Does cost-effectiveness analysis discriminate against patients with short life expectancy?

Mike Paulden and Anthony J Culyer

Contact details: mikepaulden.tel

www.theta.utoronto.ca
“In every case QALYs... favour those with the greater life expectancy regardless of age”

John Harris (2005), “Nice and not so nice”  
*Journal of Medical Ethics: 31, p.685*
Possible implications?

• If QALYs discriminate against those with shorter life expectancy, surely it follows that cost-effectiveness analysis (specifically cost-utility analysis) discriminates against patients with shorter life expectancy?

• Furthermore, surely it follows that those agencies which practice CEA (such as NICE) in turn discriminate against those with shorter life expectancy?
Take home message

CEA does *not* necessarily discriminate against patients with shorter life expectancy and it can sometimes even discriminate *in their favour*
Why is that?

- It is the *incremental* QALY benefit from treatment that matters in CEA, *not* the expected ‘remaining’ QALYs in a patient’s life.
- CEA also considers *incremental costs*, which will *generally* be greater for patients who live longer (ICER not necessarily lower).
A simple model

• Suppose that an agency such as NICE must decide whether to recommend a technology and is provided with QALY and cost data for two subgroups of patients: subgroups $S$ and $L$
• Assume that the patients in both subgroups are identical with the exception that those in subgroup $S$ have a shorter life expectancy of $p$ years, while those in subgroup $L$ have a longer life expectancy of $q$ years, i.e. $q > p$
• For now assume no discounting
The costs, QALYs and ICERs

• The incremental QALY benefits and costs of the technology are denoted as:
  • $\Delta h^S$ and $\Delta c^S$ for subgroup $S$
  • $\Delta h^L$ and $\Delta c^L$ for subgroup $L$

• The ICERs are therefore:
  • $\frac{\Delta c^S}{\Delta h^S}$ for subgroup $S$
  • $\frac{\Delta c^L}{\Delta h^L}$ for subgroup $L$
A condition for discrimination

- Where recommendations are made by comparing each ICER to a threshold ($\lambda$), CEA will discriminate against patients with shorter life expectancy if:

$$\frac{\Delta c^L}{\Delta h^L} < \lambda < \frac{\Delta c^S}{\Delta h^S}$$
The “region of differential cost-effectiveness” (RDCE)
But...

- It is unclear for what technologies this condition is more likely to hold
Expanding our expressions

- We will now expand our expressions of the costs and QALYs to account for time
- Denoting the current year as 1:
  
  \[ \Delta h^S = \sum_{t=1}^{p} \Delta h^S_t = \Delta h^S_1 + \Delta h^S_2 + \cdots + \Delta h^S_p \]
  
  \[ \Delta c^S = \sum_{t=1}^{p} \Delta c^S_t = \Delta c^S_1 + \Delta c^S_2 + \cdots + \Delta c^S_p \]
  
  \[ \Delta h^L = \sum_{t=1}^{q} \Delta h^L_t = \Delta h^L_1 + \Delta h^L_2 + \cdots + \Delta h^L_p + \cdots + \Delta h^L_q \]
  
  \[ \Delta c^L = \sum_{t=1}^{q} \Delta c^L_t = \Delta c^L_1 + \Delta c^L_2 + \cdots + \Delta c^L_p + \cdots + \Delta c^L_q \]
A slightly more complex condition

- Where recommendations are made by comparing each ICER to a threshold ($\lambda$), CEA will discriminate against patients with shorter life expectancy if:

$$\frac{\sum_{t=1}^{q} \Delta c_t^L}{\sum_{t=1}^{q} \Delta h_t^L} < \lambda < \frac{\sum_{t=1}^{p} \Delta c_t^S}{\sum_{t=1}^{p} \Delta h_t^S}$$
The “common ratio”

• Since the subgroups are otherwise identical, their associated QALYs and costs will differ only between years $p$ and $q$.

• The ICER for subgroup $S$ therefore represents a “common ratio” of costs to QALYs for both subgroups up to year $p$:

\[
\frac{\Delta c^S}{\Delta h^S} = \frac{\sum_{t=1}^{p} \Delta c_t^S}{\sum_{t=1}^{p} \Delta h_t^S} = \frac{\sum_{t=1}^{p} \Delta c_t^L}{\sum_{t=1}^{p} \Delta h_t^L}
\]
The “subsequent ratio”

- Meanwhile, the ratio of costs to QALYs for subgroup $L$ subsequent to the death of subgroup $S$ is defined as the “subsequent ratio”:

$$\frac{\sum_{t=p+1}^{q} \Delta c^L_t}{\sum_{t=p+1}^{q} \Delta h^L_t}$$
The common and subsequent ratios

- While the ICER for subgroup $S$ is determined solely by the common ratio, the ICER for subgroup $L$ is determined by both ratios.
- If these ratios are equal then both subgroups have the same ICER.
ICER for subgroup $L$ and common ratio

Cost-effectiveness threshold ($\lambda$)

ICER for subgroup $S$ and common ratio

RDCE

Subsequent ratio

$\Delta c$

$\Delta c^L$

$\Delta c^S$

$\Delta h$

$\Delta h^S$

$\Delta h^L$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$

$\Delta h$
A more intuitive condition

• Discrimination against those with shorter life expectancy **requires** the subsequent ratio to be **lower** than the common ratio
  • This is *more* likely for technologies with largely **upfront costs** and **long term QALY benefits** (such as surgery or vaccinations)
  • This is *less* likely for technologies with **long term costs** and **flat or declining QALY benefits** (such as long term care for diabetes)
Taking things further

- In our paper we also show that:
  - Discounting always reduces the scope for discrimination on the basis of life expectancy (in either direction)
  - NICE’s recent guidance on appraising “end-of-life” treatments increases the scope for discrimination in favour of those with shorter life expectancy
\[ \Delta c + 1 = 1 \]
\[ \Delta h = 1 \]
\[ \Delta c \Delta h + 1 = 1 \]
\[ \Delta h = 1 \]

*ICER for subgroup L (no discounting)*

*ICER for subgroup S (common ratio)*

**ICER for subgroup L (with discounting)**

Cost-effectiveness threshold for "end of life" treatments (\( \lambda^S \))

Cost-effectiveness threshold (\( \lambda \))

Subsequent ratio (no discounting)

Subsequent ratio (with discounting)

\[ \sum_{t=1}^{q} \Delta c_t^L \]
\[ \sum_{t=1}^{q} \Delta c_t^L / (1 + \partial)^{t-1} \]
\[ \sum_{t=1}^{p} \Delta c_t^S \]
\[ \sum_{t=1}^{p} \Delta c_t^S / (1 + \partial)^{t-1} \]

With discounting the common ratio is represented by the dotted line only; without discounting the common ratio is extended by the bold line.

**With discounting the RDCE is represented by the left shaded region only; without discounting the RDCE is represented by both shaded regions.**
Take home messages

• CEA does not necessarily discriminate against patients with shorter life expectancy, and may sometimes discriminate in their favour.

• Discrimination against those with shorter life expectancy requires the subsequent ratio to be lower than the common ratio.
  - This is more likely for technologies with largely upfront costs and long term QALY benefits.
  - This is less likely for technologies with flat long term costs and flat or declining QALY benefits.
But what of Harris’s statement?

“In every case QALYs... favour those with the greater life expectancy regardless of age”

- It is *incremental* QALYs that matter in CEA
- CEA also takes into account incremental costs
- So it does *not* logically follow that “in every case cost-effectiveness analysis favours those with the greater life expectancy regardless of age”
Thank you!

For a **PDF copy** of this presentation and a list of references please visit theta.utoronto.ca/?0178 or scan the barcode with your phone or tablet.