The Economics of Health: How do we decide?

The purpose of this pack is to give students practice in multi-step problems which relate to a real context in which maths is a vital tool. We would suggest that you show students the videos first to give them a sense of that context, perhaps then repeating any which are particularly relevant to the worksheets you intend to use with them.

Key concepts which students need to grasp are that:

- health budgets are limited, no society can afford all the health care it might like
- decisions therefore have to be made about how to balance what people want with what is affordable
- there are no simple right answers for this, although there may be wrong ones!

In the video clips, Dr Sarah Garner of NICE (the National Institute for Clinical Excellence, the body which advises the National Health Service in the UK on the affordability of treatments) discusses the mathematical tools which NICE uses to determine which treatments can be afforded. A treatment which does not offer sufficient additional health gains over existing treatments to justify any additional cost will not be recommended. The reality is that a limited budget means that if expensive treatments are allowed, other treatments which offer better heath value for money cannot be afforded.

Answers to worksheets and additional notes

Maximising Survival

1. 83 saved, cost £3.41 million, £410,000 over budget
2.

No. of patients on B	No. surviving 1 year	Cost for 1 year (£ millions)	No. of patients on A	No. surviving 1 year	Cost for 1 year (£ millions)	Total no. survivors	Total cost (£ millions)
100	83	3.41	0	n/a	n/a	83	3.41
75	62	2.56	25	15	0.26	77	2.82
50	41 or 42	1.71	50	30 or 31	0.52	71 to 73	2.22
25	21	0.85	75	46	0.77	67	1.63
0	n/a	n/a	100	61	1.03	61	1.03

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Note:

Costs are rounded to 2dp, survivors to a sensible whole number – clearly there is no single right way of making approximations. This would be a useful discussion point.

3. A bit more than 75

6. Number taking A is $100 - x$, equation is $C = \frac{10.3x + 34.1(100 - x)}{1000}$ in £ millions or equivalent

7. x = 17.2, so the best solution is 18 on A, 82 on B, at a cost of £2.98m

8. No, total cost is £3.195m

9. 59, £442,500

10. 14 on B, 11 on A, cost £441,700, 23 to 24 survivors

11. 82 to 83

12. 81 to 82

Note:

Despite things looking better at first sight on the new model, it actually makes very little difference to overall survival rates!

But is it cost effective?

1. 3,300
2. 57.1% increase relative to D
3. 0.04 QALYs, 9.52% increase relative to D
4. Would need to be 0.4725, so a gain of 0.0525 QALYs or 12.5%

   The questions about newspaper stories are to get students thinking about how journalists use information like this to slant a story in a particular way. Relative percentage increases are often used to make more dramatic headlines than the actual figures might suggest.

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Which Treatment?

Treatment	Average duration of treatment	QALYs provided	QALYs gained (relative to treatment X)	Cost per patient per day (£)	Total cost of treatment (£)	Additional cost (relative to treatment X, £)	ICER
X	24 months	0.75	n/a	28.90	21,100	n/a	n/a
A	6 months	0.8	0.05	123.78	22,600	1,500	30,000
B	Surgery and 6 days in hospital	0.4	-0.35	450 per day plus 9,500 for the surgery	12,200	-8,900	25,400
C	18 months	0.92	0.17	48.67	26,600	5,500	32,400
B + C	As B plus 6 months on Drug C	0.9	0.15	As for B and C	21,100	0	0

Notes:

- Total cost, additional cost and ICER (calculated by dividing the additional cost relative to X by the QALYs gained relative to X) are all rounded to 3sf – the exact answers obtained will depend on how a year/month are defined.
- Who gets what treatment is a matter for discussion, but the NICE limit on an ICER of 30,000 should come into that discussion.
- On the cost effectiveness plane, discussion could focus on the areas which correspond to an increase/decrease in cost and QALY, and decide what decision NICE is likely to make for a new drug in any given quadrant. Treatments in the bottom left quadrant are less costly, but also less effective than Drug X. Treatments in the top left quadrant are more costly and less effective than Drug X. Treatments in the top right quadrant are more costly and more effective – there is then a question as to whether the additional effectiveness outweighs the additional cost. Treatments in the bottom right quadrant are less costly and more effective than Drug X.
- The line corresponding to an ICER of 30,000 is a straight line through the origin. Students should calculate the coordinates of a couple of additional points. The equation is $C = 30{,}000Q$ where *C* is the additional cost relative to Drug X, and *Q* is the additional QALY relative to Drug X.

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Making Decisions

1. 0.3, 0.3

Note:

Despite *Kamtabital* appearing to give a better outcome, because of the probability of a relapse, actually it is no better than best supportive care, which is one of the reasons NICE might decide against recommending a treatment which appears to offer benefits.
Students should discuss what other factors might contribute to a decision. These could include cost, availability of best supportive care, side-effects from the drug, etc.

2. Per 100 patients, Drug A costs £70,000 for those who are successfully treated, and £300,000 for those who are unsuccessfully treated.
   Per 100 patients, Drug B costs £180,000 for those who are successfully treated, and £100,000 for those who are unsuccessfully treated.
   Total for Drug A is £370,000 and for Drug B it is £280,000.

Note:

There are other ways of phrasing this, of course, than considering 100 patients.
Students might like to consider why an unsuccessful outcome might be more expensive than a successful one.

3. 22 or 23 requiring hospitalisation (depending on how you decide to handle decimal answers) 1 or 2 requiring surgery
   683 or 684 requiring no further treatment
   Additional cost is £1.3 million, £4 million compared to £2.7 million.
   Hospitalisation would cost £9.2m per day if 23,000 patients required it.
   Surgery for 20,000 would cost £120m.

Note:

I think new NSAIDs would be considered a good thing by NICE, if cost and lack of side-effects both give benefits!
The percentages of people suffering the various side-effects are taken from a medical journal, so were accurate for 2010.
In the first part of this question, I would highly recommend using the tree diagram to help sort out all the figures, and would also stress the need to check that the all probabilities found sum to 1 (I found an elusive mistake because my probabilities only summed to 0.93).

Produced by Motivate, part of the Millennium Mathematics Project at the University of Cambridge, with grant funding from the Wellcome Trust