Disease prioritisation – what is the state of the art?

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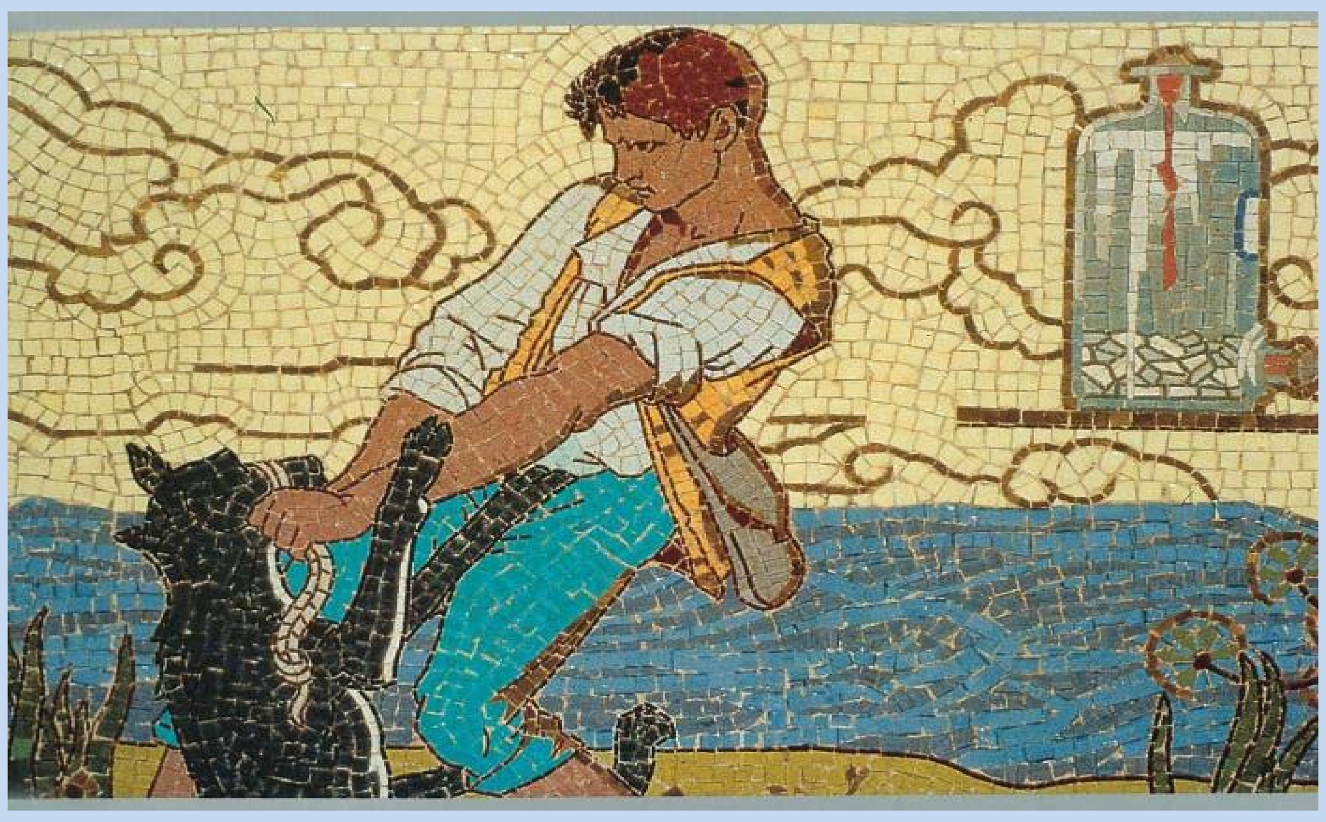


A Mosaic from Louis Pasteur's Crypt *Emerg Infect Dis [serial on the Internet]. 1999 Jun [accessed 06.03.13]. http://dx.doi.org/10.3201/eid0503.AC0503*
This mosaic from 1896 shows the shepherd Jean-Baptiste Jupille struggling against a rabid dog. The boy was one of the first people to be given post-exposure vaccines developed by Pasteur and Roux.
Although rabies is still a high priority disease, how does it rank in the 21st century compared with other emergent causes of encephalitis such as Nipah virus, Japanese encephalitis virus, Hendra virus, the equine encephalitis viruses, West Nile virus and Murray Valley encephalitis virus?

Disease prioritisation is a decision-aid. The desirable qualities of a "good" prioritisation relate to the two underlying themes of decision theory

The results of a prioritisation should be auditable and defensible – therefore, the method needs to be transparent and reproducible.

Normative decision theory

This is the dominant theory underlying decision making and is based on the "expected utility" (Bernoulli 1738, translated 1954), or value to individual decision makers, of each choice. It describes what a decision maker should do if they are following the axioms of rational choice (von Neumann and Morgenstern 1944).

Utility is described using a function in which the choice is broken down into quantifiable criteria, and each criterion is weighted to reflect the part-worth of its overall utility.

Key Point

- **Quantitative criteria provide transparency and reproducibility**

The results should be valid – they should reflect (without bias) the opinions of the stakeholders who are directing the resources.

Descriptive decision theory

This describes what people actually do when faced with decisions. Prospect Theory is an example of a descriptive decision model (Kahneman and Tversky 1979).

The research underlying this model showed that people systematically violate the axioms of rational choice and that framing the decision choice is important in how people perceive value.

Key Point

- **Modelling preferences for criterion weights using realistic scenarios aids validity of results**

Disease prioritisation is a growing field

Its use to direct both veterinary and medical resources has increased dramatically, with fewer than 10 prioritisations prior to 2000, but nearly 20 since then.

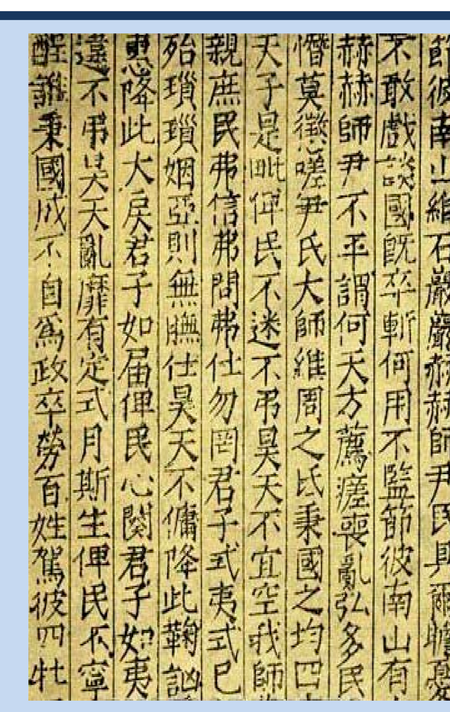
Methods used in disease prioritisation include subjective techniques such as rapid risk analysis (McKenzie et al. 2007), qualitative decision trees (Palmer et al. 2005), consensus techniques (Weinberg et al. 1999) and semi-quantitative scoring techniques based on levels of severity of disease criteria that may or may not be weighted to contribute to disease importance (Carter, 1992; Rushdy and O'Mahony, 1998; Valenciano et al, 2001; Doherty, 2006; Krause and Prioritization Working Grp, 2008; Balabanova et al, 2011).

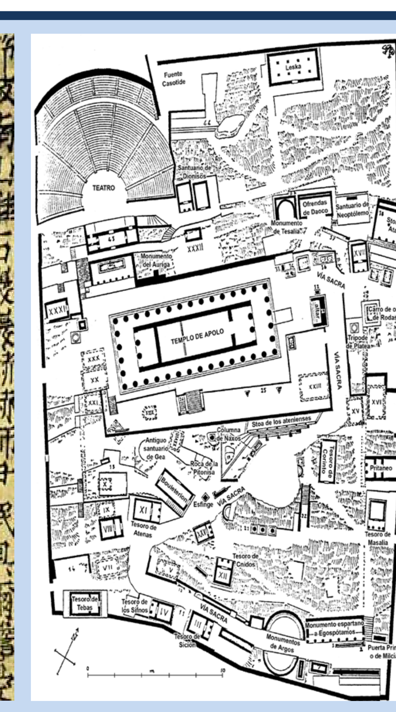
Recently, disease prioritisation has become more complex, with methods now using multi-criteria decision analysis (Havelaar et al, 2010; Mourits et al, 2010; Humblet et al, 2012; Mintiens and Vose, 2012; Del Rio Vilas et al, 2013) and weighting of criteria using probabilistic inversion (Havelaar et al. 2010).

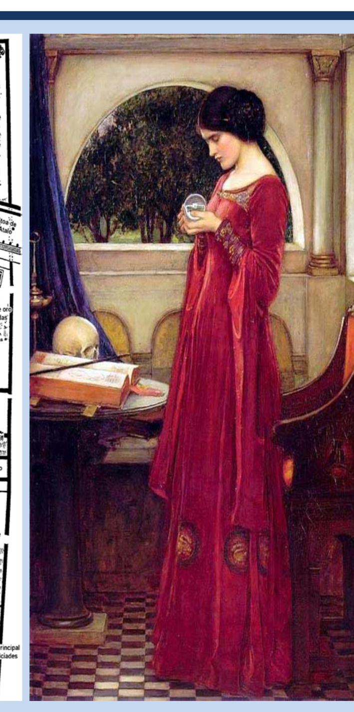
Are these new methods for disease prioritisation really necessary?

Complex decision-making methods have been used for millennia.: Chinese I-Ching, the oracle at Delphi, scrying using a crystal ball (wikipedia.com).
These methods illustrate two points:

1. *People do not like making complex decisions. We prefer someone or something else to do it for us.*
2. *The complexity, or seriousness, of the decision needs to be reflected in the apparent complexity of the method. For simple decisions we can toss a coin, or perhaps play paper-scissors –rock.*







Multi-criteria decision analysis (MCDA) aims to incorporate these key points

MCDA breaks down the decision problem into criteria on which the decision is based. Each criterion is weighted according to the opinion of the stakeholders. A weighted sum model based on normative decision theory can be used to describe the value of (score) each disease:

$$Disease_i = c_{i1} w_1 + c_2 w_2 \ldots\ldots + c_{in} w_n$$

c = quantitative criterion describing disease impact, e.g. case fatality rate
The criteria selected to describe potential disease impacts should be causal disease attributes that are measurable, and therefore transparent.

w = weight of criterion reflecting importance to stakeholder group.
The stakeholders are given complete disease scenarios to rank in order of importance. The weights are elicited by stakeholder preference modelling using probabilistic inversion (Neslo and Cooke, 2011), or regression analysis (Barry et al, 2010). As well as removing bias by using anonymous scenarios, scenario ranking accounts for aspects of descriptive decision theory by framing choices more realistically than weighting criteria individually.

Conclusion

The increased complexity of disease prioritisation has been driven by a desire to produce valid, defensible results.

Multi-criteria decision analysis is state of the art as it provides a framework to incorporate important aspects of underlying theory. However, no decision-making method is perfect and, as a result, decision theory is evolving rapidly, particularly in the field of descriptive decision theory and quantifying stakeholder opinion.

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