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The role of decision analysis in health decision making

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WHEN WAS THE LAST TIME YOU make a decision? Where to eat for lunch, should I quit my job, is this apartment worth the rent – these are seemingly normal questions one might have. And how did you come to your final decision? When considering alternatives for your apartment; you might look at the cost, distance from work or family, daily commuting time with a chance of heavy traffic, and whether you will be happy with these tradeoffs.

These decision questions have complexity, competing alternatives, risk/uncertainty, and tradeoffs viewed from multiple perspectives. Decision analysis is a method to help decision making by formally and explicitly evaluate alternatives, uncertainty, risks, benefits, and consequences.

Applications in health decision making would help answer questions for individuals (patients, physicians), or institutions (health insurer, hospitals, governments). A cancer patient may consider undergoing chemotherapy to prolong her life despite lower quality of life. The physician may weigh the benefit and harm of exposing the patient to CT-scan radiation. The government may decide to not cover the new expensive HIV drugs.

BENEFITS AND HARMS

It's much easier to demonstrate decision analysis using case illustrations (1). Let's say you are a 60-year-old patient diagnosed with cancer. After knowing all the alternatives, you can either do nothing or undergo surgery. Costs aside (i.e. you get reimbursed for all expenses); you will want to weigh the benefits and harms of the alternatives. Decision analysis gives you a framework to put all considerations together.

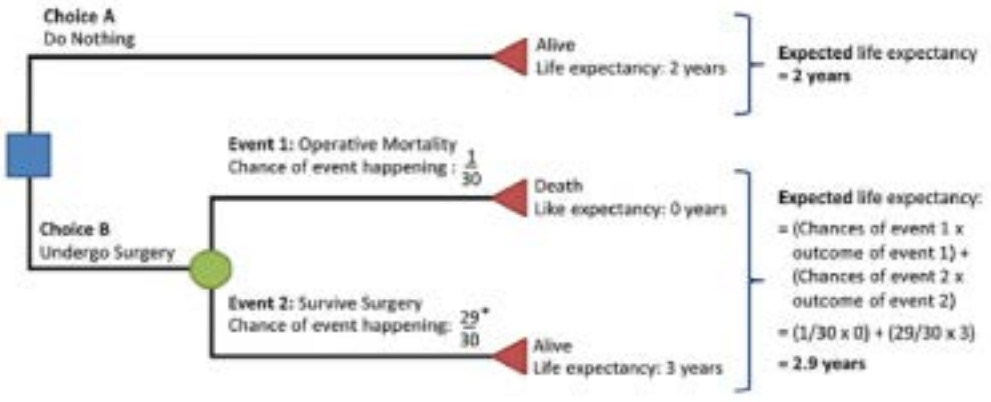

FIGURE 1. A decision tree model evaluating two treatment alternatives.
When the patient undergo surgery she is subject to the risk of death (event 1, chance 1 in 30). After evaluating the expected life expectancies, choice B (surgery) is preferred because on average it yields a better outcome of 2.9 years - instead of 2 years.

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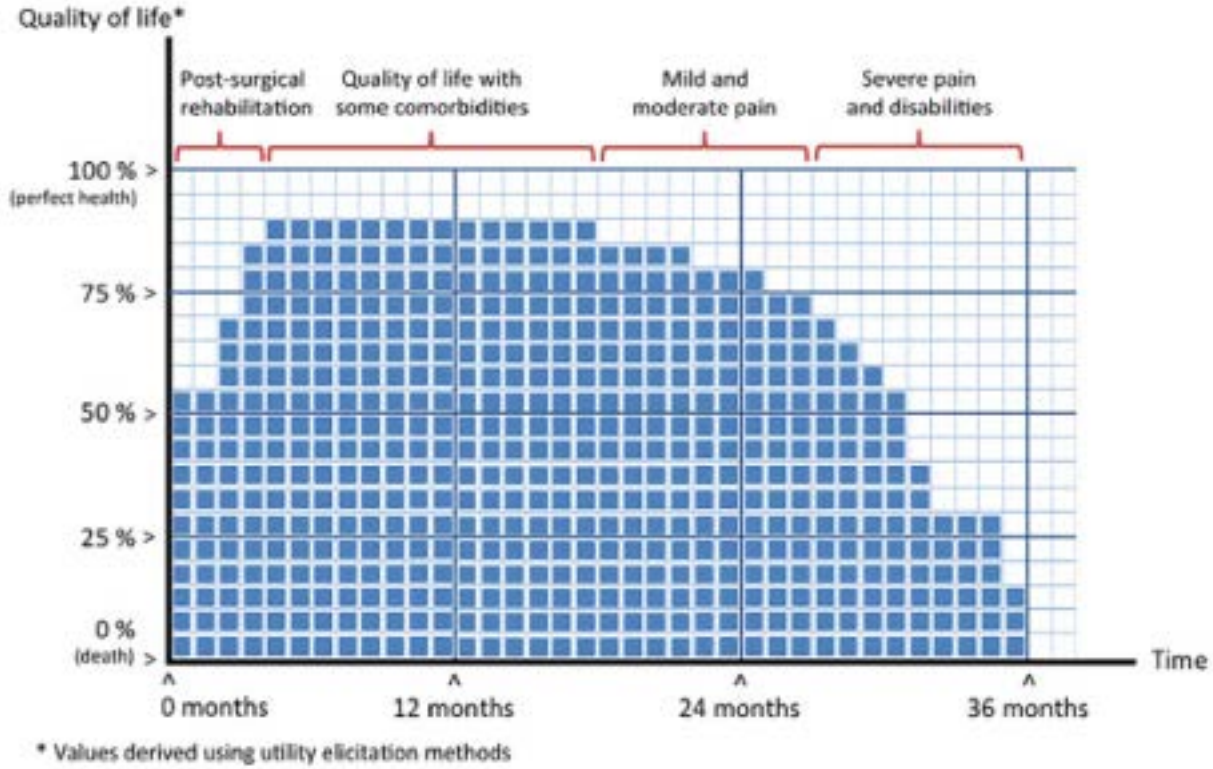

FIGURE 2. Illustration of quality of life adjustment, expanding on previous example (Figure 1 - Choice B - Event 2). This calculation takes into account the quality of life reduction associated with post-surgical rehabilitation, pain, disabilities, and end of life care. *Patient life expectancy is 3 years (the width of the bars). Adjusting for the quality of life (height of the bars), the patient has a quality-adjusted life expectancy of 2.25 years*

If you do nothing, your expected life expectancy is two years with considerably good quality of life. Surgery, however, carries some risk. On average one out of thirty surgical patients die on the table. However, people who survive the surgery on average live for 3 years. This case can be visualized using a simple decision tree as shown in Figure 1.

As we can see, this is a grossly simplified illustration. Once we grasp the concept of decision analysis, we can expand the decision tree to include multiple alternatives such as postponing treatment, a chemotherapy alternative, or initial surgery followed by chemotherapy. Further, we can incorporate chances of prolonged rehabilitation following surgery and chances of severe chemotherapy adverse reaction. One can also evaluate quality-adjusted life years (QALYs) gained - by taking into account the quality of life associated with the disease, rehabilitation, chemotherapy, and end of life care as illustrated in Figure 2.

Other factors, such as individual values, may influence decision making. For instance, how badly the patient would feel being a burden to the family, or how happy she may feel seeing her child graduate. These values are currently not quantified and not shown in the model. At the very least, decision analysis provides a framework for individuals in making an informed decision.

ADDING COSTS INTO THE PICTURE

When we add another dimension of cost, we now talk about a scarce resource and efficient allocation for institutions. Governments, for instance, are unable to provide all possible health treatments for all people, no matter how rich the country may be.

If the people request the government to cover expensive second-line HIV drugs, should they be covered? The same amount of resources might save more lives if they were allocated towards expansion of vaccination or malaria programs.

Some funds are earmarked for specific purpose. Global Fund's US$ 19 million HIV funding for Colombia is an example. Even with earmarked funds, there are other alternatives in place. Increasing access to voluntary counseling and testing clinics (VCTs), implementing prevention of mother to child transmission, providing needle exchange services for intravenous drug users, treating other sexually transmitted infections, and promoting male circumcision and condom use – all save lives and avert HIV infections with lower cost per year of life saved(2,3).

Interventions	Cost - effectiveness ($ per year of life saved)	Benefit (years of life saved)	Cost ($)	Country A (budget $ 70 million)	Country B (budget $ 50 million)
Reducing contraception unmet need	200	50,000	10 million		
Improving access to prenatal care and treatment of anemia	500	40,000	20 million		
Providing every village with a car, driver, and operational funds to carry free maternal deliveries	20,000	1,500	30 million		
Improving human and capital resource improvement at district hospitals	30,000	1,000	30 million		

FIGURE 3. Illustration of maternal mortality interventions. Richer countries have the resources to fund more interventions, albeit less cost effective (more expensive per years of life saved) (4).
Country A will fund intervention A,B,C and 10/30 of D; and would expect to save 91,833 years of live. Country B will fund intervention A,B, and 20/30 of C; and would expect to save 91,000 years of live. Assuming proportional benefits.

It is tempting to say, let's only finance the most cost-effective interventions (the best value for our money). This view is incorrect. The country's economy plays a big role in determining which interventions the government should cover.

Using households as an illustration, poor households will spend their resources tactfully - to have roof over their heads, food on the table, and clothes to wear. In a more affluent neighborhood, households hold more wealth and income. These wealthier communities have the resources to spend their money on bigger houses, aesthetically pleasing furniture, and private vehicles.

However, at one point a household will have to draw a line – i.e. this expensive car is not worth the money, we'd rather get the smaller car instead. In decision analysis, we capture this with the cost effectiveness threshold: at what point a treatment is considered not worth the money.

To illustrate this concept, assume we observe two countries. Country A is slightly richer than country B, but otherwise similar in terms of population demographics. Both countries try to reduce their maternal mortality rate. The interventions they can implement may include improving contraception use, increasing coverage of prenatal care, improved logistics such as reliable transport, and increasing hospital resource and preparedness.

In practice, both countries should evaluate the available 'shopping list'; and purchase interventions until their maternal health budget run out. Using the illustration in Figure 3, Country B can only afford contraceptive interventions, prenatal care access improvements, and provide two thirds of their villages with transportation logistics. The richer Country A has slightly more budget available for health. With this, Country A can afford contraceptive interventions, prenatal care access improvements, provide all villages with transportation logistics, and upgrade a third of its district hospitals. In short, richer governments can and should fund more health interventions, even those that are less cost effective.

The concept of cost-effectiveness threshold comes from this example. Country A has been spending money for interventions that cost $30,000 per year of life saved. Any new interventions that cost less than this should be considered cost effective and thus be covered by the government.

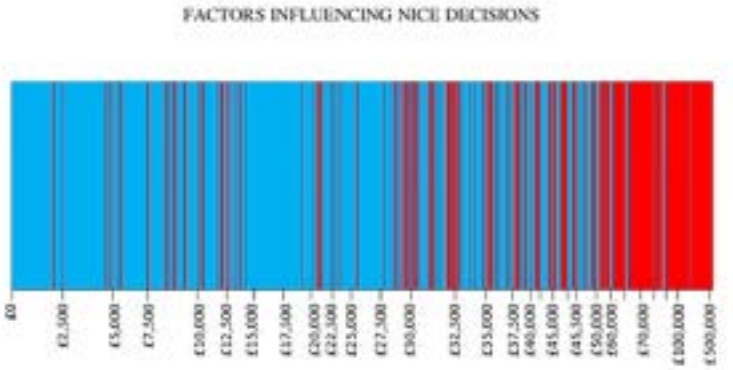

FIGURE 4. Impact of cost-effectiveness ranking on recommendations. Decisions are ranked, with NICE decisions to 'recommend' shown in blue and to 'reject' shown in red (7).

For instance, if a new legislation to allow safe abortion costs $ 1 million and is estimated to save 45 people. And both governments have an extra $1 million in their budget. Should they cover safe abortion?

It depends. For Country A, this new legislation ($22,222 / life year saved) is below their threshold and is considered cost effective. However,
for Country B, this initiative is more expensive than what they have been spending (Country B's threshold is $20,000 per life year saved). In other words, it is not cost effective. Country B is better off spending the newly gained $1 million dollar in expanding the transportation initiative, as it would yield more benefits.

Again, these cases are here to illustrate how one should conduct a decision making process rationally using decision analysis methods. In practice, the US is believed to have a threshold of about $50,000 per Quality-Adjusted Life Years (QALYs) gained, and the UK about £30,000. On a similar scale, the World Health Organization uses three times the Gross Domestic Product (GDP) per capita as the cost-effectiveness threshold.

BEYOND THE ILLUSTRATIONS

Policymaking is not simply calculating costs and benefits. The ethical dilemma of legalizing abortion, the political climate, and the society's acceptance are some of the external forces that affect decision making.

When we are dealing with resource allocation, there are context-specific values that need to be incorporated. Decision analysis is an ethically neutral method, meaning all population receives the same weight. Should we value a child higher than an adult? Should we put a higher priority for health benefits impacting the poor compared to the rich? Should we put a higher value on diseases that affect more people in the country? These are important questions that need to be addressed. New research on Extended Cost Effectiveness Analysis (ECEA) are trying to disentangle some of these ethical questions, especially on areas affecting poverty (5,6).

Although decision to cover health interventions are not deterministic using cost-effectiveness analysis, research show that these methods do play an important role in determining which interventions to cover.

For instance, The UK's National Institute for Health and Care Excellence (NICE) recommend health interventions with cost effectiveness ratio of less than £20,000. Above this threshold, other factors such as targeting disadvantaged population, end-of-life care, and severe diseases receive special considerations. As shown in Figure 4, the chance of a treatment being approved for national coverage in the UK goes down, as the intervention is less cost-effective.

In conclusion, a decision must be made, either towards action(s) or inaction. Avoiding a decision is, essentially, a decision for inaction. Despite the limitations of the methods from individual and societal perspective, decision analysis is not useless. At the very least, it provides a framework to compare multiple interventions, allocate resources efficiently, and help people and institutions make better and informed decisions.

Conflicts of interest: nothing to declare.

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