Autologous blood donation in cardiac surgery: reduction of allogeneic blood transfusion and cost-effectiveness

Dietrich W, Thuermel K, Heyde S, Busley R, Berger K

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 authors compared cardiac surgery with and without autologous blood donation (ABD).

Type of intervention
Treatment.

Economic study type
Cost-effectiveness analysis.

Study population
The study population comprised patients undergoing elective cardiac surgery for coronary artery bypass graft (CABG), CABG with aortic or mitral valve replacement (combined procedures), aortic valve replacement (AVR), mitral valve replacement or repair, double valve replacement, closure of atrial septal defects, or other types of operations. Exclusion criteria for ABD included "unwillingness of the patient to pre-donate, the combination of coronary artery disease and severe aortic stenosis defined as mean systolic pressure gradient >80 mmHg or a history of syncope, unstable angina, a preoperative haemoglobin concentration lower than 11 g/dL, acute infection, tooth extraction within the last 3 days, and a time interval less than 5 days before the operation".

Setting
The study setting was tertiary care. The economic study was carried out in Germany.

Dates to which data relate
The effectiveness and resource use data were collected from patients enrolled during 1995 and 2000. The price year was not reported.

Source of effectiveness data
The effectiveness data were derived from a single study.

Link between effectiveness and cost data
The costing was undertaken retrospectively on the same patient sample as that used in the effectiveness study.

Study sample
A total of 4,878 patients were enrolled between 1995 and 2000. Thirteen were excluded because of invalid data series and 540 because they were classified NYHA IV or had a preoperative Cleveland Clinic risk score greater than 11. Therefore, a total of 4,325 patients were included in the study. Of these, 849 (20%) were enrolled in the ABD group.
and 3,476 (80%) in the no ABD group. The ABD group comprised 27% females and the mean age for the group was 59 years (standard deviation, SD=13). The no ABD group comprised 33% females and the mean age for this group was 64 years (SD=12).

**Study design**
This was a retrospective cohort study that was carried out at a single university hospital in Germany. The patient groups appear to have been followed up only throughout the surgical intervention, consequently there was no loss to follow-up.

**Analysis of effectiveness**
All of the patients included in the study were accounted for in the analysis. The primary outcome in the study was perioperative allogeneic blood transfusion. The ABD group was found to be significantly younger than the no ABD group (59 versus 64 years; p<0.05). In addition, the weight of males in the ABD group was significantly higher than that of the no ABD patients (82 versus 79 kg; p<0.05).

**Effectiveness results**
The allogeneic blood transfusion rate was 13% in patients with pre-donation (i.e. the ABD group) versus 48% without pre-donation (i.e. the no ABD group), (p<0.05).

Stratifying by gender, the allogeneic blood transfusion rate was 21% in female patients with pre-donation versus 68% without pre-donation, (p<0.05), and 10% in male patients with pre-donation versus 38% without, (p<0.05).

Patients with pre-donation received a higher total number of any transfusion (autologous and allogeneic) compared with patients without pre-donation (2.38 versus 1.68 units; p<0.05). By gender, this difference was only statistically significant for male patients, where pre-donation patients received a higher total number of transfusions than patients without pre-donation (2.31 versus 1.38 units; p<0.05).

**Clinical conclusions**
The authors concluded that ABD significantly reduced allogeneic blood requirement in cardiac surgery.

**Modelling**
A decision model was developed to estimate the number of ABDs necessary to avoid the transfusion of one unit of allogeneic blood. A decision tree analysis was conducted for the whole population and for CABG and AVR patients, and separately for male and female patients. To avoid selection bias, patients were stratified according to their preoperative risk calculated by the Cleveland Clinic risk score. Patients who were classified as New York Heart Association (NYHA) IV (preoperative cardiovascular state), or who had a Cleveland Clinic risk score greater than 11, were excluded as most of them were not eligible for ABD.

**Measure of benefits used in the economic analysis**
The measure of benefits used was the proportion of patients having allogeneic blood transfusions.

**Direct costs**
The direct costs to the hospital were assessed in the analysis. The analysis included the acquisition costs for allogeneic blood units and laboratory material, and the costs of staff, investments and maintenance. The costs of blood units and material were obtained from hospital price lists, whereas the rest were derived from hospital departments. All costs were incurred during a short period of time, thus discounting was unnecessary and was not performed. The study reported the average costs. The price year was not reported.
Statistical analysis of costs
The costs were treated as point estimates (i.e. the data were deterministic).

Indirect Costs
The indirect costs were not included in the analysis.

Currency
US dollars ($). The exchange rate was not reported.

Sensitivity analysis
The authors conducted sensitivity analyses to evaluate whether plausible changes in the value of the main variables affected the results of the analysis. The authors reported that there was wide variation in the acquisition costs of allogeneic blood and the operating costs for ABD (such as staff costs). Consequently, a range of +/- 20% of the costs for allogeneic and autologous blood was taken to test the robustness of the results.

Estimated benefits used in the economic analysis
The results of the modelling exercise showed the following.

For male patients in the ABD group requiring 1, 2 and 3 units of blood, the proportions of patients receiving allogeneic blood transfusion were 18%, 11% and 8%, respectively. For male patients in the no ABD group, the proportion receiving allogeneic blood transfusion was 38%.

For female patients in the ABD group requiring 1, 2 and 3 units of blood, the proportions of patients receiving allogeneic blood transfusion were 35%, 22% and 13%, respectively. For female patients in the no ABD group, the proportion receiving allogeneic blood transfusion was 68%.

Cost results
The results of the modelling exercise showed the following.

For male patients in the ABD group requiring 1, 2 and 3 units of blood, the mean costs were $170, $191 and $276, respectively. For male patients in the no ABD group, the mean cost was $158.

For female patients in the ABD group requiring 1, 2 and 3 units of blood, the mean costs were $145, $212 and $303, respectively. For male patients in the no ABD group, the mean cost was $244.

Synthesis of costs and benefits
Although autologous blood transfusion was found to be more effective but more costly than non-autologous blood transfusion, the costs and benefits were not combined.

The authors reported that the sensitivity analysis did not alter the results substantially.

Authors’ conclusions
Autologous blood transfusion significantly reduced allogeneic blood requirement in cardiac surgery. If adjusted for diagnosis and gender, it was a cost-effective alternative to reduce allogeneic blood consumption.

CRD COMMENTARY - Selection of comparators
Although no explicit justification was given for the comparator used (i.e. no autologous blood transplantation), it
appears to have represented current practice in the authors' setting. You should decide if the comparator represents current practice in your own setting.

**Validity of estimate of measure of effectiveness**
The analysis was based on a retrospective cohort study which, although appropriate, is prone to bias. A better study design would have been either a prospective cohort study or a randomised controlled trial, which are less prone to biases and are considered the ‘gold’ standard study design. Despite this, patient groups were stratified according to their preoperative risk score in order to avoid selection bias. The study sample appears to have been representative of the study population. However, the patient groups were not shown to be comparable at analysis, with patients in the ABD group being younger and weighing more than those in the non ABD group. Appropriate statistical analyses were undertaken to test whether differences in outcomes were significantly different between the two groups.

**Validity of estimate of measure of benefit**
The estimation of benefits was modelled from effectiveness data from the retrospective cohort study. The model used, a decision tree, appears to have been appropriate.

**Validity of estimate of costs**
All the cost categories relevant to the hospital perspective adopted appear to have been included in the analysis. No major relevant costs appear to have been omitted from the analysis. Although the costs and the quantities were not reported separately, the authors reported the cost structure for one-unit of autologous blood, which will make their results more generalisable to other settings. The costs were derived from the authors’ settings. A limited sensitivity analysis of the costs was performed. The authors did not report the exchange rate used to convert their cost data to US dollars, nor did they report the price year. Such omissions will hamper any possible inflation exercises. Since all costs were incurred during a short time period, discounting was not relevant.

**Other issues**
The authors reported that past studies comparing autologous with non autologous blood transfusion had found that autologous transfusion was not cost-effective. However, the authors reported that with the impact of blood infections and the need to screen for them, as well as the shortage of blood donors, there was increased attention on the development of blood-conservation strategies. The issue of generalisability to other settings was not addressed. The authors do not appear to have presented their results selectively. The authors concluded that ABD could be cost-effective. However, to make such assertions, the authors should have performed an incremental cost-effectiveness analysis and determined a cost-effectiveness value, so as to determine if the extra benefits were worth the extra costs.

The authors reported a number of further limitations to their study. First, the data of the cost calculations were only applicable for the given organisation. Second, the patient groups were not comparable. Finally, the study covered a 5-year period in which medical practice could have changed.

**Implications of the study**
The authors reported that because cardiac surgery remains a high-transfusion area, it offers the ideal conditions for ABD.

**Source of funding**
None stated.

**Bibliographic details**
Other publications of related interest


Brecher ME, Goodnough LT. The rise and fall of preoperative autologous blood donation. Transfusion 2001;41:1459-62.

Indexing Status
Subject indexing assigned by NLM

MeSH
Adult; Aged; Aortic Valve /surgery; Blood Donors; Blood Transfusion, Autologous /economics; Cardiac Surgical Procedures /classification /economics; Coronary Artery Disease /economics /surgery; Cost-Benefit Analysis; Female; Heart Septal Defects, Atrial /economics /surgery; Heart Valve Diseases /economics /surgery; Humans; Male; Middle Aged; Mitral Valve /surgery; Retrospective Studies; Sex Factors; Transplantation, Homologous /economics; Treatment Outcome

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