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COST-EFFECTIVENESS ANALYSIS OF TAVR

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Abstract

Transcather aortic valve replacement (TAVR) has rapidly gained worldwide acceptance for treating very high-risk patients with symptomatic severe aortic stenosis. Two valve systems are currently in common use worldwide and under trial in the United States. The Edwards SAPIEN valve has completed its PARTNER trial and has been approved for use in nonoperative patients. The Medtronic CoreValve is currently completing its US pivotal trial. Both plan studies of intermediate-risk patients. The use of TAVR in Europe has grown rapidly and is now about 23% of the total aortic valve replacements done in which a tissue valve is chosen (generally patients over 60 to 65 years of age). This technology is used in a patient population that was either not receiving any surgical therapy due to extreme risk or was considered very high risk for conventional surgery. The procedure requires a highly trained TAVR team, advanced imaging, and the devices themselves, which are expensive. Medical device trials are generally designed to establish if the device works as planned. For TAVR in today's world of rising health care costs, the additional question of cost effectiveness is important to address. Fortunately, the PARTNER trial addressed this and the CoreValve trial has built this into the trial design as well. This article examines what is currently known about the cost-effectiveness of TAVR.

Introduction

Cardiac valve disease is the basis for about a third of cardiac surgical procedures and is associated with substantial mortality and morbidity. As our population ages, it can be expected that cardiac valve disease will increase in parallel. More and more, clinicians are seeing patients with symptomatic severe aortic stenosis who are very advanced in age and have severe comorbidities or significant frailty, making operative intervention either impossible or very high risk in the eyes of the referring physician and/or cardiac surgeon. Transcatheter aortic valve replacement (TAVR) has recently emerged as a possible solution for this patient population. The rising cost of health care has stimulated increased interest in the cost-effectiveness of new treatments such as TAVR. Most published studies on TAVR to date have focused on feasibility and effectiveness without much attention focused on cost. Only one randomized clinical trial (RCT) has been completed and published thus far, and that is the PARTNER trial.[1, 2] A second RCT, the CoreValve US Pivotal Trial, is enrolling. Both of these trials captured economic and quality of life data that will make cost-effectiveness analysis of TAVR possible. The ideal time to evaluate the cost-effectiveness of a new therapy is during the initial RCTs used to evaluate effectiveness. Although this is rarely done, with TAVR, the PARTNER Trial and CoreValve US Pivotal trial are designed to allow this. The purpose of this manuscript is to discuss the cost-effectiveness of TAVR based on information gleaned from these trials to date.

Analyzing Cost Through Quality Adjusted Life Years

Most clinicians are used to looking at a new therapy and asking if it will make their patient live longer and/or live better. Cost-effectiveness analysis adds cost to this decision. The most commonly used metric is "quality-adjusted life years" (QALY), a composite of the extra years of life gained with a treatment and the quality of that life as measured by a utility.[3] The utility is a scale of 0 to 1, where 0 is no different than death and 1 is perfect health. This utility number is then multiplied by the additional survival to obtain QALY. The utility score is generally an empiric measurement extracted from patient interviews or quality of life questions. Although QALY is the most commonly used metric to compare cost-effectiveness, clinicians recognize that utility scores are subjective and may not always match the wishes of individual patients. Noting these limitations, we will use QALY as our yardstick to ask if TAVR is reasonable from a cost-effectiveness standpoint.

A number of effectiveness studies and registries exist in Europe and Canada, where TAVR is already in commercial use. These are all observational studies with no RCT. Cost data are not consistently available and common definitions for complications are not often used in early studies, making inter-study comparisons difficult. These studies have generally been interpreted to show efficacy of the therapy but cannot address cost effectiveness. The Health Technology Inquiry Service of the Canadian Agency for Drugs and Technologies in Health published a study called Percutaneous Heart Valves for Valvular Heart Disease: An Updated Review of the Clinical and Cost-Effectiveness and Guidelines on April 30, 2010. This study examined the English and French literature on TAVR and asked three research questions:

Procedure	QALY
TAVR (PARTNER Cohort B)	$61,889
AVR (octogenerians)	$27,182
CAB (BARI data)	$14,294
Stenting (BARI data)	$15,179
Heart Transplantation	$38,000
Lung transplantation	$77,000
Liver transplantation	$26,000
LVAD	$78,000
Driver side air bag	$24,000

Table 1. A comparison of QALY costs for TAVR to other generally accepted procedures.

1. What is the clinical effectiveness of percutaneous heart valves for the treatment of patients with valvular heart disease?
2. What is the cost-effectiveness of percutaneous heart valves for treatment of patients with valvular heart disease?
3. What are the guidelines for the use of percutaneous heart valves for patients with valvular heart disease?

At the time of this publication, the PARTNER Trial had not been published and the authors noted that the lack of RCT and baseline differences made interpretation difficult. They summarized that "no conclusion about the cost-effectiveness and guidelines for percutaneous heart valves could be made from the identified literature." This is in contrast to studies showing the cost-effectiveness of surgical aortic valve replacement (AVR) in the elderly population. Long-term survival and quality of life following cardiac surgery in the elderly has been shown to be good.[4] Surgical AVR in the elderly has also been examined and found to yield a cost of $13,528 per QALY gained.[5]

Fortunately in the only RCTs — the recently published PARTNER Trial and the currently enrolling CoreValve US Pivotal trial — both collected extensive cost and quality of life data. Adding economic data to these already complex clinical trials is costly. The funds for these research trials, like funds for health care in general, are limited and the sponsors are to be applauded for their inclusion. This is especially true since the aim of the sponsor is generally to get their device approved; economic data does not aid this approval and could conceivably produce data that is harmful to device acceptance. Both trials have similar designs, with each having two arms: an extreme-risk or non-operative arm, and a high-risk arm in which patients could undergo open AVR but at high risk. The cost-effectiveness data for the nonoperative arm of the PARTNER Trial, known as Cohort B, was presented at the American College of Cardiology meeting in New Orleans in 2011 by Matthew Reynolds on behalf of the PARTNER investigators.[6] The PARTNER Cohort B compared TAVR to best medical therapy and had a 20% absolute survival difference in favor of TAVR at 1 year. Reynolds established a primary endpoint of incremental cost-effectiveness based on survival, quality of life, medical resources used, and billing data. His secondary endpoint was QALY based on survival, quality adjusted survival, and costs beyond 1 year. He used $30,000 as an estimate for the cost of the valve itself and an initial TAVR procedure cost of $78,563. Data was available for the first year of the trial, and EQ-5D™ utilities (a standardized measure of health status) were measured at baseline, 1, 6, and 12 months. This was combined with a parametric survival model fitted to trial data to extrapolate patient survival beyond the current follow-up period to determine QALY. Costs during the last 6 months in [6]3% was applied to all future costs, life years, and QALY, which is consistent with guidelines. TAVR in 175 patients was available for analysis. Of those patients, 164 (93.7%) received one device, 10 (5.7%) received two devices, and 1 (0.6%) received three devices. This resulted in a procedure cost of $42,806 +/- $15,206. There was $30,756 for nonprocedural costs and $4,978 for physician fees to account for the total cost of $78,563. Increased post-procedure hospitalizations led to a first-year cost of $52,724 in the control group compared to a first-year post-procedure cost of $29,352 in the TAVR group. The final assessment finds the cost of QALY for TAVR in the PARTNER trial Cohort B nonsurgical arm to be $61,889. This cost-effectiveness analysis cannot be extended beyond the nonsurgical Cohort B arm of the trial. The 1-year survival in the high-risk surgical arm (Cohort A) was not significantly different between patients receiving TAVR and those receiving standard open AVR. Hopefully an economic analysis of Cohort A will be published in the near future.

Grades for Adoption	
A	Compelling evidence for adoption and appropriate utilization. The new technology is as effective as or more effective than the existing one and is less costly
B	Strong evidence for adoption and appropriate utilization a) The new technology is more effective than the existing one and costs less than $20,000 per QALY gained b) The new technology is less effective than the existing one, bit its introduction would save more than $100,000 gained
C	Moderate evidence for adoption and appropriate utilization a) The new technology is more effective than the existing one and costs $20,000 to $100,000 per QALY gained b) The new technology is less effective than the existing one but its introduction would save $20,000 to $100,000 per QALY gained
D	Weal evidence for adoption and appropriate utilization a) The new technology is more effective than the existing one but costs more than $100,000 per QALY gained b) The new technology is less effective than the existing one but its introduction would save less than $20,000 per QALY gained
E	Compelling evidence for rejection The new technology is less effective than or as effective and as the existing one and is more costly

Table 2. Grades for adoption of new technology. Adopted from Laupacis[10]

Comparative Cost of TAVR vs. Standard Procedures

Is a cost of $61,889 for QALY for TAVR reasonable? This is a complex question, and the answer may differ according to the point of view of the questioner. Clinicians care for one patient at a time, and everything that occurs to that individual patient is a 100% occurrence. The goal of the physician is to aid that individual in achieving better survival and better health. Untreated symptomatic severe aortic stenosis is associated with a mortality of about 2% per month in this patient cohort and continued decreased quality of life during survival due to continued symptoms that are often severe and limiting. Almost any cost would appear worthwhile if treatment was successful at reasonable risk. For health care planners, this question is generally aimed at population health versus individual health. It can be helpful to compare QALY costs for TAVR to other generally accepted procedures. Standard AVR in octogenarians who are already candidates for open surgery has a QALY cost of $27,182.[5] Coronary artery bypass from the BARI study has a QALY cost of $14,292 and stenting a QALY cost of $15,179.[7] Heart transplantation yields a QALY cost of $38,000, lung transplantation a QALY cost of $77,000, and liver transplantation a QALY cost of $26,000.[8] Left ventricular assist devices have a QALY cost of $78,000.[9] Even driver-side air bags in cars have a QALY cost of $24,000 and extend to over $66,000 if a passenger-side airbag is included.[10] This would appear to place TAVR well within the financial cost structure that society already accepts (Table 1).

The actual acceptance of TAVR or any other new technology is a complex combination of therapy effectiveness, economics, politics, and ethics. Planners within the Canadian system have attempted to quantitate the economics of acceptance of new technology.[11] They graded new technology into five grades based on cost and effectiveness. Grade A technology is as or more effective than older technology and costs less — a compelling reason to accept this technology. Grade E technology is less effective than old technology and costs as much or more — clearly reason to reject the new technology. Grades B, C, and D are broadly defined by increased cost of the new technology being less than $20,000 in grade B, $20,000 to $100,000 in grade C, and more than $100,000 in grade D (Table 2). Grade B technologies are routinely accepted by society as a good use of healthcare resources; coronary artery bypass is a good example of a grade B technology.[12] Grade C technologies are also generally accepted by society as reasonable, with a good example being hemodialysis for renal failure. Grade D technologies can be more difficult to assess and in countries such as Great Britain can exceed what is considered reasonable, which is generally £30,000 ($47,452 US).[9] This is further complicated by the fact that new procedures in surgery and interventional cardiology are often adopted based on their ease of use rather than efficacy, and TAVR is a complex procedure with a substantial learning curve.

Further data on the cost-effectiveness of TAVR should be forthcoming after analysis of the PARTNER Cohort A study and the CoreValve US Pivotal Trial. Given the high level of acceptance in Europe, where the TAVR valves are already commercially available, there is a high likelihood of acceptance in the United States if efficacy data from the two US randomized controlled trials is positive.

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