Health Economics

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Week – 09

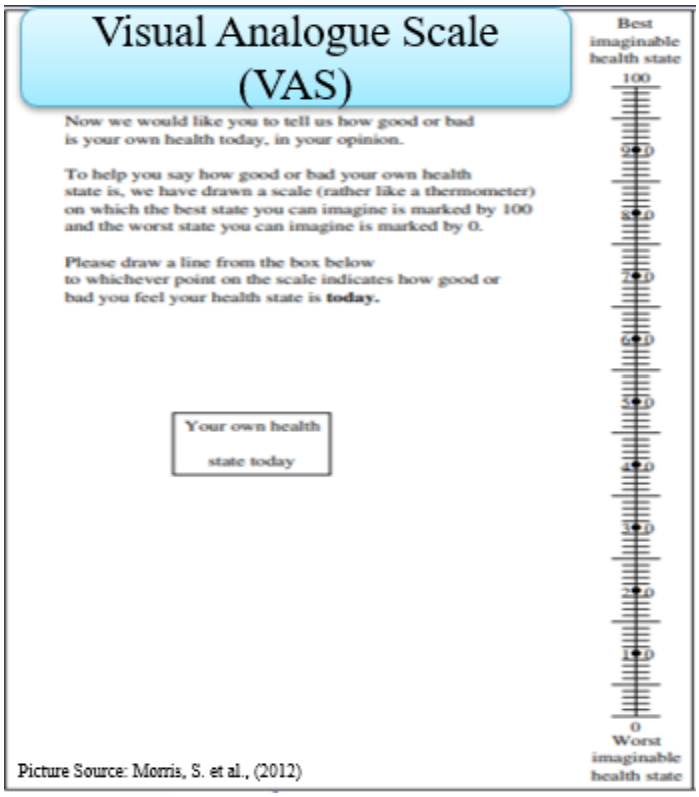
Lecture 44- Non-monetary Valuation of Health: DALY & HLYE

Welcome friends once again, to the NPTEL MOOC module on Health Economics. We are in continuation to our previous lecture. We discussed non-monetary measures of health. In particular, we discussed about the HRQOL (that is 'health related quality of life') and their generic descriptive tools. Then, we emphasised QALY and different health systems. And we also discussed about their evolution.

In this lecture, we will emphasise on health state valuation techniques. We will also discuss health indexes other than QALY, i.e., disability-adjusted life years (DALY) and healthy life years equivalent (HLYE).

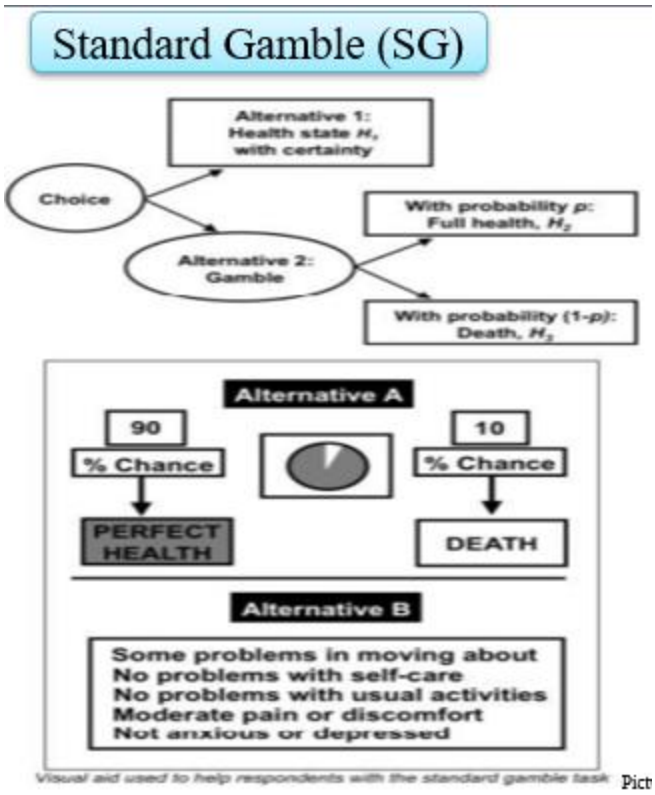
So, let us understand health state valuation techniques. These techniques are of various types. Like 'magnitude estimation', or 'paired comparison'. Here, in the magnitude estimation case, people are simply asked to give a direct estimation of size. Whereas, in the paired comparison, we are supposed to take the alternatives and find out the most preferred one. However, in all the techniques, the most widely applied techniques are 'visual analouge scale (VAS)',' standard gamble (SG)', and 'time trade-off (TTO)'. So, these three will be discussed in detail.

We will start with visual analouge scale (VAS). Here, this is your scale, where you can map directly from the scale itself:



It is currently one of the most used health evaluation techniques since it is simpler. In short, it is called VAS (i.e., visual analougeue scale). However, its role is controversial, as Parkin and Devlin (2006) mentioned. However, it has merit that it requires minimum assistance. Usually, this consists of a single line with fixed endpoints and equal intervals with verbal and numeric descriptions at each end. The vertical line illustrates VAS. The bottom value indicates 0, whereas the top value indicates 100. So, the bottom refers to the worst health issue (i.e., death), and the top indicates the best health. Respondent is asked to provide a description of the health state on this scale before and after treatment.

Another is called the 'standard gamble (SG)' method or technique. This SG was invented specifically to measure 'von-Neumann and Morgenstern' utility. This is applicable to healthcare or health. There are steps involved to understand the standard gamble (SG). In the step 1, the patient is informed about his current health condition, detailing the impact on their daily life, potential complications, overall quality of life etc. In the step 2, patient is presented with a choice between two alternatives. Alternative 1 is be in a current state, i.e., current condition associated with the quality of life (QoL) (you can also see from the figure).



Visual aid used to help respondents with the standard gamble task Pict

First, you need to find out current health, i.e., in this case we have mentioned as A1.

We will also present the A2 case. In the second alternative, it is a proposed treatment that involves gamble with two possible outcomes, one better (with a certain probability of recovery and success) (Q_F), referring to full health with probability P, and the other outcome is having a health condition, that might be worst, or it has attached with risk. So, it is called risk of adverse effects due to treatment failure. Either of outcome (both outcomes) are mentioned as the P (probability of getting), and $1 - P$ (probability of death.

Hence, the utility function is defined as an expected form with their probability as P and $1 - P$.

❖ Formally, if

$$Q_i = Current\ health\ state$$
$$P = Probability\ of\ treatment\ success$$
$$(1 - P) = Failure\ of\ treatment$$
$$Q_F = Full\ health\ \&\ Q_D = Death$$

Then,

$$\boldsymbol{Q_i = P \times Q_F + (1 - P) \times Q_D}$$

where,
In LHS, value of being in described health
In RHS, expected value of choosing risk option

So, we can mention as $Q_i = \mathrm{P} \times Q_F + 1 - \mathrm{P} \times Q_D$, (where Q_F is the patient improved with treatment and $1 - P$, that is not improved rather losing life). So, in the left-hand side, we are explaining the value about the described current health, and on the right-hand side, we are explaining the expected value of choosing the risk option.

So, one important aspect attached with this is the varying probability of success. The patient is then presented with different probabilities of treatment success in increments. Treatment not necessarily be 1 and 0 or only success or failure. So, for each probability, the patient is asked whether they would choose the 'certain outcome' that is of continuing with the current health system or health state, or take the gamble on the next treatment.

The fourth step is all about the total utility or the determining utility. So, the probability at which the patient becomes indifferent between the "certain outcome and 'the gamble', this represents their subjective assessment of the treatment's value. The utility derived from this probability reflects the perceived QoL (quality of life) associated with the treatment options (which we have already discussed).

Then comes TTO (Time trade-off). Time trade-off is simply a choice with time. A longer inferior health state (if bad health is considered to be taking longer) or a shorter life in full length, there is a trade-off between these two (trade-off between quality of life or length of life). So, whether time really matters or the quality of life matters. If individual chooses quality-of-life or he chooses more longer life time.

In the step 1 of the TTO, respondents are usually asked to imagine themselves in a described health state, let it be Qi for a period T, T maybe of 10 years. Then the respondents are asked how many years they would be prepared to trade-off in exchange of their full health. In the third step, we try to establish where respondents are indifferent between the QoL (that is, quality of life) and the LoL (that is, length of life) , by varying the amounts of time in full health (t).

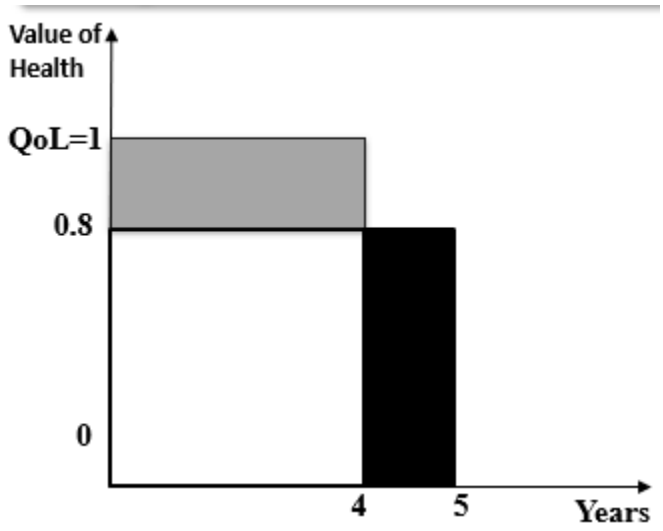
Formally, $Q_i \times T = Q_F \times t \rightarrow Q_i = t/T$

If, $Q_i = Current\ described\ health\ state$
$Q_F = Full\ health = 1$
$t = shorter\ period\ with\ Q_F$
$T = reference\ time$

Since, the Qi times the total T is nothing but is equal to the Q_F (we already said) times' t' (the amount of time in its full health, and Q_F stands for the full health, that is equal to 1). The current described health is Qi and, t is shorter period with Q_F, and T is the total reference time. Since, the full health is equal to 1 ($Q_F = 1$), hence Qi is equal to t /T.

Example:- Suppose one of the alternatives is a particular state of health (Qi) for 5 years and the respondent states that this is equivalent to 4 years in full health (Q_F). Then, the value of that health is 4 / 5 (since t = 4 and the total length of the state of health =5 years), so Qi in this case is 0.8.

A figure for this is explained here.



You can see the full QoL, and the full years is mentioned. And as per the estimated TTO, TTO is actually 0.8. So, you can just mark it from here. TTO reflects the explicit QALY choice comparing quality of life to length of life. This figure gives two equally good combinations of quantity and quality, that is two rectangles of the same size.

Hence, there is a possibility of trade-off, either you go for one, or you are compromising other or just the reverse. So, this requires a compensation (we are saying trade-off or this involves opportunity cost). Hence, it is equivalent to the expression of willingness to forgo to estimate the QoL.

Out of the choice of these three, that is VAS, SG and TTO. I am just going back and will show you what we have discussed. I will just come back. So, this is what I said- first staring with VAS, i.e., visual analouge scale and a gamble setup called standard gamble. Then, we also estimated TTO. So, now we are just trying to compare these three together. SG and TTO are choice-based measurement techniques that are preferred for economic valuations. And this is because people mainly will not reveal true preference without constraint choices like they have in their real life. Like stated preference, all these techniques are either experimental or survey-based. This means less reasons to apply economic behaviour reasoning to it. The visual analouge scale have desirable psychometric properties like data collection efficiency

and minimum cost of sample. VAS measure is argued to have some advantage over others, however, the TTO (we just say) is most widely used.

Till now, we discussed from a person point of view, just a single person point of view, not from a societal point of view. Here we are linking to how a person is trading up with the society, hence, it is called Person trade-off method. In addition to these three techniques for measuring the individual value of Q, there is called PTO (person trade-off) method that looks at the social values (SV), the SV of one health compared to another, as mentioned in the paper Nord (1995). Unlike the other three, it asks respondents to imagine a hypothetical choice between saving one person's life or treating the N persons in the described state. You might have seen whether treating disease of one is equivalent to how many other diseases that can be corrected in a hospital. Hence, policies reflect which one to emphasise and how many people can be cured.

Implicit social value of described health: $SV_i = 1 - 1/N$. The value implied for the PTO intended to reflect the social value of health state against individual utility implied from the SG and TTO. However, here always, a question persists, i.e., how great this size (that is N size we just referred for the social value), so how great N should be for respondents to consider two programs (with the choice of two programs, that is life-saving or treating N number of patients) to be equally good? So, by referring to these discussions, we are here mentioning the limitations of that QALY (which we already started).

QALY received much criticism in literature, relevance of critic depends on what QALY purports to be. If it is meant to reflect the individual utility of health gains, there are certainly deficiencies in the ways of its measurement. Its empirical evidence shows that assumptions like risk neutrality, constant proportional trade-off between Q and T usually do not hold. Hence, QALY is questionable. And if it is meant to reflect the social value of healthcare, there are certainly other concerns beyond differences in health gains. Empirical evidence shows other streams of health matters, such as severity of illness, age, etc. However, if QALY is meant only to measure health outcomes, the above criticism does not hold. So, if it is only to measure health outcome, it is perfectly fine.

Since, there are some problems we identified with the QALY. Hence, in the latest one (we are using latest two techniques) we will be emphasising are DALY, that is mostly used. DALY stands for disability adjusted life years.

This is alternatively used to QALY. This is developed by a research group of Harvard University, World Bank and WHO (World health organisation) in 1994. And to define this, one DALY represents the loss of equivalent of one year of full health. So, loss of equivalent of one year full health means one DALY. While QALY is developed for measuring health gains, DALY is developed for measuring the global burden of disease (GBD), that is to be noted. So, GBD is emphasised. Hence, the loss of equivalent one year of full health is important, so far as one year of DALY is discussed.

GBD refers to the health losses associated with various causes of disease and injury. DALY is a measure of the gap between the current health status and the ideal health situations where everyone lives to old age in full health. DALY is also intended to be used as a metric for health effects in denominator of cost-effectiveness ratios (CERs), like we discussed in QALY. Similar to QALY, DALY provides metric intended to be completely commensurable across modalities and morbidities.

Measurement of DALY is presented here. This is indeed a combination of both the years of life lost due to premature mortality (YLL) and the years lived with disabilities (YLD).

Formally, $$\boldsymbol{DALY = YLL + YLD}$$

where,
YLL = Years of Life lost (YLL) due to premature mortality in the population
YLD = Years lived with disability

DALY is just an addition or sum of the YLL and YLD (premature mortality and the years life with disability)Hence, when these two are added, we get the DALY value. So, what is YLL then?

Calculation of YLL:-

$$\text{YLL} = (\text{Life Expectancy} - \text{Age of Death}) \times \text{Number of Deaths}$$

Calculation of YLD:-

$$\text{YLD} = \text{Prevalence} \times \text{Duration} \times \text{Disability}$$

where,
Prevalence: The number of people living with a particular health condition.
Duration: The average time a person lives with a disability.
Disability Weight: A factor representing the severity of the disability, ranging from 0 (perfect health) to 1 (equivalent to death)

YLL basically is the expected life expectancy minus age of death times the number of deaths in a time frame. And calculation of YLD is basically mentioned through the product of prevalence, duration, and disability. The YLD is years life with disability that means disability is there. The years of life means the duration which is there and the extent of disability, that is prevalence, it is also present. So, prevalence is here, in terms of number of people living with particular health conditions. Disability weight is also important; it is a factor representing the severity of the disability, ranging from 0 (that is, perfect health) to 1 (equivalent to death). Here, we are taking the notation in reverse to identify the related aspects of death or disease.

Let's take an example to understand DALY use. In a community affected by a disease. Let us say, 50 individuals die at the age of 60. 30 individuals (including children and adults) experience a disability with a weight of 0.7 for 5 years. If the standard life expectancy is 80, what is DALY count?

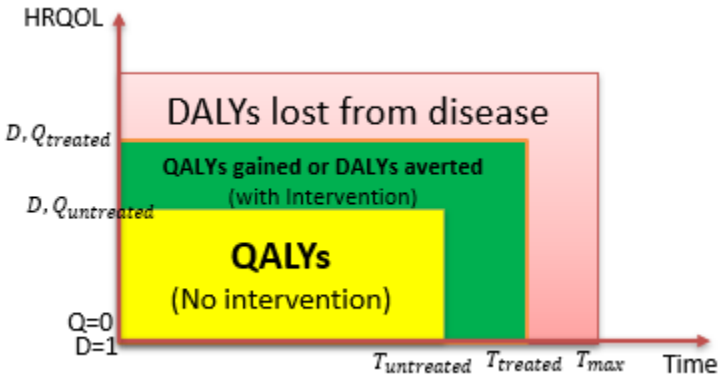
In that case, we are supposed to simply add YLL and YLD. Here, when I say years of life lost that means years of life lost from the maximum full life. The standard life expectancy is 80, and individuals die at the age of 60.

- First, calculate→ **Years of Life Lost (YLL)**= (Life Expectancy at Death)×Number of Deaths
  => =(80−60)×50=> 20×50=> 1,000 YLLs
- Then, calculate→ **Years Lived with Disability (YLD)** =
  => (Prevalence× Duration of Disability× Disability Weight)
  => 30×5×0.7 = 105 YLDs

Now, let's calculate the DALY using the formula:
DALY =YLL+YLD
DALY =1,000+105 = 1,105 DALYs

Here, the difference is mentioned and it is multiplied by the number of deaths (i.e., 50 individuals died). So, 20 times 50 is 1000 YLLs. Then, we will calculate YLD, i.e., simply multiplying three: prevalence, duration of disability, and disability weight. In this case, it is given as 0.7 (the weight) and is 5 years (the duration of weight) and 30 individuals (prevalence). So, the product gives the YLD as 105. Given these figures, we can calculate DALY by just adding these two. We will find that 1105 as the DALYs.

Now, the obvious question is how to avoid these DALYs when they are considered to be higher in number. DALY averted refers to the reduction in DALY due to an intervention. Fox-Rushby and Cairns (2005) illustrated it through a figure.



Here, the figure showed 'QALY', 'QALY-gains or DALY-averted' with intervention, and 'DALYs lost from disease' in different time indicators. With the interventions, you will see higher indicators ranging from the Q and D. The first one is untreated, then, the treated and the maximum-T (till the death) is presented. We are referring to Fox-Rushby and Cairns (2005). We need to mention clearly that DALY averted is similar to QALY gained. Arithmetically, DALY is inverted QALY. It is most important for your questions in the exam.

Healthy life years equivalent (HLYE) is another tool that measures the value of years of life in good health. We are emphasising that healthy life years equivalent is adjusted for quality of life (taking into account mortality and morbidity). So, HLYE is calculated as-

Calculation:

HLYE= Life Expectancy × Health Related Quality of Life

where,

Life Expectancy: The expected number of years an individual is anticipated to live
Health-Related Quality of Life: A measure ranging from **0 to 1**, representing the individual's perceived quality of life, where **0 is equivalent to death, and 1 is perfect health**

Health-related quality of life, in this case, ranges from 0 to 1, representing individuals' perceived quality of life (where 0 is equivalent to death, and 1 is perfect health). Life expectancy is the number of years an individual is anticipated to live.

This HLYE is similar to QALY but may be used specifically to emphasise a healthy state or disease-free years of life. See an example, that you can easily calculate. If the life expectancy is given as 70 years, then due to some illness, the individual has a lower quality of life, and hence the HRQOL score is 0.8.

HLYE=70 years × 0.8 = 56HLYE

So, the life expectancy we have already mentioned and the HRQOL figure is given as 0.8. So, in total, it is 56 HLYE. This means the individual is expected to live 70 years, and these years are considered equivalent to 56 healthy years, given the quality of life.

It also has limitation that this is too simplistic and predicting healthy years of life is very difficult. This HLYE is useful for assessing the population's overall health, but it does not provide information on the burden of disease or the effectiveness of specific interventions. This does not even provide like DALY and QALY.

Here are the comparisons of these indicators, which are already mentioned.

	Commensurable across:			Preference based
	mortality, T	morbidity, Q	mortality and morbidity, Q*T	
Survival rates, increased life expectancy	Yes	No	No	No
Uni-dimensional end points; 'soft' or 'intermediate' Multi-dimensional condition-specific instruments	No	No	No	No
Health profiles, e.g. SF 36	No	Yes	No	No
QALYs (quality-adjusted life years)	Yes	Yes	Yes	Yes
DALYs (disability-adjusted life years)	Yes	Yes	Yes	No

Source: Olsen, J. A. (2017)

The most important indicator is preference which is rare among all indicators. In this figure which one can be chosen? The table answers this question as it shows the type of health outcome measures depending on commensurability (based on four resource allocation requirements), i.e., mortality, morbidity, mortality and mobility and preference based, which we have stated from the beginning. You can see that you will hardly find figures in each of the indicators. For survival rates, etc., of course, it will be 'NO' here. Hardly preference is noted because these are macro figures, and individual figures is not indicated.

But in other cases, like QALY and DALY, especially QALY has all have YES as the response. Even in preference-based situations, QALY is preferred. In the case of DALY (disability-adjusted life years), the preferences are not made, which is again because the figures related to morbidities, disease, and life expectancies are where preferences are not taken. But other indicators are perfectly fine. Hence, it depends upon the context you are into and you can apply the technique accordingly.

So, in short, what is important in this lecture. In the previous lecture we discussed about the QALY. And here, we discuss health state valuation techniques, such as the VAS, the Standard Gamble (SG) and TTO, and PTO (where we link with social values). And we also addressed the limitations of the QALY. You can refer to the previous lecture on the different aspects of QALY. The also discussed the alternative uses of QALY, i.e., DALY and HLYE. However, DALY is preferred even better than HLYE, given its objective, methods, and purpose. So, we have also explained those with their respective examples.

I think these two lectures will be very useful from your exam point of view. You can compare these outcomes and answer the questions accordingly. I strongly suggest reading carefully between the lines in the PPT and their respective readings. In the next lecture, we will have information that emphasises the cost and discount in health evaluation and other aspects of economic evaluation.

So, these are the readings. I think I should conclude without delay since we have already exceeded the time. I hope you will raise questions about further clarifications. Thank you.