

Economics of Health and Healthcare
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Lecture – 38
Cost-utility Analysis

Hello everyone, I hope you all are doing well so, in this session we will continue with this economic evaluation techniques and in our last session as we learnt that there are primarily 4 types of economic evaluation techniques and I will just give you a; you know a brief background that economic evaluation tries to understand the efficiency of a particular health process it; economic evolution is mostly used in Health Sciences, yeah.

To understand the you know the most, you know optimum technique or process out of different ultimate or alternative choices what we have, so given the inputs and the outputs we have several processes, we have choice of drugs, hospitals, providers, treatment techniques and then based on my you know, cost and the effectiveness of each of all these processes, alternative processes or choices, I will try to select the best one you know which will be most kind of most efficient for me either minimizing cost, maximizing benefit.

Or you know, otherwise you know either in terms of this allocative, technical efficiency or in terms of allocative efficiency, where my distribution gives me the perfect or the best output having a budget constraint therefore, once we try to understand you know, the effectiveness of different health processes and we try to do, we select a particular one when we compare them based on the cost as well as this effectiveness.

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- ① Cost minimization Technique
- ② Cost - benefit analysis
- ③ Cost - effectiveness analysis
- ④ Cost - utility analysis
↓
QALY.

We have 4 this thing right, techniques, the first one is cost minimization technique, what we learned in cost minimization technique is; when we have idea about the health outcomes or health processes but the health processes are absolutely, I mean the effectiveness are very, very similar, very uniform right, yeah all the processes or all the alternatives, the effectiveness is absolutely same.

Yeah, so that is the assumption we take and then we just you know try to understand which has a minimum cost and we select that number 2 is cost benefit analysis, if now we can estimate our effectiveness in terms of monetary you know, values, so if we can estimate the benefit especially, you know cost is monetary value benefit, if we can estimate them in terms of monetary values, then we do a cost benefit analysis yeah.

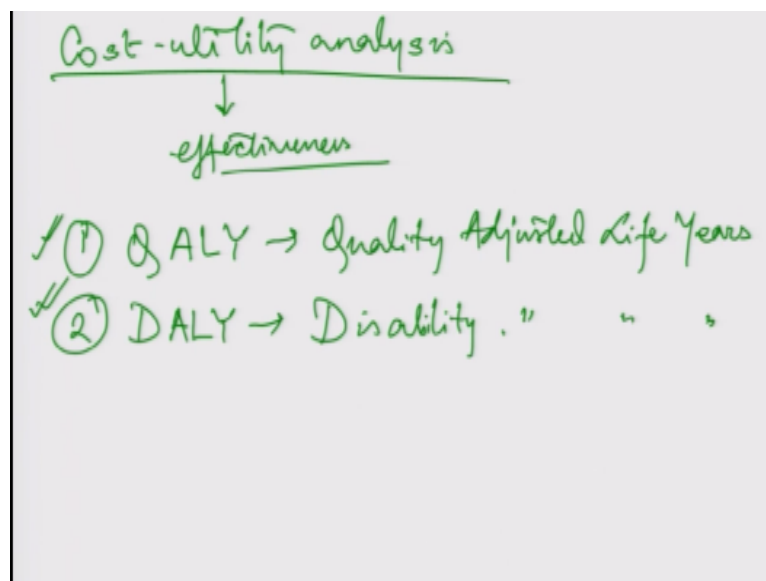
And then the third one is cost effectiveness analysis, where we estimate the effectiveness in terms of a numerical figure and then we try to form a decision rule based on the incremental cost effectiveness ratio that is how much the change will; how much a change in the cost will take place based on 1 unit you know, change in one unit more effectiveness and these effectiveness are often measured in terms of simple glucose level you know the maybe the blood pressure, sugar level, these haemoglobin level and all these things.

And it can eventually, be measured in terms of quality adjusted life years, dis adjusted life years that to get one disability adjusted life years, to get one unit DALY or one unit QALY whatever but I what amount of cost I extend it to incur but at the same time, you know when we talk about QALY and DALY, we basically attach it with cost utility analysis especially, in cost utility analysis, my effectiveness is measured in terms of utility.

And then, it is measured in terms of QALY, yeah quality adjusted life year and that is my utility like a kind of assumption based or abstract value of utility measurement, when it is attached with the health or the improvement in quality in terms of life years therefore, these are the 4 basic; basic economic evaluation techniques, we have learnt yesterday cost effectiveness analysis and cost minimization analysis.

Today, we will learn more about or start learning about cost; first cost utility analysis and then cost benefit analysis okay. Now, what is cost utility analysis?

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Cost utility analysis is when my effectiveness can be measured in terms of utility, yes and again this utility out of several comparative; comparative measures like I can get a level of utility from process A, I can get a different level of utility from process B, may be process A and process B has 2 different costs associated with that and then based on those cost, I will try to understand that you know how far I am gaining my utility.

It can be from a particular treatment you know, medicine, it can be out of a particular or completion of a treatment process or it can just be you know, kind of medical care or kind of you know trauma management, kind of palliative care that is that you know, even it takes the psychological treatments, so they are getting because that is that is the process or just the kind of time they are getting from the doctors, you know.

So and this all can be estimated in terms of the patient satisfaction or a utility measurement finally, but otherwise in a holistic form we, when we try to estimate the health outcomes, overall in terms of utility we generally, measure it in terms of QALY; QALY again is quality

adjusted life years, very difficult to understand; quality adjusted but it is very difficult to measure because often you know, people; it is again an imperfect market.

And people do not have much idea about the you know, the quality is about the not only quality of the life, the quality of the services, what kind of services they are being given, what is the different components of those services, so they really do not have much idea and then the collecting the data is often very difficult to know and in countries like India or any developing countries where data has is; has been a scarcity.

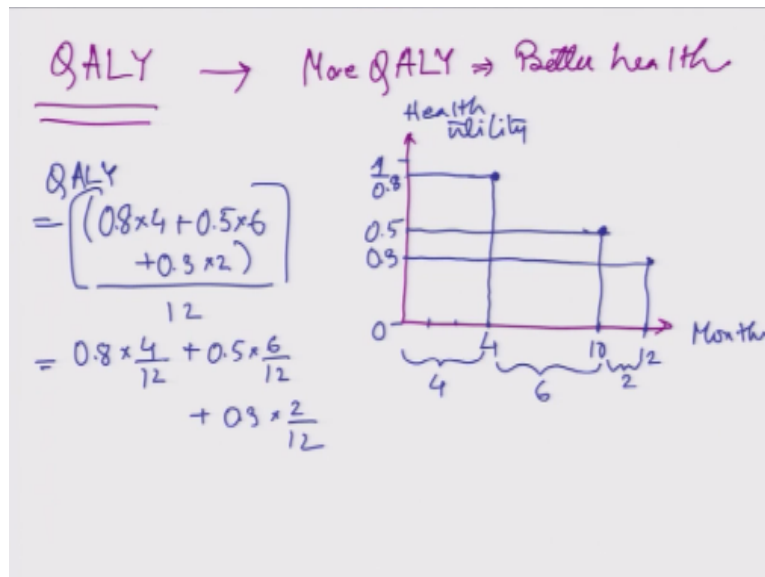
It is very difficult to estimate QALY but then the best alternate measure is DALY; disability adjusted; adjusted life years otherwise, there is HY healthiest year in equivalence and all this you know that for a particular treatment, how much, how many years you have got but these are the main 2 estimates; QALY and DALY, which is used worldwide you know and is most used of course yeah.

So, can identify this, can identify only relatively large amount of changes or individual the health status that is primarily because you know slight change may be my utility, my satisfaction, it does not really change or the years I get you know, life years, the change in terms of the life years are really not meaningful. If it is 1 day, does not really make sense you know through an estimate QALY or DALY.

Because when the; we are estimating in terms of years, the value of 1 day you know, the you need the value is so low that it really does not make much sense and so therefore, we estimate QALY and DALY for a larger period of time for a particular individual or a group of individuals or country, the micro level as well as the macro level and when you know the change the effectiveness is really large you know, relatively large as compared to effectiveness.

Effectiveness we can you know, estimate even the small changes but over here, it really does not make sense, we can estimate but very difficult to estimate and so small the estimates in terms of the units given for this particular measurements are you know does not really make sense, so how we estimate; first, we will try to understand that you know how we estimate QALY and then probably, we will go to DALY.

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So, when we estimate QALY; quality adjusted life years, say I will try to estimate, I will try to show this in terms of diagram but in QALY as we said last day that more the QALY better the health because more the satisfaction, better is the health right, QALY better is health, so therefore, let us see you know diagrammatically, how we can present that let us show what graph yeah and maybe this is 0 and this is 1.

That means, my health utility or QALY's values will fall within the range of 0 and 1, yeah and then it can be estimated in terms of months or years you know, years it is often difficult to know to accumulate and then again, the recall period and all being large, so often the patients do not really remember or the hospital statistics may not be collated well, so months or years yeah, so whatever we are taking the example of months, year.

And as I say it that you know over here it will be, let us take that this is still 12 months during a particular year yeah, every unit is 1 month, 2 months, 3 months and so on and then, we have seen for a particular individual that you know, the for 4 months, the QALY was something like 0.8, so here was the point; 0.8 and 4 months here. That same person, he for the; you know, till 10 months, till 10 months, his QALY was, so I will just write down here 0.8.

His QALY was 0.5 here and then for the last 2 months of the year, his health deteriorated and his QALY was 0.3, right so, this is you can see, this is kind of an indifference curve, is not it but it is not basically like that here, this is the; this graphical explanation about you know, how it can eventually come in and all yeah, so when the month increases, how their QALY is falling yeah, it can eventually increase like you know, so it is not like a basic indifference curve.

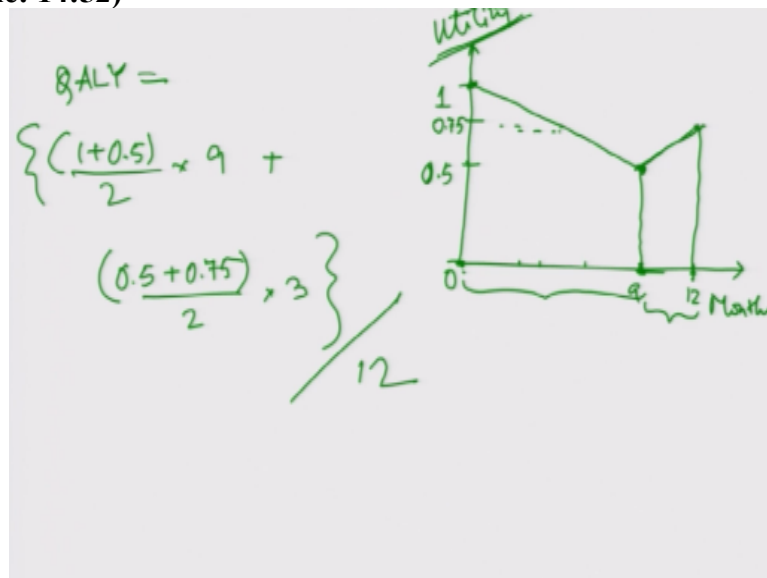
Because here, I am estimating the utility not year, yeah so what, what I am doing over here is now, given this, given this diagram, I will try to estimate QALY, so in this my QALY =; you can

see 0.8 and the persons QALY for 0.8, where was for 4 months and 0.5 was 6 months and 0.3 was for 2 months right, therefore if I try to take an estimate or you know, so what we will do; $0.8 * 4 + 0.5 * 6 + 0.3 * 2$, this is the total QALY for 12 months.

I will take an average, is not it yeah, divided by 12, right, you can if otherwise, like this is the total and I took the average of this total, right or if you feel, you will write like that then $0.8 * 4/12$, the proportion of the year, right; $0.5 * 6/12 + 0.3 * 2/12$, whichever form you fill is good you know, so and then you can estimate $3.2 + 3.0 + 0.6$, $6.8/12$ is that total QALY, right so okay, this is this kind of a year, we are not actually seeing that it is gradually going down.

It is we are trying to get a point estimate, a simple example we will take when it is gradually coming down, year are not like distinct points yeah, so what we see when the you know, in a particular person's health utility is gradually coming down.

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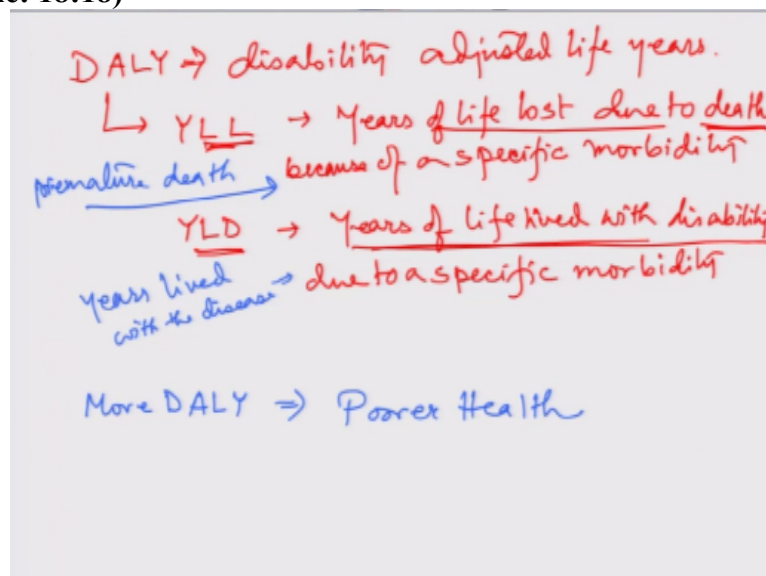
Then, let us take an example yes, again 1 to 0, right, utility, this is my month, years and let us say if this is still 12 months in 3, 6, maybe here on the 9th month, till 9th month the, this thing came down, so if it is 0.5 and this is 9 months, this is 0.5, yeah and it came down from to 1 to 0.5 gradually, yes and then what happened, till the 12th month this is 0.75, it increased that is what I was saying, right.

It is not a directly straight, always downward like this, downward sloping, so it can also improve right, so let us see how we will estimate yeah, this is the form, so when we try to estimate QALY for this example, we estimate it like, this is any, any time during 0 to 9 months, what is my average QALY, I mean average utility? Any time during these 9 months, my average utility will be $1 + 0.5/2$.

Therefore, this is $1 + 0.5/2$, yeah something worse, it is like the average utility in the 4.5th months or something like that *; if I am taking that $1; 9/12$ or you can just keep 9 and then divide it by 12 + over year, during these 3 months, what is the average utility; 0.5 and 0.75; $0.5 + 0.75/2 * 3/12$ or you can do; you can remove this by 12, by 12 and can write just 9 and 3, total divided by 12, right because you are taking the average value for a particular year.

Because it is generally, given in a form of a time period or in an in a particular time period average number of year yes, so therefore this is what we do in terms of QALY in quality adjusted life years but as I say again that while we do not have much idea, it is very difficult to estimate the utility, so you know it is it is not that recommended over DALY, so now if DALY is recommended list and learn what is DALY, yeah.

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So, DALY is disability adjusted life years yes, it has got 2 components; 1 is YLL, another one is YLD, YLL is years of life lost due to a specific morbidity; morbidity or disease, yeah just synonymous and YLD is years of life lost due to death over year sorry, so due to death; years of life lost due to death because of a specific morbidity and years of life lost due to that morbidity due to a specific; specific morbidity, years of life or I will; years of life lived with disability due to a specific moment.

So, this is years of life, years of life lived with disability that is also not desired, yeah and years of life lost due to the death, yeah so now, why these measures are important, what happens is; let us take an example that a government gives me know, 100, 1000 rupees and says that you have to improve the health of this society. Now, when we talk about cost effectiveness analysis, this is primarily, you know mostly utilized in pharmaceutical organizations and all.

Because it looks at the even smaller this thing changes but where you know this QALY and DALY is mainly with the policy level, it encompasses a largest sphere, larger number, larger time, largest sphere of population all this, so Government gives me a 100, 1000 rupees and says that you know, you have to improve the QALY; you know the health status.

So, then I said with 1 lakh rupees or say, you know 1 crore whatever, did it is very difficult to now there are several problems you know and then it is difficult, there is under nutrition say and there is anaemic problem, under nutrition among children, anaemic problem among the mothers, there are HIV AIDS or you know, so which one should I you know concentrate because with this fund, I cannot really or awareness generation programs for a particular this thing you know sanitation say.

So and then I said that which one should I focus, then the Government says, you figure out, this is your area, right, so then what I will try to do is; I will try to estimate a QALY or DALY, yes because of which particular program or which particular problem, not program, which particular problem, how what is the total life lost due to premature death, this one, yes and life lost due to disability of the disease.

Because you know the years lived with the disease, is not it, so these are the 2 components and if I can estimate and for which the you know, DALY is more that is that is more dangerous, so on the you know, contrary to this QALY, if in QALY, we have said more quality and better health over here, more DALY means poorer health right, more QALY better health QALY is satisfaction, more satisfaction good, more DALY; DALY is disability right, disability adjusted life years.

So, more DALY poorer health okay, now let us see that how we estimate this dis adjusted life years, disability adjusted life years. First, we will try to estimate, YLL very simple.

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$DALY = YLL + a * YLD$
a → disability weight
 $YLL = 67 - 60 = 7 \text{ years.}$
 $YLD = a * 8 = 0.50 * 8 = 4$
 $DALY_{CVD} = 7 + 4 = 11 \text{ years}$
 DALY_{HIV}
 DALY_{CHW}
 DALY_{Smit}

Death at 60 years may be because CVD
 Life expectancy for that population is 67 years

We have found then in a particular area, in a particular, among a particular population or for a particular let us take very simple example, for a particular individual that person passed away in the age of 60 years you know, so death at 60 years maybe because of any cardiovascular disease right, heart attack or something, yeah, however the life expectancy for that area that population; population cohort.

Cohort is a group of people sharing some you know, common feature, common characteristics often, it is estimated in terms of a birth code that everybody in a particular group of people in a particular say, class you know academic class everybody is from a same year of birth or close by, so that is a birth cohort yeah. So, life expectancy for that population is 67, so one is 60 years, he passed away.

However, he was supposed to live for 67 years, if the life expectancy is 67 years, so what is the years of life lost simple; 67 – 60 that is 7 years yes, very simple, years of life lost because of premature death because of death before the life expectancy, if the person dies after life expectancy, no problem right because he has lived his quota, the average expectancy; expected life.

The next is YLD, this is years of life lost due to years of life lived with disability, how do we calculate that YLD that is primarily because as a part of how many years of life they have lived with this disability and then, we estimate say, I should have mentioned this, this is YLL straight away +a * YLD, yes, a is my disability weight; a is my disability weight and it varies from 0 to 1, yes, so a; the value of a varies from 0 to 1.

So, what is if a = 0, what does that mean? That means that the person has no disability, perfect health yes, what is 1, if a is 1, then the person is living with absolute disability you know,

maybe a chromatic condition or something like that completely dependent you know no movement or something like that so that is 1 but that value of a varies from 0 to 1, the more the severe the problem is, more it closes towards 1.

If it is a simple problem say, the fever or something is very close to 0 or say a person living with cancer or in the different stages of cancer of course, this may change but we generally, keep it simple you know. So, for a particular disease, we just you know not for many diseases we have this, the value of a based on the severity and how do we, do we, how we have found this value of a due to severe you know out of a simulation process, looking at several people, several population over the years.

And then try to understand that what is the severity score or this disability weight for a particular disease or disability or mobility whatever you say therefore, YLD is basically, the proportion of life you know the, so a basically says the proportion of life he lived with that particular disease and then that shows the how severe was it say, if I say 50% of last 8 years; 50% is a disability weight.

And the person has; was suffering from cardiovascular disease for the last 8 years of his life, then we can, we will say this is basically $a * 8$ years right, 8 years now, the say for that particular cardiovascular disease problem, my a value is 50% right, 50 % means $0.50 * 8$, so 4 years that person has you know, lived with that disability that you know out of those 8, you know for 4 years, he has lived with the disability, 4 years he has not lived with the disability.

Even if you know, even if I have a pain, I do not feel the pain or you know I would not say that the because I have pain I; my life is gone, it is not like that so, that is how we just you know try to adjust it, so now my total DALY is YLL, which is 7 years + YLD, which is 4 years, so, $7 + 4$ is 11 years. Now, say you have got this DALY for CVD, you will get a DALY for maybe, HIV you will get a DALY for child under; under weight problem yeah.

You have got a DALY for sanitation problem; next generation of sanitation problem now, how do we measure that so, if that awareness generation is not there, how many DALY's are happening, how many people are dying, so together that is that is not a for a particular person's right person, so it is for a community, it can be you know, summing up the individual DALY's, you can do that but eventually it may not be like that.

Now, this is a very simple formula of DALY, how, but the you know, our formula for DALY will remain the same that it incorporates a YLL and YLD; years of life lost and years of life lived with disability but at the same time, if we had just these YLL and YLD in terms of the

discount rate and with the you know, age weight, say different age has different severity and age at date or the standard life expectancy again varying from different.
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Discount rate is r .
 age weighting b & K .
 a is age at death
 L is standard life expectancy at age a .

$K=0$ then uniform age weights
 $r=0$, no discounting

$$YLL = \frac{K e^{ra}}{(r+b)^2} \left[e^{-(r+b)(L+a)} \left[-(r+b)(L+a) - 1 \right] - e^{-(r+b)a} \left[-(r+b)a - 1 \right] \right] + \frac{L-K}{r} (1 - e^{-rL})$$

$YLD = D \left\{ \frac{K e^{ra}}{(r+b)^2} \left[* \right] \right\}$

So that that can be taken care of this but when we talk about discount rate and age weighting, you know then, we have a formula which is; if my discount rate, I will just first write my discount rate is r , age weighting is b , a is age at death, L is standard life expectancy, at age a when the person is dying, here age weighting is b and k yeah, a is age at death yeah, so that is all. So how; so what does this k means?

When k is 0, then uniform age weights, when $r = 0$, then we are not doing any discounting of you know, discounting effect of the disability on the life years yeah, so this is all and then how we estimate this YLL and YLK ; YLL is ke power ra , yeah and $+ 1 - K/r 1 - e$ to the power $-rL$, so I will just check the formula $L + a - r + b L + a - 1 -$ this + yeah, perfect, yes and whereas this YLD is; this is the disability and then the rest as same here, so this component, I will just mark this component as the $(*)$ (34:22) yes.

So, this is how we estimate this, you know, so it is a bracket closest here, bracket closes here yeah, okay, so this is about how we estimate years of life lost and years of life death and once you have got an idea about the years of life lost and years of life; life you know, lived with disability, then you have got disability adjusted life years and once, you have got the disability adjusted life years for different diseases, then the unit remains same.

And different programs, the unit remain same, the unit remain years or months in terms of DALY or you will say that the amount of DALY you know, the DALY is 5, the DALY is 7, the DALY is 11, there is a standard way of, of saying this and then, you can actually you know, try

to compare between all the interventions and then give you justifications that how you want to use the money and where exactly, thank you.