Estimating the costs of the diagnosis and treatment of melanoma for a model-based cost-effectiveness analysis: a new expert elicitation method

Rob Hainsworth[a], Martin Eden[a], Louisa Gordon[b, c, d], Adele Green[b,e], Paul Lorigan[f,g], Gabriel Rogers[a], Katherine Payne[a]

a Manchester Centre for Health Economics, Faculty of Biology, Medicine and Health, The University of Manchester, Manchester, UK.
b Population Health Department, QIMR Berghofer Medical Research Institute, Brisbane, Australia.
c School of Nursing, Queensland University of Technology (QUT), Brisbane, Australia.
d School of Public Health, University of Queensland, Brisbane, Australia.
e Cancer Research UK Manchester Institute, The University of Manchester, Manchester, UK.
f The Christie NHS Foundation Trust, Manchester, UK.
g Division of Cancer Sciences, School of Medical Sciences, The University of Manchester, Manchester, UK.

Background

When empirical evidence is not available, decision-analytic models often rely on eliciting expert estimates of input parameters using structured methods. Beta distributions commonly represent uncertainty in proportions of interest. Published methods for eliciting proportions ask experts to characterise the density of the uncertainty distribution in various ways.

Melanoma is a potentially fatal skin cancer treated by dermatologists, surgeons and oncologists. Interventions are rapidly evolving, meaning that up-to-date cost data are not available. Estimating treatment costs for melanoma requires an understanding of the proportions of people receiving each intervention. We aimed to elicit proportions receiving each intervention in the multidisciplinary care pathway for melanoma.

Methods

We mapped pathways for the dermatological, surgical and oncological management of melanoma. The Sheffield elicitation framework[1] informed an expert elicitation exercise to estimate proportions receiving each intervention. Consultants from each speciality piloted the relevant pathway and exercise. We adjusted the pathways and question format based on pilot feedback. We identified a sample of experts from each specialty, considering geographical spread across the NHS. Experts were consultants managing melanoma (surgeons, dermatologists and oncologists). Participating experts completed the final exercises. …

Figure 1 – Practice question illustrating the format of the questions for eliciting proportions

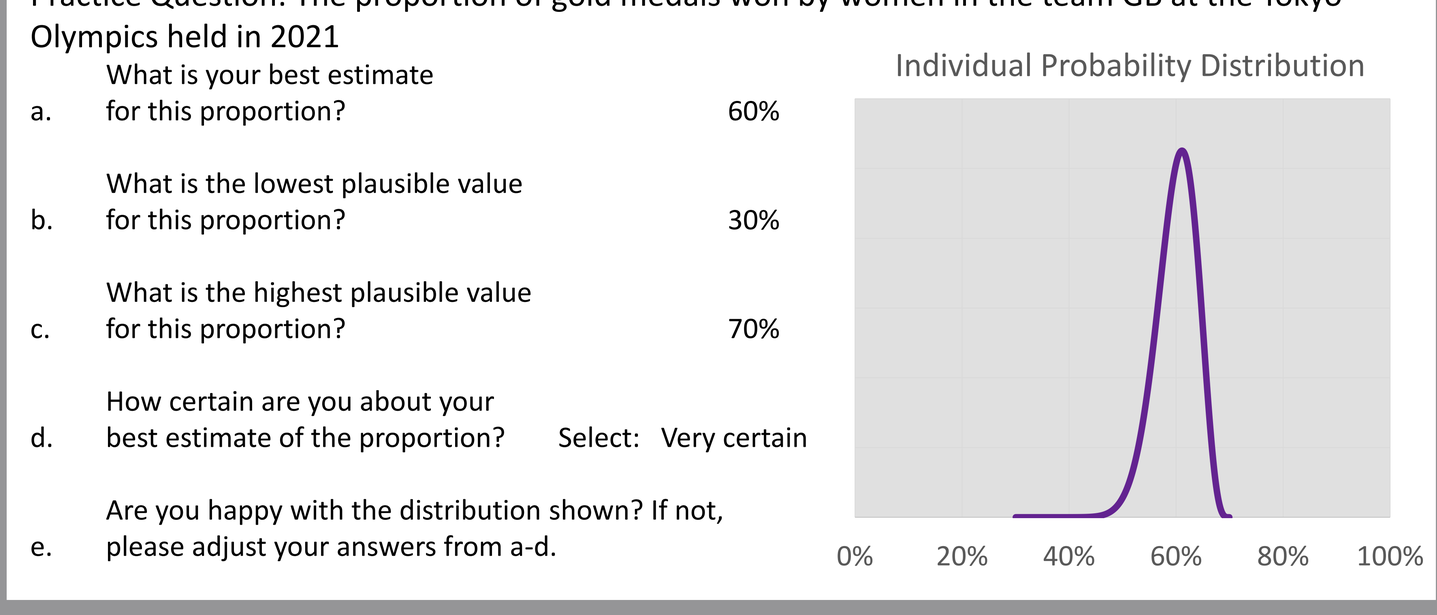
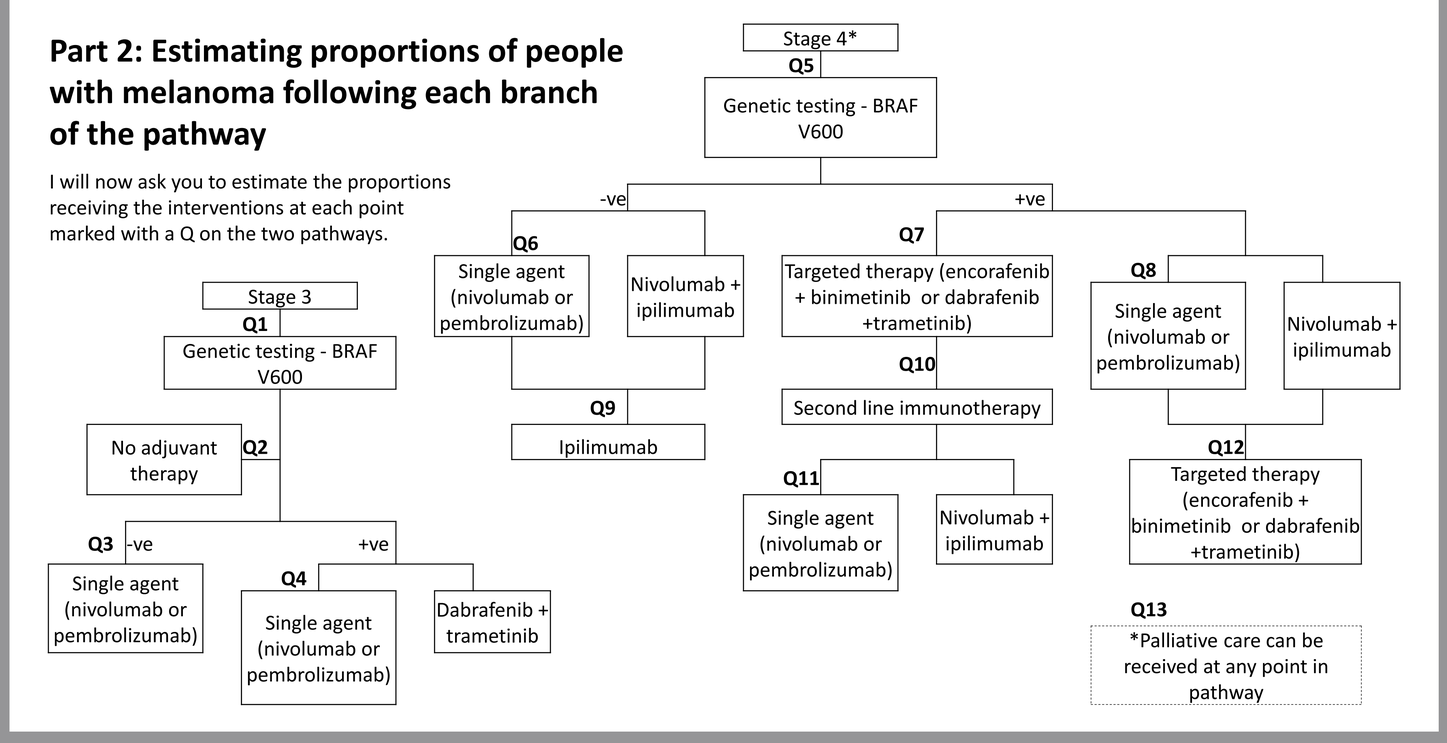


Figure 2 – One of three care pathways for which we elicited proportions (oncological management)



… The final question format asked for best estimates, lowest and highest plausible values, and extent of certainty on a three-level scale. We modelled experts' beliefs using beta distributions scaled between their lowest and highest plausible values (min, max). We used the best estimate as the mean (μ), and hypothetical sample sizes (Φ) of 5 for not certain, 10 for moderately certain and 20 for very certain. The following formulas gave the model parameters.

$$\alpha = \frac{\mu \times \Phi}{max - min}, \qquad \beta = \Phi - \alpha.$$

We found unscaled beta-distributions (α_2, β_2) with matching mean and variance (σ^2) as follows.

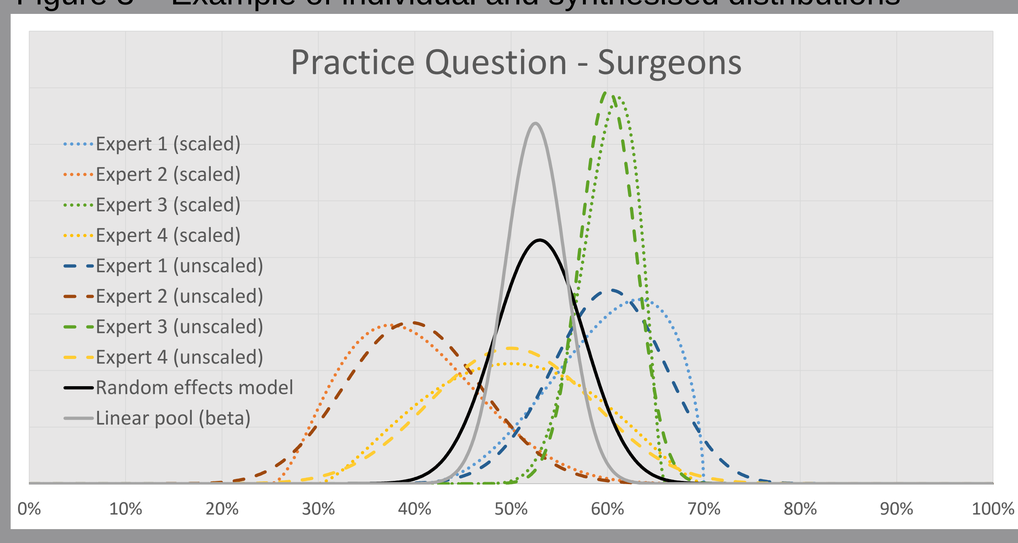
$$\sigma^2 = \frac{\alpha \times \beta \times (max - \min)}{(\alpha - \beta)^2 \times (\alpha + \beta + 1)}, \qquad \alpha_2 = \left(\frac{1-\mu}{\sigma^2} - \frac{1}{\mu}\right) \times \mu^2, \quad \beta_2 = \alpha_2 \times \left(\frac{1}{\mu} - 1\right)$$

Random-effects meta-analysis combined distributions. A sensitivity analysis fit a beta model to the average distribution (linear pool).

Results

The experts piloting the elicitation exercise found quartiles for a mean proportion difficult to estimate. We redesigned the exercise to ask for a best estimate, lower and upper plausible limits and a qualitative level of uncertainty for each proportion. Seven dermatologists, five oncologists and four surgeons completed the new exercise (August 2022-February 2023). Experts gave heterogeneous estimates of the proportions of people receiving many of the interventions.

Figure 3 – Example of individual and synthesised distributions



Discussion

Our estimates of the proportions of people with melanoma receiving each intervention, and associated uncertainty, will help to inform costing studies and decision-analytic models. Heterogeneity may reflect differences in clinical practice between experts. However, although we piloted the exercises, experts may have interpreted questions or pathways differently. This may obscure the true differences. Using a best estimate and a slider for uncertainty is a direct and intuitive way to derive a beta distribution for a proportion.

Acknowledgements

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1 Gosling, J. P. (2018) 'SHELF: The sheffield elicitation framework', in *International Series in Operations Research and Management Science*. doi: 10.1007/978-3-319-65052-4_4.

Information: research.bmh.manchester.ac.uk/healtheconomics **Contact:** rob.hainsworth@manchester.ac.uk