Why it's Time to Abandon the ICER

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1 Introduction

The incremental cost-effectiveness ratio (ICER) is the most commonly reported summary measure for economic evaluations of health technologies [1–3]; however, considering ICERs is unnecessary. Alternative measures exist, based on the concept of ‘net benefit’ [4]. Although previous authors have outlined advantages to using net benefit [5–14], many health technology assessment (HTA) agencies continue to use ICERs [15–17].

The ICER and net benefit share several commonalities [18]. Both aid in determining which treatment ‘strategy’ is most cost effective, and both are calculated and interpreted using a common set of parameters. Nevertheless, there are important differences in terms of the methods used for their calculation and interpretation. These are described in the accompanying Practical Application [19]. In considering these methods, some fundamental weaknesses of the ICER become apparent.

2 ICERs are More Laborious to Calculate

The ICER is simple to calculate between two strategies; however, calculating ICERs in evaluations of three or more strategies can be laborious. Since the ICER is a pairwise measure, multiple ICERs need to be calculated. ‘Dominant’ strategies must be identified, and recalculations may be needed as strategies are ruled out through ‘extended dominance’.

By contrast, calculating net benefit is simple, regardless of the number of strategies. Since it is not a pairwise measure, the net benefit of each strategy is not dependent on other strategies. It follows that there is no need to check for dominance or extended dominance, and no recalculations are necessary.

3 ICERs are More Difficult to Interpret

In evaluations of two strategies, interpreting the ICER requires consideration of different decision rules in each ‘quadrant’ of the incremental cost-effectiveness plane. A strategy with a positive ICER lower than the cost-effectiveness ‘threshold’ is cost effective if it lies in the north-east quadrant, but not if it lies in the south-west quadrant. A strategy with a negative ICER is cost effective if it lies in the south-east quadrant, but not if it lies in the north-west quadrant. In evaluations of three or more strategies, the decision rule is unintuitive: the most cost-effective strategy is that with the *highest* ICER that lies *below* the threshold.

By contrast, interpreting net benefit is straightforward: regardless of the number of strategies, the most cost-effective strategy is simply that with the highest net benefit.

4 ICERs Cannot Easily be Used for Sensitivity or Scenario Analysis

HTA agencies often wish to conduct sensitivity or scenario analysis on model parameters or assumptions. Economic evaluations frequently report how the ICER varies in a sensitivity or scenario analysis compared with the reference-case analysis.

However, as noted in the Practical Application, observing change in the ICER does not necessarily imply that a strategy is more or less cost effective than in the reference-case analysis [19]. If the ICER increases, this does not necessarily

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imply that the cost effectiveness of the strategy has worsened. Nor does it necessarily imply that the cost effectiveness has improved. This presents a critical problem for using ICERs in sensitivity or scenario analysis.

By contrast, net benefit allows sensitivity and scenario analyses to be easily interpreted. If the net benefit increases, the strategy is unambiguously more cost effective. Conversely, if the net benefit decreases, the strategy is unambiguously less cost effective.

5 ICERs Cannot be Used to Rank Strategies

In evaluations of three or more strategies, HTA agencies may wish to *rank* strategies from most to least cost effective. This is particularly useful if there is a desire to provide patients with a choice of treatment options, rather than only the single most cost-effective treatment.

However, as noted in the Practical Application, ICERs cannot be used to rank strategies [19]. Although ICERs can be used to identify the *most* cost-effective strategy, the *second* most cost-effective strategy may have been ruled out through dominance or extended dominance. Since ICERs are not calculated between dominated or extendedly dominated strategies, ranking such strategies using ICERs is impossible. Even if no strategies are dominated or extendedly dominated, ICERs cannot be used for ranking because a higher or lower ICER does not necessarily imply that a strategy is more or less cost effective than another strategy.

By contrast, net benefit can be used to easily rank strategies, since a higher net benefit implies that a strategy is more cost effective. The novel figure proposed in the Practical Application, reproduced here as Fig. 1, allows HTA agencies to visually rank strategies on the cost-effectiveness plane [19]. In this example, strategy D is the most cost effective, followed by strategy A, while strategy H is the least cost effective.

From Fig. 1, note that strategy A is more cost effective than strategies B and F. However, when using ICERs, strategy A would be ‘ruled out’ through dominance, while strategies B and F would lie on the ‘efficiency frontier’. This illustrates one of the many challenges of interpreting ICERs.

6 ICERs Cannot be Used to Consider Relative Cost-Effectiveness

Since a higher or lower ICER does not necessarily imply that a strategy is more or less cost effective, it follows that ICERs do not allow for consideration of relative cost effectiveness; that is, the *magnitude* to which one strategy is more or less cost effective than another.

Fig. 1 A novel means for interpreting net benefit on the cost-effectiveness plane. Indifference curves of identical slope are plotted through each strategy, with this slope representing the threshold (\$50,000 per QALY, in this example). The points where each indifference curve intersects the horizontal and vertical axes represent the NHB and NMB, respectively, for all strategies on the respective indifference curve. Strategies on lower indifference curves are relatively more cost effective than strategies on higher indifference curves. *QALY* quality-adjusted life-year, *NHB* net health benefit, *NMB* net monetary benefit

By contrast, net benefit provides meaningful information on the relative cost effectiveness of each strategy. For example, if the net health benefit of a strategy is 2 QALYs greater than that of another strategy, this means that adopting the first strategy will improve population health by an additional 2 QALYs compared with the latter strategy.

7 ICERs Cannot Easily be Used for Probabilistic Analysis

Using ICERs for probabilistic analysis is burdensome, requiring that the convoluted steps for their calculation and interpretation be repeated for each Monte Carlo simulation.

Furthermore, since the ICER is a discontinuous measure, it may be impossible to report a meaningful credible interval [5, 6, 10, 12, 14]. Even if a credible interval can be reported, it is difficult to interpret, since a higher or lower ICER does not necessarily imply that a strategy is more or less cost effective.

By contrast, net benefit allows for probabilistic analysis to be easily conducted, since calculation and interpretation are straightforward. A meaningful credible interval can also be reported around the expected net benefit.

8 ICERs Cannot Easily be Used to Consider Equity Concerns

Although beyond the scope of the Practical Application, there is increasing interest in using economic evaluation to address equity concerns through the assignment of 'equity weights' [20].

When using ICERs, the only practical means for assigning equity weights is to vary the threshold itself. For example, the UK's National Institute for Health and Care Excellence (NICE) applies 'threshold weights' for end-of-life technologies and drugs for rare diseases [21, 22]. However, this approach does not easily allow for application of equity weights to the health forgone by patients who incur the opportunity cost of new health technologies, resulting in horizontal inequities and other inconsistencies in NICE's consideration of social values [23, 24].

By contrast, using net benefit allows the health gains and losses to be disaggregated according to relevant equity-bearing characteristics, permitting equity weights to be applied directly to the relevant QALYs gained and forgone [25]. This avoids the inequities and inconsistencies that arise through threshold weighting.

9 What if the Threshold is 'Unknown'?

Anecdotally, a reason often given by HTA agencies for using ICERs is that a threshold is required to calculate net benefit but is not required to calculate ICERs. For HTA agencies who do not specify a threshold, or in cases where the threshold is 'unknown', it follows that ICERs can be calculated but net benefit cannot, providing an apparent justification for using ICERs.

This argument is viscerally appealing but fundamentally flawed. As the Practical Application demonstrates, ICERs can be calculated without a threshold but they cannot be *interpreted* without a threshold [19]. Without interpretation, ICERs cannot inform HTA agencies as to whether a strategy is cost effective. Except in the special case where one strategy dominates all others, a threshold is *required* to determine the most cost-effective strategy, regardless of whether the HTA agency uses ICERs or net benefit [19]. Accordingly, there is no advantage to using ICERs if the threshold is 'unknown'.

10 Conclusion

Measures of net benefit have numerous advantages over ICERs: they are easier to calculate and interpret, particularly in evaluations of multiple strategies; they can be used to meaningfully interpret the results of a sensitivity or scenario analysis; they allow for the ranking of strategies and for the consideration of relative cost effectiveness; and they have clear advantages in the consideration of uncertainty and in the application of equity weights.

Furthermore, the argument often given in favour of using ICERs—that a threshold is required to calculate net benefit but not ICERs—is logically flawed. The requirement to specify a threshold is identical for ICERs and net benefit: there are no instances in which one measure can be calculated and interpreted without a threshold while the other measure cannot.

With the growing complexity of economic evaluations, the relative advantages of using net benefit will only increase over time. Given the importance of the decisions made by HTA agencies, it is clearly unacceptable to use a flawed measure when better alternatives exist. It is time to abandon the ICER in favour of measures of net benefit.

Compliance with Ethical Standards

Conflicts of interest Mike Paulden has no relevant conflicts of interest to declare.

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