Model-based economic evaluation for medical decision making: learn from the past and prepare for the future

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In July 2012 issue of *Annals of Cardiothoracic Surgery*, Gada and colleagues (1) presented an economic evaluation for transapical aortic valve implantation (TAVI) in high risk patients with aortic stenosis. A Markov model was developed to compare mortality, costs and quality-adjusted life years (QALYs) of TAVI with aortic valve replacement (AVR) and medical management from a payer's perspective over a life time horizon. In the reference case, the incremental cost effectiveness ratios (ICERs) were $44,384/QALY for TAVI and $42,637/QALY for AVR when compared with the medical management, while TAVI was dominated by AVR (i.e. TAVI gained fewer QALYs at higher costs). The ICERs were sensitive to post-surgery mortality, health utilities, and the cost of TAVI.

Economic modeling is one of the important approaches in evaluating cost effectiveness of health care programs (2). It synthesizes existing knowledge and evidence on different treatment strategies through a validated model and then predicts how cost effective of one treatment versus another using ICER (2). Model-based economic evaluations are often used especially when long term evidence is important but not available. They have been recognized as an important tool used to inform decision and policy making in many countries.

Randomized trials, if available, are usually used as a source of clinical evidence with high quality for economic evaluations. Despite the ongoing debate on strengths and limitations of these different study designs, one highlight from this economic evaluation is that registry data were specifically chosen to input the model. It offers an opportunity to examine the performance of TAVI in real clinical practice.

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Parameters in economic models come from a variety of sources. Uncertainty is thus an inevitable issue in economic models. The results from base-case or reference-case analysis are often not sufficient to present a full picture on the performance of treatments. Therefore, uncertainty needs to be properly and adequately dealt with any economic evaluation. Probabilistic sensitivity analysis (PSA) is one of the methods that assess the impact on ICER by varying multiple parameters stochastically and simultaneously (3). With the increasing use of Bayesian probability theory and the advances in computational technologies, it has been easier than before to conduct PSA which used to be very time consuming. As shown by Gada and colleagues, the probability of TAVI being cost effective compared with AVR is only 0.47 at a maximum willingness to pay of $100,000/QALY. This means that regardless of whether to choose TAVI or AVR as an optimal strategy for the indicated patient population we would be wrong for around half of them. It conveys an important message that uncertainty is so substantial that further investigation is necessary. Through multiple-way deterministic sensitivity analyses Gada and colleagues found that the ICERs are mostly sensitive to three sets of parameters: mortality risks, health utilities, and costs. These further analyses are very important in identifying the subpopulations for whom TAVI is an optimal choice. It would be more straightforward if the probabilities of TAVI being cost effective for each of these key subgroups are presented through cost effectiveness acceptability curves (4).

Model-based economic evaluations can help understand the performance of new and existing treatments based on the knowledge and experience accumulated in the past. They can also be used to set future research prioritization through value of information analysis (VOI). VOI is such an analysis that quantifies net health benefits from conducting further research in reducing uncertainty about which treatment is optimal (5). It informs efficient allocation of research resources by setting research prioritization which is expected to generate maximum benefit on population health.

Model-based economic evaluations integrate multiple factors into a single decision analytical framework to inform complex and multidimensional medical decision makings. It is a powerful

tool that allows us to reflect on what we have known in the past and prepare for what we could do better in the future.

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