Using decision-analysis and meta-analysis to predict coronary artery bypass surgical outcomes: a model for comparing off-pump surgery to miniaturized cardiopulmonary bypass circuits

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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.

CRD summary
This study compared the costs and effects for patients undergoing off-pump coronary artery bypass surgery with those for patients undergoing on-pump surgery using high-prime circuits or low-prime circuits with retrograde autologous prime, based on outcomes identified in a meta-analysis. The author concluded that low-prime circuits could make on-pump surgery as effective as off-pump surgery and therefore a better option. There were some limitations to the study so the author's conclusions should be considered with caution.

Type of economic evaluation
Cost-effectiveness analysis

Study objective
This study compared the costs and effects of three alternative coronary artery bypass surgeries. These were on-pump standard high-prime surgery; off-pump surgery; and on-pump surgery using low-prime circuits with retrograde autologous prime.

Interventions
On-pump surgery using high-prime circuits was the standard practice in the general coronary artery bypass population. On-pump surgery using low-prime circuits with retrograde autologous prime was studied because low-prime circuits had been shown to decrease the need for blood transfusions and decrease the length of hospital stay. These two on-pump surgeries were compared with off-pump coronary artery bypass surgery, which was performed while the heart was beating.

Location/setting
USA/primary care.

Methods
Analytical approach:
A decision tree was developed, with three arms for the three surgical alternatives, to calculate the costs and health outcomes associated with coronary artery bypass surgery and to determine the clinical and economic impact of the three surgeries. The model analysed 100,000 patients in each group. The author did not report the perspective.

Effectiveness data:
The effectiveness data were from a review of the literature, in which 49 studies were identified and 14 of these were randomised prospective clinical trials. A meta-analysis was performed with data from 11 of the 14 trials. The key clinical parameters were the transfusion rate, the number of bypass grafts, the length of hospital stay, and freedom from major events, which were myocardial infarction, the need for angioplasty, and the need for reoperation and these were reported at four years.

Monetary benefit and utility valuations:
Not relevant.

Measure of benefit:
The benefit measures were reductions in the transfusion rate; the number of bypass grafts; the length of hospital stay; and the major event rate at four years.

Cost data:
The cost categories were blood transfusion, hospital day-care, myocardial infarction, percutaneous coronary intervention, and reoperation. These costs were from published sources. They were reported in US dollars ($).

Analysis of uncertainty:
Sensitivity analyses were performed on the transfusion rate and the length of hospital stay in the low-prime group, to estimate a best- and worst-case scenario for the costs. A break-even cost per patient was determined for the freedom from major events for high-prime versus off-pump and low-prime versus off-pump surgeries.

Results
The meta-analysis revealed that compared with on-pump, off-pump surgery showed an average reduction of 0.97 days in length of hospital stay and a reduction in the transfusion rate of 63.2%. There were 0.33 more grafts with on-pump than with off-pump surgery, but the on-pump surgeries also showed a reduction in the major event rate at four years of 5% compared with off-pump; on-pump was 90.2% and off-pump was 85%.

The cost saving of low-prime surgery over off-pump surgery was $510 per patient. High-prime cost $467 more than low-prime or $43 less than off-pump surgery.

The sensitivity analysis showed significant differences in the costs per 100,000 patients between the best- ($27,673,000) and worst-case ($79,725,246) scenarios. The break-even cost per patient, was determined to be at 2% freedom from major events for off-pump versus low-prime and 5% for off-pump versus high-prime surgeries.

Authors' conclusions
The author concluded that the development and implementation of on-pump low-prime surgery was an important step in matching the outcomes associated with off-pump surgery. The relative ease of operating on a motionless, non-beating heart, along with matched outcomes, would make on-pump surgery the best option.

CRD commentary
Interventions:
The interventions were well described and relevant in the author's setting; off-pump surgery was compared with on-pump surgery with low retrograde autologous prime or high prime, which was the current practice.

Effectiveness/benefits:
The author undertook a detailed search for the clinical effectiveness estimates for all coronary artery bypass surgeries, but this was limited to one database, which is insufficient for the review to be systematic. Clear inclusion and exclusion criteria were reported and a meta-analysis was performed to produce potentially reliable estimates. The sources were referenced, but few details were reported in the paper and it was not clear if the quality of these studies was assessed.

Costs:
The author did not report the perspective, so it is not clear if the appropriate cost categories were included. The cost data was not adequately reported. The published sources were listed in an appendix, but there were no details on these studies. No details of inflation, discounting, and other cost adjustment techniques were given and the price year was not reported.

Analysis and results:
The analytic approach was satisfactorily reported, but the time horizon was unclear. The major event rate was reported at four years, which indicates that the time horizon must have been at least four years, but this was not explicitly stated. The analysis did not include mortality as a major event because the source study did not define the cause of death. This was questionable given the type of intervention. The results were reported clearly and in full. The issue of uncertainty was addressed for two model parameters creating best- and worst-case scenarios, but no probabilistic sensitivity analysis was performed. The author did not acknowledge any limitations of the analysis.
Concluding remarks:
There were some limitations to the study and the author's conclusions should be considered with caution.

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