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Beyond outcomes: applying cost-effectiveness analysis to policy making

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The PREVENTT trial, just published in *The Lancet*, provides valuable insight into the effectiveness of i.v. iron to treat anaemia before major abdominal surgery.[1] This double-blind randomised controlled trial (RCT), combined with the recent COCHRANE review of the topic,[2] should definitively settle the debate regarding the non-efficacy of i.v. iron in reducing need for blood transfusion, length of hospital stay, and other health-related quality of life outcomes.

In this case, the (in-)effectiveness of the intervention would be enough to preclude it from the standard of care. It should also be noted that when considering implementation of certain interventions, effectiveness is just one component to examine; the value of the intervention in terms of cost-effectiveness must also be considered. Because surgical interventions themselves are often quite costly, it is critical to consider value propositions using cost-effectiveness analysis in order to guide health policy using a validated and transparent framework.[3] Of course, the ideal outcome is improved outcomes with lower costs. However, most new interventions in healthcare result in improved outcomes but are associated with higher costs. In these cases, cost-effectiveness analysis can be used to justify the introduction of various interventions.

In a system such as the UK NHS, it is important to evaluate cost-effectiveness for the country as a whole, although it is also possible to conduct such analyses on a smaller scale, such as for an individual hospital. Using a societal perspective would be best able to capture a number of different costs and outcomes, and also make the results as generalisable as possible. For example, while i.v. iron infusion alone is not a particularly expensive intervention, setting up formal preoperative iron clinics nationwide to evaluate and treat preoperative anaemia incurs more expenses for less utility.

Measuring costs

A cost-effectiveness analysis must include the costs to the healthcare system, the provider, and the patient. All costs include aspects of *fixed costs*, those that are required for infrastructure, and *variable costs*, that accrue per additional unit. Fixed costs include things such as an operating room or ventilator machine, and these can be amortised over the lifetime of the item. Variable costs would include disposable items opened in the operating theatre, medications administered, and any operating room time. Labour costs can be a fixed or variable cost, depending on whether providers are paid a flat salary or per unit of work or unit of time.

Costs should include those borne by the patient, including *direct medical costs*, *direct non-medical costs*, and *indirect costs*. *Direct medical costs* relate to the fees for hospital admission, medication payments, test fees, etc. In high-income countries, it is possible to estimate per-day hospital costs based on published rates.[4,5] There are also *direct non-medical costs*, such as the fees patients may need to pay for transportation, food, lodging, and childcare. Finally, there are also some *indirect costs* when considering loss of income and opportunity cost. These may be valued in terms of wages lost or household expenditures. Depending on the case, it may also be of value to consider *caregiver costs*; for example, if a child is undergoing surgery, his parent may accrue various indirect costs from not working. Costs should, of course, be standardised and adjusted for inflation. If comparing across different countries, adjustments should also be made according to standardised currencies ('international dollars' are typically used) and purchasing power, using the World Bank's Purchase Power Parity conversion factor.[6] There has also historically been a 'discounting' adjustment to costs, assuming that costs incurred *now* are more valuable than the same cost being incurred in the future. For this adjustment, costs are usually discounted 3% per year.

Measuring effectiveness

There are two major metrics of effectiveness, both of which measure the effects on years of life, with some adjustment. The *Quality-Adjusted Life Year* (QALY) is a measure of years lived in perfect health gained, whereas the *Disability-Adjusted Life Year* (DALY) is a measure of years in perfect health lost. The historical debate between these two metrics is beyond the scope of this editorial; in practice, QALYs are generally more common in high-income country cost-effectiveness analyses and DALYs are generally more common in global health cost-effectiveness analyses, especially those of low- and middle-income countries.

A QALY calculation can be made as:

$$QALY = qT$$

where q is a QALY weight valuation from 0 (death) to 1 (perfect health) and T is the time spent in that state of health.

The quality of life assessments for QALY calculations are often elaborate, as they are based on the preferences and opinions of patient sets. In order to calculate the q values of certain health states, a sample set of patients is asked certain questions such as 'standard gamble' or 'time trade-off'. Many QALY quality weights can be found in a searchable database managed by Tufts University (Medford, MA, USA).[7]

A DALY calculation can be made as:

$$DALY = YLL + YLD$$

where *YLL* is years of life lost and *YLD* is years of life lived with disability. *YLD* is calculated in the inverse of QALYs: dT, where d is a DALY weight for disability, 0 (perfect health) to 1 (death), and T is the time spent in that state of health.

Many DALY disability weights are found in the Lancet Global Burden of Disease study.[8] When disability weights do not exist, it is possible to estimate disability weights. In general, estimates should be congruent with the scale published by McCord and Chowdury.[9] The Global Burden of Disease Initiative recommends an estimation using DW for 'generalised illness,' and the estimated DW can be referenced against other DWs for accuracy. Just as with QALYs quality weights, these are also subjective.

For both QALY and DALY, there also exists a discounting adjustment. As with cost discounting, 'discounting' in these metrics assumes that a year of healthy life *now* is more valuable than a future year of healthy life; typically this discount is 3% per year. DALYs previously included an 'age weighting' adjustment that values certain 'highly productive' years as more valuable than others, although the Global Burden of Disease study stopped using age weighting for DALYs in its 2010 edition.

There are some additional factors that go into the calculation of QALYs or DALYs for an intervention, which include the risks of death, risks of permanent disability, probability of successful treatment, risk of complications from treatment, and any change in mortality risk after unsuccessful treatment. Constructing a decision tree (Fig. 1) may be the most accurate method to assess true weights.[10]

Analysing cost-effectiveness

To calculate cost-effectiveness, the *incremental cost-effectiveness ratio* (ICER) equals cost per QALYs gained or cost per DALYs averted. The simplest measure of cost-effectiveness can be established based on GDP *per capita*. Interventions that are cost-effective typically have ICERs one to three times the GDP *per capita*. Interventions with ICERs fewer than one times GDP *per capita* are considered 'very cost-effective,' while interventions with ICERs more than three times GDP *per capita* are considered 'not cost-effective.'

Another comparator of cost-effectiveness is known as the *Value of a Statistical Life (VSL)*, which is the average amount a person would be willing to pay to reduce the risk of death. Calculating this number involves assessing a group's willingness to pay for risk reductions that equal to one statistical life. The monetary value per QALY or DALY can be calculated from VSL estimates and cost-effectiveness determined based on these numbers.

In any cost-effectiveness analysis, it is critical to explicitly state any assumptions that underlie the calculations, especially since small differences in weights can lead to huge differences when applied to the ICERs of an entire population. The WHO has guidelines through its CHOosing Interventions that are Cost-Effective (CHOICE) project.[11]

To ensure the quality of cost-effectiveness analysis, the Drummond checklist has often been used.[12] Shrime and

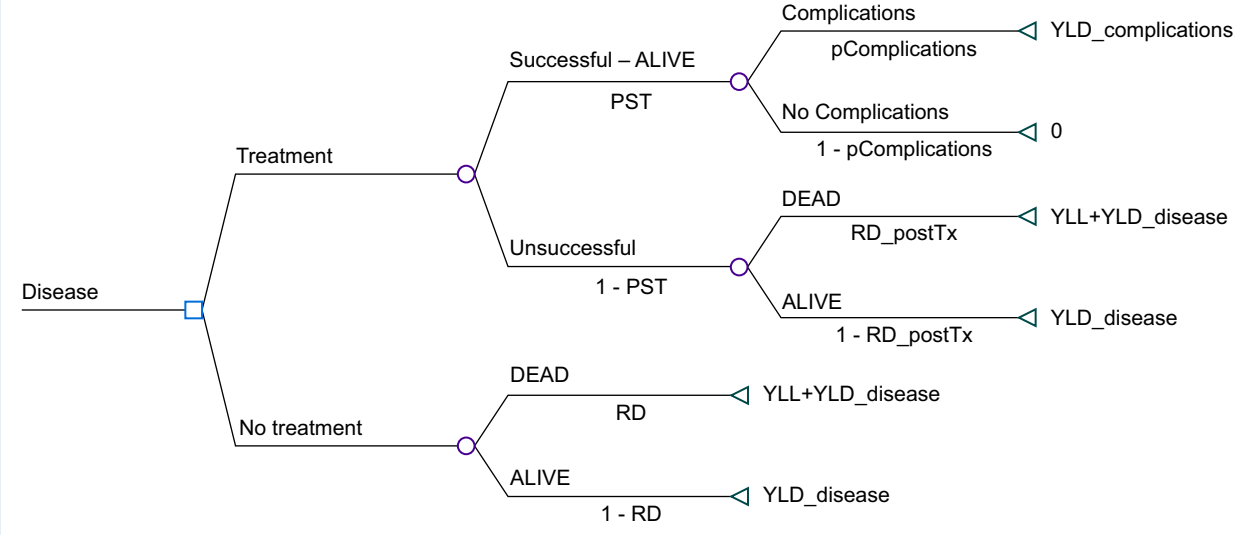

Fig 1. Decision tree for Disability-Adjusted Life Year (DALY) calculation, from Shrime and colleagues.[10] PST, Probability of Successful Treatment; RD, Risk of Death; Tx, Treatment; YLD, years of life lived with disability; YLL, years of life lost.

colleagues published a newer checklist for cost-effectiveness analyses in global surgery in 2017.[10]

Conclusions

High-quality, double-blind RCTs, such as the PREVENTT trial, are the highest standard for determining effectiveness of various medical and surgical interventions and can help define standards of care. Economic considerations must also be taken into account when making health policy decisions. Cost-effectiveness analysis is a critical tool, and maximising reproducibility of these calculations using standardised techniques and verifying with existing checklists will allow for the highest standard in data-driven policymaking for population-based healthcare delivery.

Declarations of interest

The author declares that they have no conflict of interest.

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Desflurane in modern anaesthetic practice: walking on thin ice(caps)?

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