

The Impact of Hybrid Coronary Revascularization on Hospital Costs and Reimbursements

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Background. Hybrid coronary revascularization (HCR) combines a minimally invasive, left internal mammary artery-left anterior descending coronary artery (LAD) bypass with percutaneous intervention of non-LAD vessels for patients with multivessel coronary disease. The financial implications of HCR have not been compared with off-pump coronary artery bypass (OPCAB) through sternotomy.

Methods. The contribution margin is a fiduciary calculation (best hospital payment estimate – total variable costs) used by hospitals to determine fiscal viability of services. From 2010 to 2011, 26 Medicare patients underwent HCR at a single United States institution and were compared with 28 randomly selected, contemporaneous Medicare patients undergoing multivessel OPCAB. All HCR patients underwent a robotic-assisted, sternal-sparing, off-pump, left internal mammary artery-LAD anastomosis plus percutaneous intervention to non-LAD vessels. A linear regression model was used to compare fiscal and utilization outcomes of HCR to OPCAB adjusted for hospital length of stay and The Society of Thoracic Surgeons Predicted Risk of Mortality score.

Results. On regression analysis controlling for overall length of stay and Predicted Risk of Mortality score, the contribution margin (+\$8,771, $p < 0.0001$) was greater for HCR than for OPCAB. Despite higher total cost for HCR compared with OPCAB (+\$7,026, $p = 0.001$), the total variable cost (+\$2,281, $p = 0.07$) was not significantly different. Best payment estimates (+11,031, $p < 0.0001$) and Medicare reimbursements (+\$8,992, $p = 0.002$) were higher for HCR than for OPCAB, and there was a reduction in blood transfusion (–1.5 units, $p < 0.0001$), ventilator time (–10 hours, $p = 0.001$), and postoperative length of stay (–1.2 days, $p = 0.002$) for the HCR group.

Conclusions. Compared with OPCAB, HCR results in a greater contribution margin for hospitals. This may result from higher reimbursement as well as improved resource utilization postoperatively, which may offset more expensive procedural costs associated with HCR.

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As the cost of health care continues to rise, more attention is being directed to the cost of new technology and innovative procedures. The increased cost of novel medical technology and therapeutics must be balanced against the potential value that these new treatment approaches bring to health care delivery [1]. These increased procedural costs may be considered valuable if complications, resource utilization, improved quality of life, and quicker return to employment are favorable.

With hybrid coronary revascularization (HCR), a minimally invasive left internal mammary artery

(LIMA)-to-left anterior descending coronary artery (LAD) bypass is combined with percutaneous coronary intervention (PCI) and stenting to non-LAD vessels for the treatment of selected patients with multivessel coronary artery disease. HCR offers the potential advantage of a less invasive procedure with the best available treatment for LAD disease, the LIMA [2, 3], with comparable treatment options for non-LAD disease, using drug-eluting stents instead of saphenous vein grafts [4]. Although the safety and efficacy of this approach has been documented in numerous reports [5–8], only a few reports have addressed the cost of HCR or nonsternotomy coronary artery bypass grafting (CABG) [9–12].

In this study, detailed financial data were collected that reflected all cost categories associated with HCR procedures and off-pump coronary artery bypass (OPCAB).

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This included variable costs such as resource utilization metrics as well as disposable robotic instruments and drug-eluting stents. Also captured were fixed costs such as overhead and the cost of acquiring and maintaining the da Vinci robotic system (Intuitive Surgical, Sunnyvale, CA). The collection of these data in addition to best payment estimates and Medicare payments enabled calculation of the contribution margin and net profit. Therefore, the purpose of this study was to compare financial data, both cost and revenue, as well as clinical outcomes directly related to cost, for patients undergoing HCR and OPCAB.

Material and Methods

Hybrid coronary revascularization procedures were defined as those in which a minimally invasive, sternal-sparing off-pump LIMA-LAD bypass was planned in combination with PCI to at least one major non-LAD coronary artery for patients with multivessel coronary artery disease. Patients were considered eligible for HCR if they had LAD targets that were amenable to minimally invasive LIMA-LAD grafting and non-LAD lesions that were amenable to PCI. From 2010 to 2011, 102 HCR cases were performed at Emory University by 2 surgeons. Of these, 28 HCR cases were identified that met the following criteria: (1) patients aged 65 years or older who had Medicare Part A insurance, (2) the surgical and interventional portions of the procedure were performed during the same hospitalization, (3) urgent or elective indications for revascularization, and (4) patients underwent the treatment they were intended to receive. We compared these HCR patients with 28 contemporaneous, randomly selected Medicare patients undergoing isolated multivessel OPCAB that were performed by the same 2 surgeons performing minimally invasive CABG.

Patients who were converted from OPCAB to on-pump CABG were excluded, as were all patients undergoing emergency or salvage CABG. Furthermore, to ensure an adequate comparison, patients with major adverse events, such as in-hospital death, myocardial infarction, stroke, or mediastinal reexploration, were excluded from cost analysis. These criteria did not exclude any eligible HCR patients. After retrospective review, 2 HCR patients were excluded because of incomplete financial data and mixed insurance coverage. Thus, there were 26 HCR patients and 28 OPCAB patients.

All patients in both groups had insurance coverage provided by Medicare Part A, which was chosen to ensure comparable hospital reimbursements by a single provider to enable accurate comparisons of costs and reimbursements between treatment groups. This study was conducted in accordance the Health Insurance Portability and Accountability Act. The Institutional Review Board approved the study and waived the need for individual patient consent.

Cost Analysis and Clinical Outcomes

Patient financial data were abstracted from the Emory institutional financial reporting system, using the Product

Line Analyst Reporting tool. Within each individual patient financial record, each detailed charge was then broken down into charge and cost categories. Each item is assigned cost into as many as four cost categories, including direct variable, direct fixed, indirect variable, and indirect fixed. Within the methodology of the Emory financial reporting system, costs are first divided into direct and indirect costs. Direct costs are those costs that generate revenue, and indirect costs are overhead and do not generate revenue. Costs are then broken down into variable or fixed. Variable costs are those that occur or fluctuate because of that specific usage, whereas fixed costs are those that remain stable regardless of usage.

Disposables, such as robotic instruments, coronary stabilizers, and positioners, are examples of variable costs. The cost of the da Vinci robotic SI system, estimated at \$1.5 million, along with a maintenance fee of approximately \$200,000, is an example of fixed indirect costs, which were included in this analysis. These costs are amortized across the entire annual operating room budget. Indirect cost items must be allocated over the direct cost items that do produce revenue. The hospital administration uses an overhead cost allocation method to allocate these costs to the direct cost items. Included within the indirect costs is depreciation expense for all associated capital outlays, including those from the da Vinci robot used during all HCR procedures in this study. Therefore, in this study, the cost of the purchase as well as maintenance of the robotic system was included in this cost analysis.

The contribution margin is a fiduciary calculation (best hospital payment estimate – total variable costs) used by hospitals to determine fiscal viability of services. Contribution margins allow hospitals to review the fiscal feasibility of services without accounting for additional fixed overhead cost allocations. To account for these costs, net profit (best hospital payment estimate – total costs) allows hospitals to account for the total impact, including fixed overhead costs.

Although the relatively small sample size of this study precludes most comparisons of clinical outcomes, specific utilization measures were collected to account for possible cost differences: intensive care length of stay, hospital preoperative and postoperative length of stay, incidence of blood transfusion, ventilation time, and operative time.

Surgical and PCI Technique

All HCR patients underwent a robotic-assisted, sternal-sparing, off-pump, manual LIMA-LAD through a 3-cm to 4-cm minithoracotomy anastomosis, and PCI to non-LAD vessels. OPCAB is performed using several commercially available coronary stabilization devices and cardiac positioners. PCI was performed before or after, or concomitant with robotic-assisted CABG. Drug-eluting stents were used in all patients.

Statistical Analysis

Financial data on each patient were merged with data acquired from The Society of Thoracic Surgeons (STS)

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