The determinants of change in the cost-effectiveness threshold

Mike Paulden, MSc
James O’Mahony, PhD
Christopher McCabe, PhD

1 Department of Emergency Medicine, University of Alberta, Canada
2 Centre for Health Policy & Management, Trinity College Dublin, Ireland
Disclosure

I have no actual or potential conflict of interest in relation to this topic or presentation
Overview

1. What is the threshold?
2. Why might the threshold change?
3. Why does this matter?
What is the threshold?

- The ‘**threshold**’ is used in **economic evaluations** to determine if a **health technology** is ‘cost-effective’

- Three different ways to **use** the threshold:
  1. Compare the technology’s **ICER** to the threshold
     - Cost-effective if ICER lies **below** the threshold:
       \[
       \frac{\Delta C}{\Delta E} < \lambda
       \]
  2. Derive the **net health benefit** using the threshold
     - Cost-effective if net health benefit (NHB) is **positive**:
       \[
       \Delta E > \frac{\Delta C}{\lambda}
       \]
  3. Derive the **net monetary benefit** using the threshold
     - Cost-effective if net monetary benefit (NMB) is **positive**:
       \[
       \Delta E \cdot \lambda > \Delta C
       \]
What is the threshold?

- Two different ways to **conceptualize** the threshold:
  1. The ‘value’ society places on **marginal improvements in population health** (‘demand-side’ threshold)
     - Requires *estimation* of the ‘value’ that individuals place on improvements in health, then *aggregation* of these values
  2. The ‘opportunity cost’ of **funding** the new technology within a **budget-constrained health care system** (‘supply-side’ threshold)
     - Requires *estimation* of the ICERs of *marginal* technologies in the system that must be *displaced* to fund the new technology
Suppose you value apples at $1 each

Stall A
60¢ each

At the market are two identical stalls selling identical apples but at different prices

Stall B
30¢ each

Which stall would you purchase apples from?
If the owner of stall A is willing to haggle, how much would you be willing to pay for an apple from Stall A?
What relevance is your ‘value’ of $1 per apple?
Suppose society values health at $100,000 per QALY (‘demand-side’ threshold)

New technology $60,000 per QALY

Displaced technology $30,000 per QALY (‘supply-side’ threshold)

Funding the new technology will displace one or more other technologies within the health system, resulting in health losses for other patients.

Suppose society wants to improve population health and adopts the equity position that all QALYs have equal value.

What ‘threshold’ ($ per QALY) should we use when assessing the new technology for reimbursement?
ICER for each technology

- Funded
- Budget
- Not Funded

Health care expenditure
ICER for each technology

Threshold

ICER for each technology

Funded

Budget

Not Funded

New technology

Health care expenditure
Why might the threshold change?

• Theoretically, the threshold may **change over time** for a number of reasons:
  • Changes in the **budget** for health care (↑)
Why might the threshold change?

• Theoretically, the threshold may change over time for a number of reasons:
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  • Changes in the budget for health care (↑)
  • Changes in the demand for health care services (↓)
  • Changes in the technical efficiency of technologies (?)
    • If funded technologies become less expensive then ↑
1. Expenditure on tech falls
2. ICER of tech falls
3. Bookshelf reorganized
4. Additional tech funded
5. Threshold increases
Why might the threshold change?

• Theoretically, the threshold may **change over time** for a number of reasons:
  • Changes in the **budget** for health care (↑)
  • Changes in the **demand** for health care services (↓)
  • Changes in the **technical efficiency** of technologies (?)
    • If funded technologies become **less expensive** then ↑
    • If funded technologies become **more effective** then ↓
ICER for each technology

1. Effectiveness of some techs fall, so ICERs fall
2. Expenditure unchanged - *no change in book width*
3. Threshold **falls**
Why might the threshold change?

• In theory, the threshold may change over time for a number of reasons:
  • Changes in the budget for health care (↑)
  • Changes in the demand for health care services (↓)
  • Changes in the technical efficiency of technologies (?)
    • If funded technologies become less expensive then ↑
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• Where many changes apply, threshold may ↑ or ↓
<table>
<thead>
<tr>
<th>Determinant</th>
<th>Change in determinant</th>
<th>Change in threshold (marginal technology, if known)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The health budget</strong></td>
<td>↑ Increase</td>
<td>↑ Increase to ICER of new marginal technology</td>
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<tr>
<td></td>
<td>↓ Decrease</td>
<td>↓ Decrease to ICER of new marginal technology</td>
</tr>
<tr>
<td><strong>The demand for existing technologies</strong></td>
<td>↑ Increase</td>
<td>↓ Decrease to ICER of new marginal technology</td>
</tr>
<tr>
<td></td>
<td>↓ Decrease</td>
<td>↑ Increase to ICER of new marginal technology</td>
</tr>
<tr>
<td><strong>The technical efficiency of existing technologies</strong> *</td>
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</tr>
<tr>
<td>Effectiveness of the marginal technology (G)</td>
<td>↑ Small increase</td>
<td>↓ Decrease to ICER of marginal technology (G)</td>
</tr>
<tr>
<td></td>
<td>↑ Large increase</td>
<td>↓ Decrease to ICER of marginal technology (F)</td>
</tr>
<tr>
<td></td>
<td>↓ Small decrease</td>
<td>↑ Increase to ICER of marginal technology (G)</td>
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<tr>
<td></td>
<td>↓ Large decrease</td>
<td>↑ Increase to ICER of marginal technology (H)</td>
</tr>
<tr>
<td>Effectiveness of funded non-marginal technologies (A-F)</td>
<td>↑ Small increase</td>
<td>↔ No impact</td>
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<tr>
<td></td>
<td>↑ Large increase</td>
<td>↔ No impact</td>
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<td></td>
<td>↓ Small decrease</td>
<td>↔ No impact</td>
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<tr>
<td></td>
<td>↓ Large decrease</td>
<td>↑ Increase to ICER of marginal technology</td>
</tr>
<tr>
<td>Effectiveness of non-funded technologies (H-L)</td>
<td>↑ Small increase</td>
<td>↔ No impact</td>
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<tr>
<td></td>
<td>↑ Large increase</td>
<td>↔ No impact</td>
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<tr>
<td></td>
<td>↓ Small decrease</td>
<td>↔ No impact</td>
</tr>
<tr>
<td></td>
<td>↓ Large decrease</td>
<td>↔ No impact</td>
</tr>
<tr>
<td>Cost of the marginal technology (G)</td>
<td>↑ Small increase</td>
<td>↑ Increase to ICER of marginal technology (G or H)</td>
</tr>
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<td></td>
<td>↑ Large increase</td>
<td>↑ Increase to ICER of marginal technology (G or H)</td>
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<td></td>
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<tr>
<td><strong>Funding for newly available technologies</strong> **</td>
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<tr>
<td>Not a substitute for any existing technology</td>
<td>N/A</td>
<td>↓ Decrease to ICER of marginal technology</td>
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<tr>
<td>Substitute for the marginal technology (G)</td>
<td>Equal budget impact</td>
<td>↓ Decrease to ICER of marginal technology*</td>
</tr>
<tr>
<td></td>
<td>Smaller budget impact</td>
<td>? Increase/decrease to ICER of marginal technology</td>
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Why might the threshold change?

• In theory, the threshold may change over time for a number of reasons:
  • Changes in the budget for health care (↑)
  • Changes in the demand for health care services (↓)
  • Changes in the technical efficiency of technologies (?)
    • If funded technologies become less expensive then ↑
    • If funded technologies become more effective then ↓
• Where many changes apply, threshold may ↑ or ↓
• In practice, we have little empirical evidence of the current threshold, let alone its rate of change
Why does this matter?

- Recall that there are three different ways in which the threshold is used in conventional practice
  1. Compare the technology’s ICER to the threshold
     - Cost-effective if ICER lies below the threshold:
       \[ \frac{\Delta C}{\Delta E} < \lambda \]
  2. Derive the net health benefit using the threshold
     - Cost-effective if net health benefit (NHB) is positive:
       \[ \Delta E > \frac{\Delta C}{\lambda} \]
  3. Derive the net monetary benefit using the threshold
     - Cost-effective if net monetary benefit (NMB) is positive:
       \[ \Delta E \cdot \lambda > \Delta C \]
- But what \( \lambda \) do we use if \( \lambda \) is changing over time?
Why does this matter?

• Consider the following hypothetical example:
  • There are two time periods, $t = 1$ and $t = 2$
  • The threshold falls from $50,000\text{ per QALY}$ in $t = 1$ to $40,000\text{ per QALY}$ in $t = 2$
  • There are three technologies (A, B and C), with the following discounted incremental costs and benefits:

<table>
<thead>
<tr>
<th>Period</th>
<th>$\lambda$</th>
<th>$\Delta C^A$</th>
<th>$\Delta E^A$</th>
<th>$\Delta C^B$</th>
<th>$\Delta E^B$</th>
<th>$\Delta C^C$</th>
<th>$\Delta E^C$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$50,000$</td>
<td>$18m$</td>
<td>400</td>
<td>0</td>
<td>0</td>
<td>$9m$</td>
<td>200</td>
</tr>
<tr>
<td>2</td>
<td>$40,000$</td>
<td>0</td>
<td>0</td>
<td>$18m$</td>
<td>400</td>
<td>$9m$</td>
<td>200</td>
</tr>
<tr>
<td>Total</td>
<td>-</td>
<td>$18m$</td>
<td>400</td>
<td>$18m$</td>
<td>400</td>
<td>$18m$</td>
<td>400</td>
</tr>
<tr>
<td>ICER</td>
<td>-</td>
<td>$45,000\text{ per QALY}$</td>
<td>$45,000\text{ per QALY}$</td>
<td>$45,000\text{ per QALY}$</td>
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</tbody>
</table>

• What $\lambda$ should we compare each ICER to?
Why does this matter?

• Following Claxton et al. (2011), we can solve for $\lambda$ by specifying the problem in terms of NHB

• Over two periods, a technology is cost-effective if:

$$\Delta E_1 + \Delta E_2 > \frac{\Delta C_1}{\lambda_1} + \frac{\Delta C_2}{\lambda_2}$$

where $\Delta E_2$ and $\Delta C_2$ are already discounted, such that $\Delta E = \Delta E_1 + \Delta E_2$ and $\Delta C = \Delta C_1 + \Delta C_2$
Why does this matter?

• **Technology A** is cost-effective if:

\[
400 + 0 > \frac{18m}{50k} + \frac{0m}{40k} \implies \frac{18m}{400} < 50,000 \implies \frac{\Delta C}{\Delta E} < \lambda_1
\]

• **Technology B** is cost-effective if:

\[
0 + 400 > \frac{0m}{50k} + \frac{18m}{40k} \implies \frac{18m}{400} < 40,000 \implies \frac{\Delta C}{\Delta E} < \lambda_2
\]

• **Technology C** is cost-effective if:

\[
200 + 200 > \frac{9m}{50k} + \frac{9m}{40k} \implies \frac{18m}{400} < 44,444 \implies \frac{\Delta C}{\Delta E} < f(\lambda_1, \lambda_2, \Delta C_1, \Delta C_2)
\]
Why does this matter?

• Comparing ICERs to a changing $\lambda$ is problematic
  • A unique threshold is needed for every technology

• But considering NHB is also problematic
  • A changing $\lambda$ has positive and normative implications
    • Since $\lambda$ is influenced by the health system budget, which in turn is determined by a socially legitimate authority, a growing $\lambda$ may imply that future society is willing to pay more than today’s society for improvements in population health
    • The decision maker may wish to assign greater value to some health benefits/losses than others
  • Yet NHB assigns all health benefits/losses equal value
    • Inappropriate if the decision maker’s objective is to maximize the value of population health over time
Why does this matter?

• This leaves us with net monetary benefit (NMB)

• **NMB** allows the *decision maker* to apply
  *differential ‘weights’ to net health benefits*

  • Conventional NMB uses $\lambda$ to weight net health benefits
    – by extension, if $\lambda$ is changing, then net health benefits
    in *each year* ought to be weighted using $\lambda$ in *that year*:

    $$\lambda_1 \cdot \Delta E_1 + \lambda_2 \cdot \Delta E_2 > \lambda_1 \cdot \frac{\Delta C_1}{\lambda_1} + \lambda_2 \cdot \frac{\Delta C_2}{\lambda_2}$$

• Yet *this is also problematic*, since $\lambda$ in *future years*
  reflects the values held by *society in future years*, which
  may not reflect the values of the *decision maker today*
Summary

• The threshold should reflect the opportunity cost of funding new technologies (‘supply-side’)
• The threshold depends upon a number of factors, including the budget, the demand for health care, and the technical efficiency of health technologies, each of which may change over time
• The threshold is therefore continuously changing
• This has implications for economic evaluations:
  • Comparing ICERs to a threshold is problematic
  • Using NHB or conventional NMB is problematic
  • Research needed to develop new methods in this area