK but were converted into the US currency.

Other issues
The authors reported the results of other studies for the specific outcomes assessed in the current analysis. In general, consistent findings were observed. The issue of the generalisability of the study results was not explicitly addressed and no sensitivity analyses were performed. Thus, the external validity of the study was limited. The authors underlined the importance of a reduction in the overall homologous blood component use associated with autotransfusion. The study referred to patients undergoing OPCAB surgery and this was reflected in the authors' conclusions.

Implications of the study
The study results supported the routine use of intraoperative cell salvage and autotransfusion in OPCAB surgery. The authors stated that the relative cost-effectiveness of intraoperative cell salvage and autotransfusion should be further investigated.

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None stated.

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Other publications of related interest


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MeSH
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