Session 2

Cost Analysis

A. Opportunity Cost

Opportunity cost of an action is the value of the best foregone alternative use of those resources. Opportunity cost can only arise in a world where the resources available to meet wants are limited so that all wants cannot be satisfied. The concept of opportunity cost is a key in economics and cost should always correspond to the opportunity cost.

The opportunity cost of using an intervention is the value of the best intervention that was not used. For example, when an Ministry of Health chooses to spend $1000 to finance tuberculosis chemotherapy, the opportunity cost is the health benefit that could have been gained by spending that $1000 on, for example, the Expanded Program of Immunization (EPI).

1. Opportunity Costs of Goods and Services Exchanged on the Market

The opportunity cost associated with goods and services that are exchanged on the market is simply the market value of the good or service, after correcting for any distortions in the market price.

2. Opportunity Costs of Goods and Services Not Exchanged on the Market.

Classic examples of goods or services not exchanged on the market include: time spent by patients waiting or traveling, and volunteer labor. Another example is a hospital bed-day in a hospital that is always running below full capacity.

Arbitrary conventions often used to value non-exchanged goods and services. For example, various arguments have been made to value volunteer labor at zero, at the prevailing casual-labor wage-rate, or at the prevailing overtime wage-rate.

B. Types of Costs: Recurrent and Capital Costs

1. Recurrent Costs

Recurrent costs are expenditures for items that are consumed in one year.

a. Salaries and Wages

b. Transport and Travel.

c. Operations and Maintenance.

d. Supplies.

e. Drugs and Vaccines.

f. Rent.

g. Training—short-term course for health workers, etc.

2. Capital Costs.

Capital expenditures are expenditures for items that are consumed over more than one year.

a. Vehicles.

b. Equipment.

c. Buildings.

d. Training—if used for human capital development.

3. Land.

Opportunity cost for land can be calculated as the value of the rent that could be collected on the land.

C. Costs of an Intervention: Fixed and Variable Costs

1. Use of the General Health System Infrastructure

Infrastructure costs are the costs of the existing health system infrastructure used to deliver the intervention. These are costs related to the use of hospitals, clinics and other infrastructure and their staff that are allocated according to arbitrary joint cost allocation rules – discussed below.

2. Fixed Costs

Fixed costs are those costs that, in the short and medium term, do not vary with the number of units of the good or service produced.

These include: wages and salaries, the equivalent annual cost of a capital good (see below), maintenance, administration, etc.

3. Variable Costs

Variable costs by definition increase as a function of the number of intervention recipients increase. This category includes items such as drugs, supplies, fuel and diagnostics.

4. Patient costs

This category includes those costs incurred by patients or recipients including costs of transportation.

5. Cost Offsets

When one intervention replaces another, the savings of not delivering the original intervention are a negative cost. Offsetting costs may be infrastructure, fixed, semi-fixed or variable in nature

6. Lost Earnings

Some cost-effectiveness studies will include 'indirect costs' such as foregone earnings or time costs of the recipients of an intervention. US guidelines on cost-effectiveness recommend including these costs, standard international practice (World Bank, World Health Organization)

do not. In defining this category of costs, bearing in mind the primary purpose of undertaking cost-effectiveness studies, the definition should be consistent with the definition of total health sector expenditure.

7. Summary: Capital-Recurrent vs. Fixed-Variable

	Capital	**Recurrent**
Fixed	Central Office Building	Central Office Staff
Variable	Home Glucose Monitors	Drugs

D. Cost Functions and Unit Costs

Cost analysis yields estimates of the cost of producing a certain number of units of a good or service. From these analyses, we can calculate cost functions and a number of unit costs.

1. Total Cost and Cost Equalities

$$Total\ Cost = Fixed\ Cost + Variable\ Cost$$

2. Average Cost

$$AverageCost = \frac{TotalCosts}{TotalOutput} = \frac{FixedCosts}{TotalOutput} + \frac{VariableCosts}{TotalOutput}$$

$$AverageCost = AverageFixedCost + AverageVariableCost$$

3. Marginal Cost

The cost of producing one more unit of a good or service.

For example, the cost of immunizing the 101st child at a clinic after immunizing 100 children.

The margin is a pervasive concept in economics. This concept of the margin is used in evaluating both costs and benefits.

Exercise 1

A) Construct an Excel worksheet as shown below.

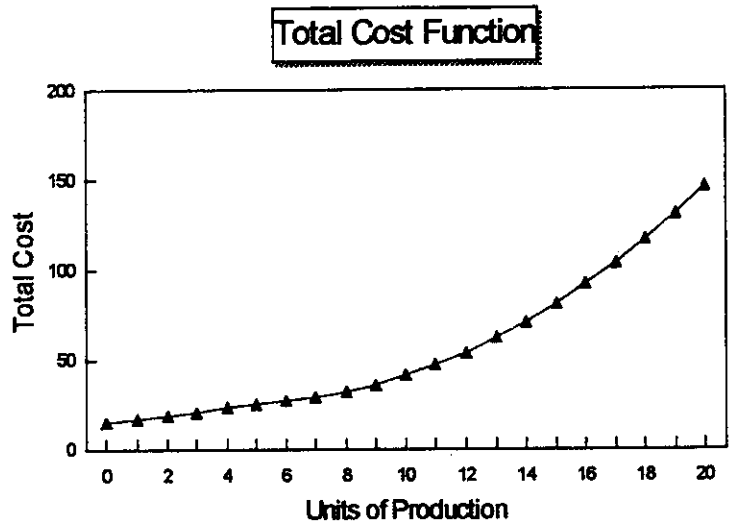
Units	*Fixed Cost*	*Variable Cost*	*Total Cost*	*Average Cost*	*Marginal Cost*
0	15	0			
1	15	2			
2	15	4			
3	15	6			
4	15	8			
5	15	10			
6	15	12			
7	15	14			
8	15	17			
9	15	21			
10	15	26			
11	15	32			
12	15	39			
13	15	47			
14	15	56			
15	15	66			
16	15	77			
17	15	89			
18	15	102			
19	15	116			
20	15	131			

B) Calculate total, average and marginal costs.

C) Draw graphs of total, average and marginal costs as functions of the units of output.

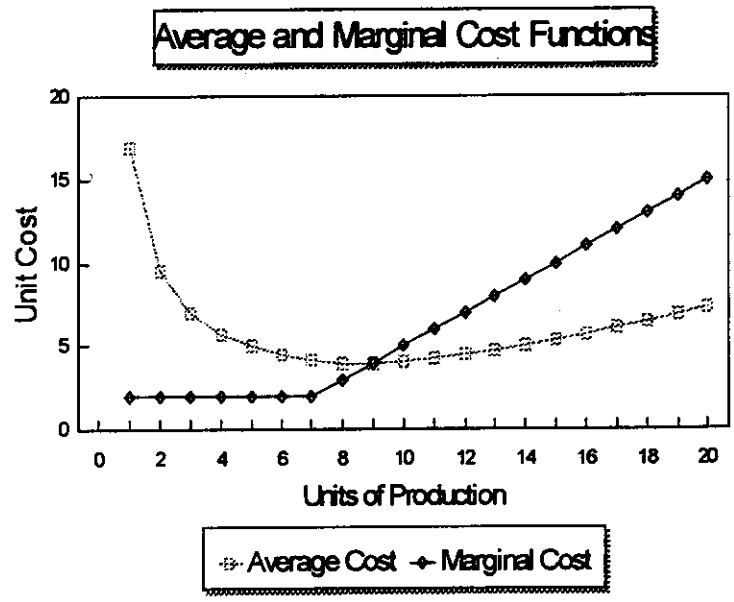
4. Total Cost Function

The total cost function (on the y-axis) defines the total cost of producing different amounts of a good (on the x-axis) such as fully immunized children:



5. Relationship Between Average Cost and Marginal Cost

The marginal-cost curve always crosses the average- cost curve at the average-cost curve's lowest point. As marginal cost rises above average cost, the average cost curve must increase.



6. Average Variable Cost

In real studies, it is frequently difficult to measure marginal cost for a range of output levels. A reasonable approximation of marginal cost is *average variable cost* (assuming that marginal cost is constant). In rare circumstances, it may be possible to measure average cost at many different levels of output. In such cases, one can derive an empirical estimate of marginal cost as a function of output by fitting a curve and calculating its first derivative.

D. Joint production

1. The Basic Problem of Joint Production

When an entity produces two or more products and certain resources (such as labor or capital) are used in the production of *both* products, how do you attribute to one product or the other the cost of the resources used in common?

Consider a clinic that only conducts two activities: immunization and oral rehydration.

Facility Overhead	$10,000
Clinic Director salary	$2,000
Public Health Nurse salary	$5,000
Vaccines	$3,000
ORS	$2,000

Shared costs total $17,000, how do we allocate these costs to immunization and ORT?

2. Direct Allocation

Direct allocation is one possible method for attributing jointly-incurred costs. Indirect costs are attributed in proportion to the share of total activity that a particular task consumes.

In the above example, if the public health nurses spend 70% of their time immunizing, allocate 70% of the $17,000 shared costs to immunization.

A variety of methods is used in practice to estimate the share of overhead that should be costed to each activity— e.g., proportion of staff-time consumed, proportion of floor-area occupied, and other indices of activity.

3. Step-Down Allocation

Step-down allocation is relevant to facilities with complex production functions, such as hospitals. Multiple cost centers are allocated in turn to the direct activities of a hospital.

E. Costing Capital-- Equivalent Annual Cost of A Capital Good

Unlike recurrent budget items, the cost of a capital good has two components: depreciation or the annual consumption of the good and the opportunity cost of the resources committed to the good.

1. Depreciation.

How much of a capital good, such as a microscope, is consumed in one year? This question introduces the concept of depreciation. Depreciation depends on the expected useful life of a capital good. For example, in many developing countries, vehicles last from 3 to 5 years, buildings last from 20 to 30 years, and equipment have widely variable life spans.

2. Opportunity Cost.

Because a capital good that lasts many years must actually be purchased at the beginning of its use, there is an opportunity cost for the resources committed to the capital good.

3. Formulas for Equivalent Annual Cost.

The equivalent annual cost of a capital good is the sum of depreciation and opportunity cost. Several methods allow one to calculate directly equivalent annual cost without separately calculating depreciation and opportunity cost.

Microsoft Excel

In the computer spreadsheet program Microsoft Excel, use formula = PMT(interest rate, life span, purchase price) if the item will be fully depreciated or = PMT(interest rate, life span, purchase price, resale value, date) if you know the resale price to calculate directly the equivalent annual cost.

Exercise 2

This example illustrates costing techniques and concerns a hypothetical schistosomiasis control program that screens 30,000 patients per year and treats 3,000 per year. All prices are in Malawi Kwacha (MK) in 1986. This activity has two sub-components: detection and treatment.

Cost both the recurrent and capital costs associated with each activity. Identify variable and fixed costs, then calculate average cost and average variable cost.

a. Labor.

1. Nurses.

Public health schistosomiasis nurses screen symptomatic patients at the primary clinic level and treat those found to be positive for schistosomiasis. There are 10 nurses, with an average annual salary MK 500. The total annual cost for the 10 nurses is MK_____.

2. Laboratory Technicians.

Laboratory Technicians spend 1 hour per stool exam. Their annual salary is MK 500. They work 210 days per year and 8 hours per day. The cost per stool exam is MK_____. For every ten stool exams, one positive is found. Therefore the labor cost per positive is MK_____. The total annual labor cost for stool exams is MK_____.

b. Drugs and Supplies.

1. Stool Examinations.

Supply costs for stool exams are MK 0.50 per patient screened; hence, costs for stool exam are MK_____ per case detected. The total annual supply cost for stool exams is MK_____.

2. Treatment.

The drug cost per patient treated is MK1.The total annual drug cost for treatment is MK_____.

Exercise 2--continued

c. Capital.

1. Microscopes.

There is one microscope at each of 10 facilities. Each microscope has a lifetime of 10 years and a purchase price of MK1000. Using a 10% market interest rate, the total annual cost for the ten microscopes is MK_____.

2. Facilities.

The replacement cost of a clinic is MK10,000 and the average lifetime is 20 years. 10% of the time at each clinic is devoted to schistosomiasis control. The annualized cost for facilities is MK_____.

Summary for Detection and Treatment.

	Fixed	Variable	Total
Labor			
Drugs/Supplies			
Microscopes			
Facility			
Total			
Average Cost			

Calculate the average cost for the current level of output (3000 patients treated per year): MK_____ per patient screened, found positive and treated. At the current level of output, average variable cost is MK_____ per patient treated; this is an approximation of the marginal cost of treating an individual with schistosomiasis.

To expand schistosomiasis screening and treatment activities at that marginal cost, one must assume that the microscopes are not being used at full capacity (since the cost of microscopes becomes variable if it increases as the outputs increase).

With expansion, more of the fixed facility cost would be attributed to schistosomiasis control. However, unless the facility is fully utilized there would be no opportunity cost to this expansion. The true marginal cost will probably increase, as, for this example, the yield on stool examinations decreases.

Final question. Suppose someone asks you to give him/her an estimate of average cost of the above program in 1990 US dollars, how do you convert Malawi Kwacha into US dollars? (Note that we have calculated the cost in 1986 Malawi Kwacha.)

F. Comparability

In any cost study, prices must be presented in comparable units. When using studies from one environment to guide policy choice in another environment, we need to adjust prices to reflect differences in relative cost (*within* and *between* nations).

G. Deflators

1. Inflation

The general price level increases overtime. This increase can be extremely rapid in some environments—for example, the hyper-inflation in Bolivia in the early 1990s.

a Nominal (or current) price: Prices in current currency without adjustments.

b Real (or constant) price: Prices adjusted to a standard currency unit.

2. Price Indexes and GDP Deflators.

a. Consumer Price Indexes.

Consumer price indexes are based on annual measurements of the prices of items in a basket of specific consumer goods. The consumer price index indicates the relative increase in cost of purchasing the same basket of goods over time. The consumer basket of goods and services changes overtime.

Note that the basket of consumer goods does not reflect the average price level for the economy in general nor health sector price levels.

b. GDP Deflators.

Gross Domestic Product is a widely used measure of economic activity in a country. A similar measure Gross National Product differs only in that it takes account of net property income from abroad.

Gross Domestic Product is calculated in nominal and real terms (see Appendix). GDP deflator series provide indicators of growth in price level for entire economies.

3. Method for Adjusting Expenditures to Constant Currency Units

To convert from expenditure in the currency of year A to the currency of year B use the following formula:

$$Cost\ A \times \frac{GDP\ Deflator\ B}{GDP\ Deflator\ A} = Cost\ B$$

Remember always to report the year of the currency units, e.g., 1990 US$ 3.7 million.

H. Converting Prices to a Common Numeraire

To cost programs that include expenditures in both local and foreign currencies, we must be able to convert expenditures in one currency to another by employing either official exchange rates or purchasing power parity ratios.

1. Official Exchange Rates

To facilitate analyzing exchange rates, we can calculate the real exchange rate which is the exchange rate expressed in constant real terms. For example, an official exchange rate of Malawi Kwacha in 1990 is: $\frac{1990\ MK}{1990\ US\$}$

In order to convert a local currency cost in year A to dollars in year C using the exchange rate from year B:

1. Convert local currency costs in year A to year B using the GDP Deflator:

$$Local\ Cost\ A \times \frac{Local\ GDP\ Defl\ B}{Local\ GDP\ Defl\ A} = Local\ Cost\ B$$

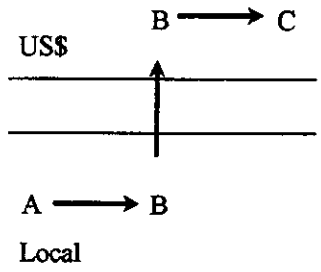
2. Convert local currency costs in year B to dollars in year B using the exchange rate for year B:

$$Local\ Cost\ B \times \frac{US\$\ B}{Local\ B} = US\$\ Cost\ B$$

3. Convert US dollars in year B to US dollars in year C:

$$US\$\ Cost\ B \times \frac{US\$\ GDP\ Defl\ C}{US\$\ GDP\ Defl\ B} = US\$\ Cost\ C$$

4. A graphical illustration of price conversion.



Exercise 2--continued

Using the tables in Appendix, reply to a person who asked you to give him/her an estimate of average cost of the above program in 1990 US dollars instead of 1986 Malawi Kwacha. Calculate first by using 1987 exchange rate. What is the answer if you use 1990 exchange rate?

2. Purchasing Power Parity Ratios

a. Traded and Non-Traded Goods

The price for non-traded goods and services, such as labor, vary widely between countries. For example, a nurse with equivalent training in Zimbabwe would be paid five to ten times more in Brazil or Korea.

The market for foreign exchange only equates purchasing power for traded goods.

Non-traded goods are undervalued by the official exchange rate, so that the gap between high and low income countries is exaggerated by official exchange rates.

b. International Comparison Project.

Started in the 1960's, the International Comparison Project developed measures of relative purchasing power in different economies independent of the official exchange rate.

Now estimates are available for many developing and industrialized countries (see the Wrold Bank's website and attached figures).

Purchasing power parity ratios provide an alternative for converting costs into a common numeraire.

Optional

So far we have concerned only with the current costs of a health service. In reality, costs may incur at different time periods: e.g., MK 500 today, MK 2000 next year, etc. For example, if given the choice between MK 100 today or MK 120 in one year, which would you choose? 100 today versus 150 in one year?

I. Time Preference (Discounting)

1. Time Horizon and the Discount Rate

Individuals with a positive discount rate value an amount of *current* consumption or income more highly than they value a *future* amount of consumption or income.

The discount rate is the rate at which future benefits and costs (denominated in dollars) are discounted.

For example, if given the choice between 100 dollars today or 120 dollars in one year, which would you choose? 100 today versus 150 in one year? The percent increase required to persuade you to defer consumption for one year is a measure of your discount rate.

2. Present Value

Present value is the value of a future stream of benefits or costs in terms of their value today. The present value of any stream of costs or benefits can be calculated using the discount rate.

a. Formulae

$$\text{Cost}_{\text{Present value}} = \frac{Cost}{(1+r)^t}$$

where r is the discount rate and t is the time period when the cost occurs. (r and t must be provided for the same units; i.e., if r is given as the annual rate of discount, then t should be expressed in units of years.). The term $\frac{1}{(1+r)^t}$ is a discount factor.

Suppose we have the following project cost schedule:

Year	Cost
1	Cost_1
2	Cost_2
3	Cost_3
.	.
.	.
i	Cost_i

Then the present value of the project cost is:

$$\text{Cost}_{\text{Present value}} = \sum_{t=1}^{i} \frac{Cost_i}{(1+r)^t}.$$

Exercise 3

Calculate the present value of the following cost schedule discounted at 10%.

Year	Expenditure	Discount factor	Discounted value
1	200		
2	200		
3	100		
4	100		
5	100		
6	200		
7	300		
8	300		
9	300		
10	300		
Total =	2100	Present Value =	

Homework

To be returned 27 February, 2001.

Program costing

In Guyana, schizophrenia is treated through the primary health care system.1000 patients are treated each year with a combination of drugs and therapy. Therapy is provided by primary health center nurses. Primary health center nurses work 200 days a year and 8 hours a day. Nurses are paid on average $600 a year. Patients have six therapy sessions a year. Each therapy session last one hour. Patients are brought to therapy sessions by vehicle; patients travel singly. Five vehicles are reserved for transporting schizophrenics. Each vehicle costs $20,000, and last for 5 years. The interest rate in Guyana is 11%. The average distance per round trip is 30km. Fuel and maintenance costs per kilometer are $0.20. Drugs cost $39 per patient per year. What is the average cost per schizophrenic patient treated each year? What is the average variable cost per schizophrenic patient treated each year?

Session 3

Measures of Effectiveness and Cost-Effectiveness of Health Interventions

A. Measures of Burden and Intervention Effectiveness

Outcome measures used in studies range from specific *process* indicators—such as fully immunized children or tuberculosis patients diagnosed and treated—to more general *health outcome* measures, such as deaths or years of life lost.

Method	Units of Cost	Units of Benefit
Decision Analysis	-	Health
Cost-effectiveness Analysis	$	Process or Health
Cost-Benefit Analysis	$	$

Specific narrow health outcomes or process measures have an advantage in that they are easy to measure. They are often produced in routine program monitoring

A chief disadvantage is that narrowly defined outcome measures, such as the number of children immunized, severely restrict comparisons across health interventions.

Outcome measures can be used to assess the burden of a disease or a risk factor as well as evaluating the benefits of an intervention.

Two types of health outcomes can be used: premature mortality and non-fetal health outcomes such as morbidity and disability. We will focus on premature mortality in the following section.

B. Measures of Premature Mortality

Dempsey (1947) argued that all deaths are not equivalent. A death at a younger age represented a greater loss of life than a death at an older age. She proposed a class of indicators, years of life lost, that use time as the unit of measure.

In the past 50 years, a variety of measures have been developed that attempt to measure the stream of life lost due to death at different ages. These measures are the variants of potential years of life lost.

When used as measures of the population burden of premature mortality, all these families of indicators measure the *gap* between the current mortality pattern of a population and some reference norm.

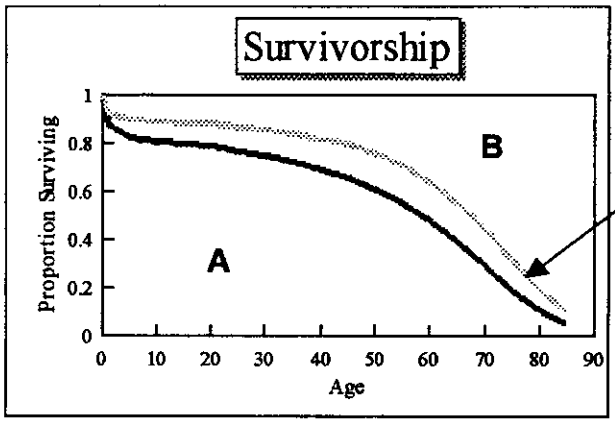
1. Survivorship Curves

Survivorship curves are a useful representation of mortality rates in a population.

The y-axis shows the proportion of a birth cohort exposed to a set of age-specific death rates that will survive to any age shown on the x-axis

In life table notation, the number surviving of a birth cohort of 100,000 is represented by *l(x)*. Often in demographic notation the proportion surviving to age x, is represented as *p(x)*.

In the following graph, which represents the conventional life expectancy at birth, A, B or C?



A = area under curve

B = area above curve

C = survivorship curve itself

2. Example For Illustrating Different Measures

To illustrate the calculation of these various time-based measures of premature mortality, we will use a population with a life expectancy at birth of 50 and a stable population with a growth rate of zero percent. The population and the number of deaths in each age-group in this population are shown in the following table.

Age-Group	Population	Death Rates Per 1000	Deaths	Average Age of Death	E(x)
0	92,279	128.7	11,879	0.3	50.00
1	335,667	19.0	6,372	3.0	55.69
5	403,919	4.3	1,755	7.5	55.93
10	396,763	3.4	1,337	12.5	52.11
15	389,000	4.6	1,786	17.5	47.95
20	379,009	5.9	2,228	22.5	44.00
25	367,341	6.7	2,448	27.5	40.24
30	354,531	7.6	2,685	32.5	36.51
35	340,596	8.5	2,897	37.5	32.82
40	325,613	9.5	3,105	42.5	29.14
45	309,320	11.1	3,425	47.5	25.43
50	290,048	14.9	4,319	52.5	21.74
55	266,031	20.0	5,328	57.5	18.22
60	235,184	30.1	7,081	62.5	14.87
65	196,135	43.8	8,600	67.5	11.87
70	149,400	68.0	10,156	72.5	9.17
75	97,363	105.3	10,253	77.5	6.88
80	50,024	163.4	8,176	82.5	5.01
85	17,860	255.0	4,555	87.5	3.53
90	3,605	394.7	1,423	92.5	2.43
95	306	604.6	185	97.5	1.63
100	7	928.6	7	101.1	1.08
Total	5,000,001		100,000		

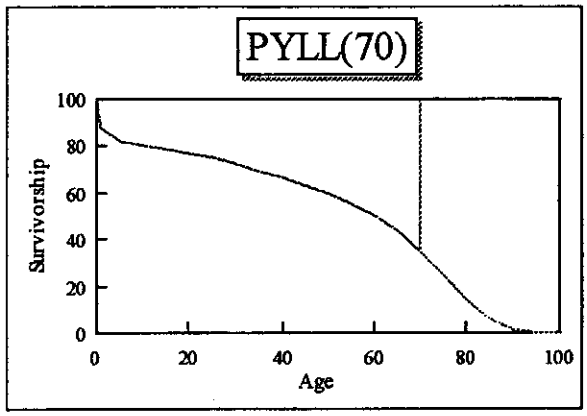
C. Potential Years of Life Lost

1. Definition

The general notion behind potential years lost is that, for example, a death at age 5 represents a greater loss of potential life than death at age 70.

Potential years of life lost requires defining the potential limit to life. Different groups have suggested 60, 65, 70, 75 or 85 years old.

In a stable population with no net population growth, PYLL can be represented as the triangle on the top right hand corner above the survivorship curve.



Potential years of life lost:

$$PYLL = \sum_{x=0}^{x=L} d_x (L - x)$$

Where d_x is the number of deaths, L is the potential limit to life, and x is the age of death.

The expression (L-x) can be thought of as a weight that is attached to death at each age. We can graph this weight to provide a convenient method of comparing different types of outcome measures.

Variants of PYLL can be used by employing different potential limit to life (L), including period life expectancy, cohort life expectancy, and standard life expectancy.

2. Calculation of PYLL

To calculate PYLL, we must assume an average age of death within each age-group and then calculate the PYLL lost per death in that age-group.

Exercise 4

Calculate PYLL for the population below based on the definition of PYLL. Use 70 years as the limit to life. (You can calculate years of life lost by using standard life expectancy as well (SEYLL))

Age-Group	Deaths	Average Age of Death	70-(Age of Death)	PYLL(70)	*Standard Life Expectancy at Age of Death	*SEYLL
0	11,879	0.3			82.3	
1	6,372	3.0			79.9	
5	1,755	7.5			75.5	
10	1,337	12.5			70.5	
15	1,786	17.5			65.6	
20	2,228	22.5			60.6	
25	2,448	27.5			55.7	
30	2,685	32.5			50.8	
35	2,897	37.5			46.0	
40	3,105	42.5			41.1	
45	3,425	47.5			36.4	
50	4,319	52.5			31.7	
55	5,328	57.5			27.1	
60	7,081	62.5			22.6	
65	8,600	67.5			18.3	
70	10,156	72.5			14.2	
75	10,253	77.5			10.6	
80	8,176	82.5			7.6	
85	4,555	87.5			5.2	
90	1,423	92.5			3.6	
95	185	97.5			2.4	
100	7	101.1			0.8	
Total =	100,000		PYLL =		SEYLL =	

* optional

3. Criticisms of PYLL

First, deaths averted for people older than the arbitrarily-chosen potential limit of life do not contribute to the burden of premature mortality.

If such a measure is used to influence the allocation of health resources, it implies that there is no benefit to health interventions that reduce mortality over the potential limit to life. This is at odds with clinical practice and with the values of most societies.

Second, when evaluating the benefits of a health intervention, the true number of years of life saved will depend on local mortality patterns. The true number of years of life saved will be lower in high mortality populations and higher in low mortality populations.

When estimating the benefits of an intervention, the change in PYLL should be calculated. This will be larger in developing low mortality populations than in high mortality populations.

D. Defining the Benefits of a Health Intervention

Regardless of the time of time-based measure used, the benefits of a health intervention are simply the difference in the population burden of disease with the intervention compared to the population burden of disease without the intervention.

For example, if we choose to measure the burden of premature death by PYLL then the benefits of an intervention should be:

$$B_i = \sum_{t=0}^{t=\infty} PYLL_{t,NO} - \sum_{t=0}^{t=\infty} PYLL_{t,i}$$

where B_i is the benefits of intervention i, $PYLL_{t,NO}$ is the PYLL in the population without the intervention at time t, and $PYLL_{t,i}$ is the PYLL in the population with intervention I at time t.

E. Measuring non-fatal health outcomes

Measures of health outcome need to include non-fatal health outcomes, such as morbidity and disability.

As a society, we are willing to invest in health interventions that have no effect on mortality, but do reduce suffering from morbidity or disability. Cost-effectiveness must allow comparisons of these outcomes with death-aversion if the results are to be used to guide resource allocation.

The question of whether a single indicator of health is needed is a non-issue for cost-effectiveness analysis and burden of disease assessment.

F. The Basic Challenge

The problem, regardless of the conceptual approach taken, is: (1) to define, describe and measure a set of health states spanning from death to perfect health, and (2) then to value time spent in these health states.

The initial work provided the mathematical framework within which joint indicators could be constructed by using time as a common unit and indicated the various uses of such measures including Quality-Adjusted Life-Years (QALYs) and Disability-Adjusted Life Years (DALYs).

Exercise 5

Hepatitis B immunization is given to young infants in order to prevent the sequelae of chronic hepatitis B many years later. You are asked to calculate the cost-effectiveness of a Hepatits B immunization program in the Gambia. The cost of delivering an independent program for a population of 100,000 in which 5,000 children a year will be immunized includes the following: 3 vehicles that cost $25,000 each will last 4 years, vaccine at $1.5 per immunized child, labor costs of $35,000. Calculate the cost of the program in a single year. Assume that the interest rate is 3%. What is the cost per child immunized.

In unimmunized children 40% would become chronic Hepatitis B carriers. Of chronic carriers, 4% would develop primary liver cancer, which is 90% fatal with an average age death of 47. Studies show that for every case of liver cancer caused by hepatitis B, 0.42 cases of cirrhosis also develop with a case fatality rate of 30% and an average age of death of 44. Assume that the only health benefits of the program are death prevention. Calculate the benefits of the program in terms of (undiscounted) potential years of life lost, using a potential limit to life of 70. What is the cost per (undiscounted) potential year of life saved in this program?