Placing a Value on New Technologies

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In this issue of *Circulation*, two studies examine the value (cost-effectiveness) of two rapidly changing technologies: ventricular assist devices (VADs) as a bridge to transplant for patients with heart failure, and left atrial appendage (LAA) occlusion as an alternative to anticoagulation for atrial fibrillation. Both heart failure and atrial fibrillation impose an important economic and health burden on western societies that is only going to worsen as their populations age. In addition, the high cost of treating these conditions in the United States (US) is increasingly paid by Medicare resulting in greater taxes and premiums for all.

Heart failure is already the most common reason for hospitalization in the US Medicare program and its prevalence in the US is estimated to grow by 43% to 8 million people by 2030\(^1\). The cost of this care, due solely to the aging of the US population is expected to increase from 30 to 70 billion during the next 20 years. As the number of patients with heart failure grows so will the number of those with end-stage heart failure. Given that the rate of cardiac transplantation has not increased\(^2\) many patients, providers, and payers will consider the use of ventricular assist devices (VADs) as a potential therapy for those not responding to other therapies. Older generation VADs were shown to improve survival in patients with severe heart failure (REMATCH)\(^3\). More recently continuous flow devices have been found to provide even better outcome and have been used routinely for several years\(^4\). Unfortunately the devices are expensive with an acquisition cost near $150,000\(^5\). The use of VADs for both destination therapy and as a bridge to transplant has increased resulting in estimated VAD costs in the US climbing from $143 million to $479 million in 2009\(^6\).

Atrial fibrillation is the most common arrhythmia requiring treatment and is projected to affect 15.9 million Americans by 2050 if the growing age-adjusted rate continues\(^7\). While anticoagulation with warfarin or newer agents has decreased the incidence of stroke, it has also
raised the risk of bleeding. Since left atrial thrombi often originate in the LAA, there is interest in occluding the appendage as a way of avoiding anticoagulation. The PROTECT AF study was a randomized trial that found LAA occlusion to be non-inferior to warfarin for the combined endpoint of cardiovascular death, stroke and system embolism\(^8\). The cost of implanting the LAA occlusive device has been estimated to be near $13,000\(^9\).

Given the high cost of VADs and appendage occlusion devices relative to medical therapy it is important to determine the value (benefit per cost) as they are currently used. The most rigorous method for evaluating value of medical care is a formal cost-effectiveness analysis. These analyses can be done as either part of a clinical trial where both cost and outcome are determined during the course of the trial, or through modeling when relevant data are available from prior work.

Both of the cost-effectiveness studies in this issue used models that suggest the increased benefit of a device (VAD or LAA occlusion) is worth the cost. Alba and colleagues found that over a 20 year time horizon, using a VAD as a bridge to transplant, increases life expectancy by 1.19 years in high risk patients at a cost of $100,841 resulting in a cost-effectiveness ratio near $85,000 / life-year gained compared to not using a VAD as a bridge\(^10\). VADs in lower risk patients had worse value with a cost-effectiveness ratio near $120,000 / life-year gained. In the model by Singh and others, \(^9\)LAA occlusion was estimated to increase life-time survival compared to warfarin by 0.13 years (due in part to less bleeding) at a cost near $42,000 per quality adjusted life year (QALY) gained. While life-years are easier to measure, adjustment for quality of life is important if the disease or the treatment has a significant impact on health status.

As with clinical trials, when evaluating economic modeling studies it is often helpful to compare results and assumptions to prior similar studies. Initial cost-effectiveness analyses of
pulsatile VADs using data from the REMATCH trial found them to be a poor value costing more than $800,000 per QALY when used as destination therapy. The newer continuous flow devices have better outcomes and better value with an estimated cost of $200,000 per QALY gained (170,000 per life-year gained) as destination therapy compared to medical therapy. Reviews of prior studies of VADs used as a bridge to transplant estimated their cost-effectiveness to range from $50,000 to over $130,000 per life-year gained. However, the quality of many of these studies was considered poor.

There is less economic data on LAA occlusion devices though previous studies have compared the cost-effectiveness of anticoagulants with warfarin. One recent study found that when compared with warfarin dabigatran cost approximately $51,000 per QALY if used at low doses and $45,000 per QALY if used at high doses.

Most cost-effectiveness analyses are aimed at policy makers and it is unclear how clinicians should use the results of these studies. While clinicians have a duty to provide effective care to all patients they are treating, one can argue that this duty extends to their future patients as well. Given a limited health care budget these patients (present and future) will likely want their providers to be thoughtful stewards of medical resources.

Clinical decisions are often informed by practice guidelines which synthesize the available evidence of benefit. Until recently clinical practice guidelines rarely incorporated cost into their recommendations. Similarly, legislation often has not allowed the consideration of cost in coverage decisions requiring that a new technology be covered if it is “reasonable and necessary." However, the American College of Cardiology and American Heart Association are increasingly considering cost and value in their guidelines, appropriate use criteria and performance measures. It will be an important service to providers and policy makers if future
clinical guidelines summarize data on strength of evidence for both benefit and value (benefit per cost).

However, in order to determine value one must declare a threshold that indicates a good or poor value. While there is no simple method to do this, one can use an expensive but widely accepted technology (such as dialysis) as a benchmark. If other technologies cost less (per life-year gained) than this benchmark then the technology is considered an acceptable value.

Traditionally the cost-effectiveness of dialysis has been in the 50,000-80,000/QALY range\textsuperscript{17} though a recent evaluation suggested this ratio may now be as high $125,000 / QALY\textsuperscript{18}.

The willingness of a society to pay for a therapy will obviously depend on the society’s wealth. The World Health Organization has suggested that an intervention that has a $/QALY below gross domestic product (GDP) per capita ($48,000 for the US) is a good value (highly cost-effective) while one that costs 3 times GDP ($150,000 in the US) is a poor value (no cost-effective)\textsuperscript{19}. The two studies in this issue were from Canada with a GDP per capita similar to the United States. While high compared to many non-western countries, their GDP per capita is less than Switzerland at $83,000 or Monaco at $171,000. The United Kingdom ($39,000 GDP per capita) has set a £30,000 per QALY as a threshold of good value. Using the current exchange rate and a similar ratio per GDP per capita gives a corresponding US threshold for value of $60,000/QALY.

If one accepts the results reported by the authors in this issue of Circulation one would conclude that a bridge to transplant is likely in the cost-effective range (1-3 GDP per capita, or similar to the cost of dialysis) while the LAA occluder would be considered highly cost-effective (less than GDP/capita and the cost of dialysis). However, there are uncertainties in both study’s model results that should make one cautious in interpretation.
Medical care of advanced heart failure has improved since the time of the REMATCH study comparing pulsatile VAD to medical therapy. More use of chronic resynchronization therapy (CRT) and aldosterone antagonists, in addition to more beta-blocker use likely improved “usual care”. Without a new randomized trial it may be difficult to know how much benefit a VAD offers over current medical/CRT therapy. In addition, the VAD model in this issue used 20 years as the baseline time-horizon but the model estimated that between 35% and 50% of patients will still be alive at this time. If their survival projections are correct they are underestimating the benefits of VADs. However, their survival estimates may be optimistic given that they project a 40 year survival of 20% for 55 year old patients being considered for transplant.

The modeling of outcome is also important for the LAA occlusion analysis. The authors estimate a survival benefit with LAA occlusion despite the main clinical trials showing non-inferiority (as opposed to superiority). This uncertainty is reflected in the probabilistic sensitivity analysis each study conducted where the different assumptions are varied simultaneously. For VADs, 10% of simulations were over $300,000/life year gained. For LAA occlusion there was still a < 50% chance that this therapy was the cost-effective choice compared to warfarin and dabigatran. For VADs there was substantial uncertainty in the cost and outcome while for the LAA occlusion it was primarily the benefit that was uncertain. Despite the uncertainty, these studies are important for showing where the uncertainty lies and where more data are needed before clinical guidelines can recommend for or against a treatment based on value.

When determining whether a health system should pay the cost of any particular care strategy, both value and the impact on the budget must be examined. Even if the treatment is cost-effective, can we absorb this cost with our current health care budgets? In the case of bridge
to transplant the total number of potential VADs per year is small. There were 1949 heart transplants in 2011, and VADs were used in 35% of patients prior to transplant, a number that was unchanged from 2010, though up from 20% from 2006. The wait list at the start of 2011 was 2867, thus even if VADs were used in all patients on the waiting list the overall financial burden would not be large. In contrast, the potential population for the LAA occlusion device is several million patients, so even though the cost of the device is substantially less than the VAD cost, the budget impact could be far greater.

Perhaps the greatest uncertainty is the rapidly changing technology. Newer generations of VADs and LAA occlusion devices are in development and their impact on future cost and outcome is unclear. Cost, complications, and benefit are also likely to change as experience grows. Thus, while a VAD as a bridge to transplant and an LAA occluder for atrial fibrillation may ultimately prove to be a good value, policy makers, guideline writers and clinicians should wait for more definitive data before changing payment, recommendations or treatment decisions.

**Conflict of Interest Disclosures:** None.

**References:**


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