Cost of Illness Analysis

Assoc Prof Arthorn Riewpaiboon
Division of Social and Administrative Pharmacy
Department of Pharmacy
Faculty of Pharmacy Mahidol University
arthorn.rie@mahidol.ac.th

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Definition: CoI measures the economic burden of disease and illness on society.

Steps of CoI analysis.

- First step: study design
- Second step: define cost component
- Third step: collect resources and services use.
- Fourth step: covert to monetary value.
- Fifth step: calculate the cost

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First step: study design

- Objective; Burden estimation/ prioritizing, Efficiency management, reimbursement, economic evaluation, BIA
- Definition and scope of the illness
- Approach (prevalence or incidence)
- Time horizon
- Perspective
- Type of treatment or health service facilities.

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Objectives (1)

- **Burden:**

  - to explore the cost of illness of diabetes from societal perspective

  - To compare the costs of illness across different levels of severity of disability

- **Efficiency:** to developed a cost function model to estimate the public treatment cost of diabetes and to provide a better idea about the factors influencing them.
- **Reimbursement:**

  - to provide evidence of cost of informal care for planning of the social welfare system (disability pension for people with disabilities).

  - patient-level costing for Diagnostics Related Groups

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Objectives (2)

- **Economic evaluation:**
- Economic analysis for evidence-based policy-making on a national immunization program: A case of rotavirus vaccine in Thailand
- These charges were converted to economic costs of providers by adjusting the findings of a study by Riewpaiboon on the cost of bacterial diarrhea [63].
- 63. Riewpaiboon A, Intraprakan K, Phoungkatesunthorn S. Predicting treatment cost for bacterial diarrhoea at a regional hospital in Thailand. J Health Popul Nutr 2008;26(4):442–50.

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Objectives (3)

- **Budget impact analysis:**
- Budget Impact of the Thalassemia Management under the National Health Security Scheme in Thailand
- *Cost analysis;* Baseline data on resource utilization and unit cost were drawn from the study of Riewpaiboon et al.
- Riewpaiboon A, Nuchprayoon I, Torcharus K, *et al.* Economic burden of beta-thalassemia/Hb E and beta-thalassemia major in Thai children. *BMC Res Notes* 2010; 3(1):doi:10.1186/1756-0500-3-29.

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Scope of the illness

- Primary illness and consequences; complications, sequelae/ not include co-morbidity
- Complication: A secondary disease, an accident, or a negative reaction occurring during the course of an illness
- Sequela: A pathological condition resulting from a prior disease, injury, or attack. / A secondary consequence or result of primary illness.
- Co-morbidity: a medical condition existing simultaneously but independently with another condition in a patient

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Scope of the illness

Diabetes

coronary artery diseases

nephropathy

High blood sugar

foot ulcer

cataracts retinopathy

pneumonia diarrhea car accident

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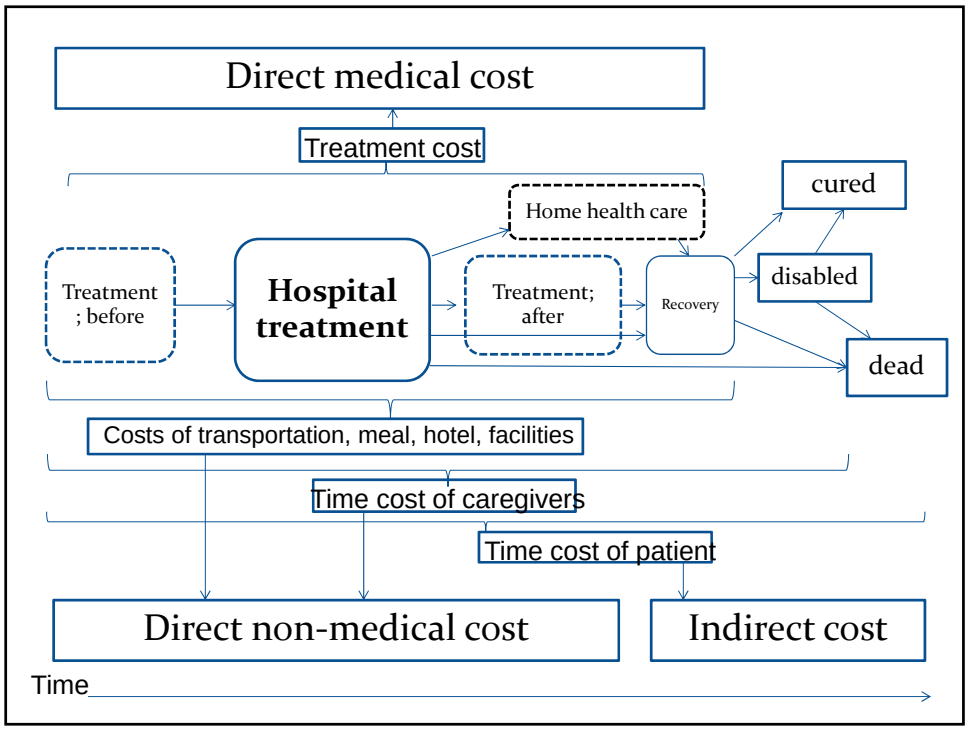

Definition and scope/ treatment/ health facilities/ time horizon of the illness

- Diabetic patients who received treatment from DM clinic of the study hospital and the health centres during the financial year 2008.
- The patients were identified according to International Classification of Diseases, tenth revision (ICD-10 codes = E10–E14).
- Definition of diabetic complications: Thailand diabetes registry project
- Definition of disability: Rehabilitation of Disabled Persons Act, 1991

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- **. Prevalence-based approach**

Prevalence-based approach covers all patients during time horizon of the study. Time horizon is normally 1 year to avoid seasonal variation. The patients can start having the illness before or during the time horizon. Therefore, the patients included in the study have various levels of disease progress and severity. Study results are presented as cost per person per year (or time horizon).

- **2. Incidence-based approach**

Incidence-based approach covers new cases during a period of time designed (normally 1 year) until end of the illness (cure or death). This is also called life time cost. Study results are presented as cost per episode.

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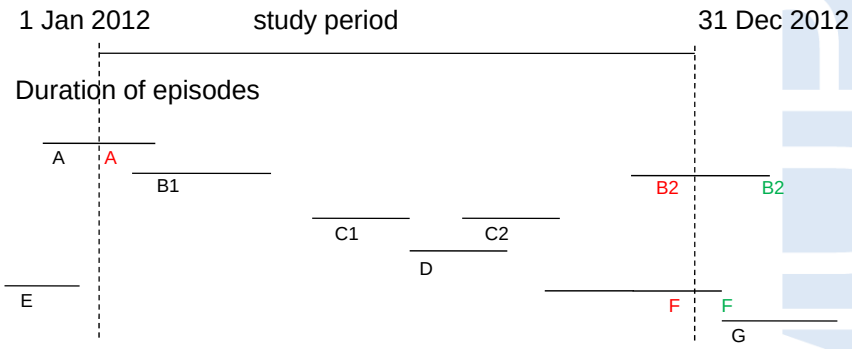
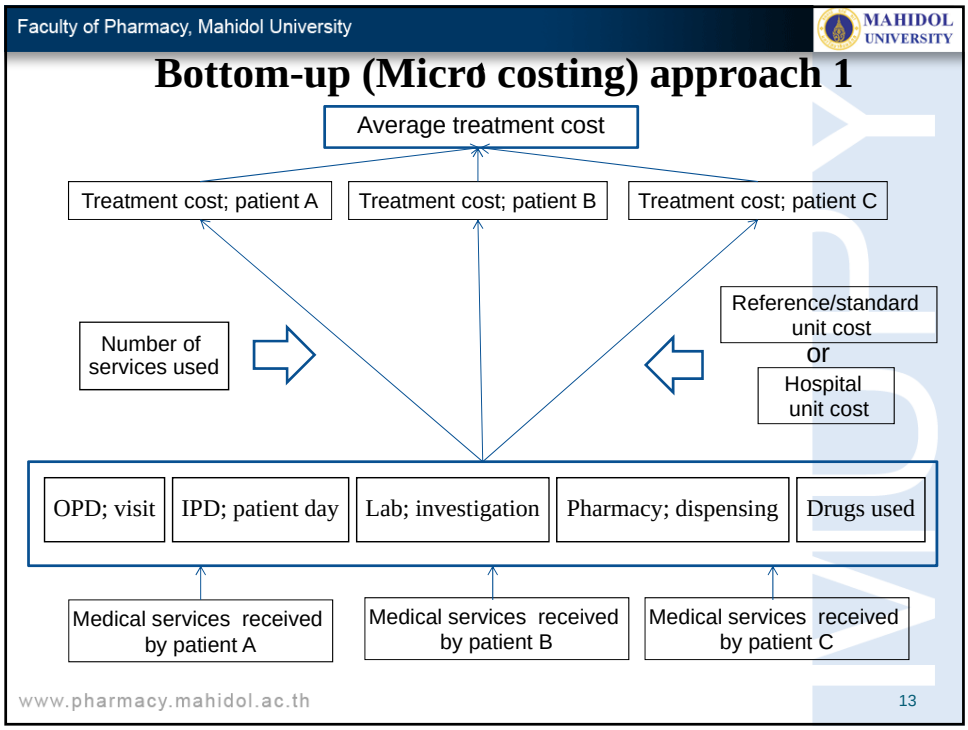
Prevalence vs incidence approaches



Prevalence-based approach includes A (from 1 Jan) , B1, B2 (until 31 Dec), C1, C2, D, F (until 31 Dec)

Incidence-based approach includes B1, B2 (until end of episode beyond 2011), C1, C2, D, F (until end of episode beyond 2011)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Bottom-up (Micro costing) approach 1
Average treatment cost
Treatment cost; patient A
Treatment cost; patient B
Treatment cost; patient C
Number of services used
Reference/standard unit cost
or
Hospital unit cost
OPD; visit
IPD; patient day
Lab; investigation
Pharmacy; dispensing
Drugs used
Medical services received by patient A
Medical services received by patient B
Medical services received by patient C
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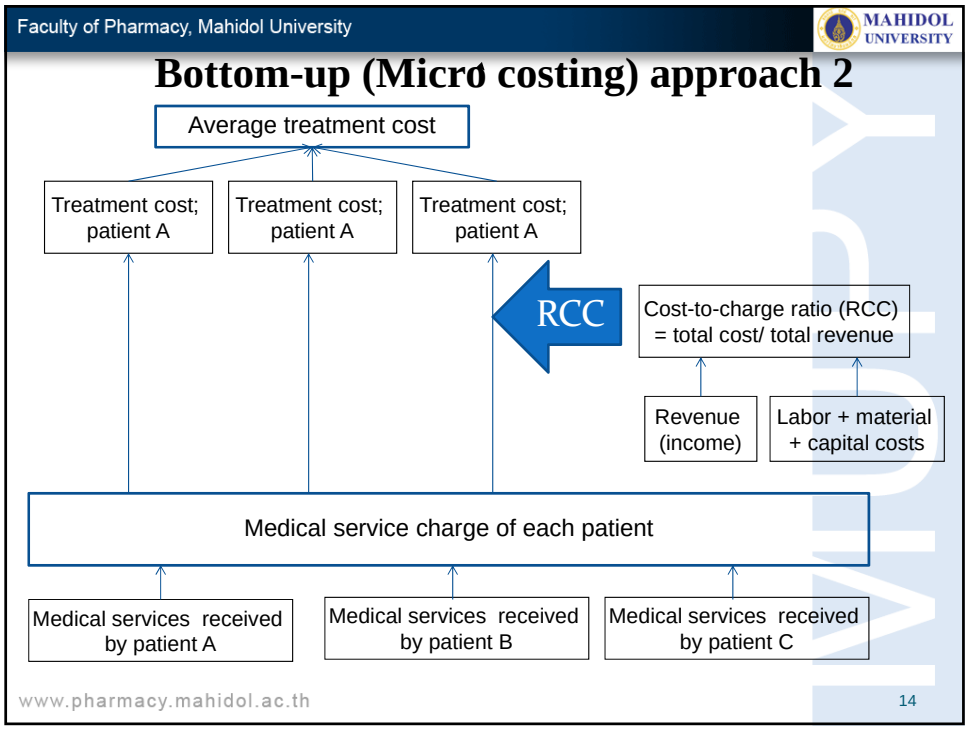
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Bottom-up (Micro costing) approach 2
Average treatment cost
Treatment cost; patient A
Treatment cost; patient A
Treatment cost; patient A
RCC
Cost-to-charge ratio (RCC) = total cost/ total revenue
Revenue (income)
Labor + material + capital costs
Medical service charge of each patient
Medical services received by patient A
Medical services received by patient B
Medical services received by patient C
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Second step: define cost component

- Objectives
- Perspective; patient or consumer, provider, payer, societal

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Costs in different perspectives

Service	Cost by perspective		
	Patient	**Hospital**	**Society**
Drug store	50	0	50
Taxi	300	0	300
Meal	50	0	50
Treatment cost	0	350	350
Drug not in NDL*	150	0	150
Wage loss	225	0	225
Total	**775**	**350**	**1,125**

* not available in the hospital

NDL= national drug list

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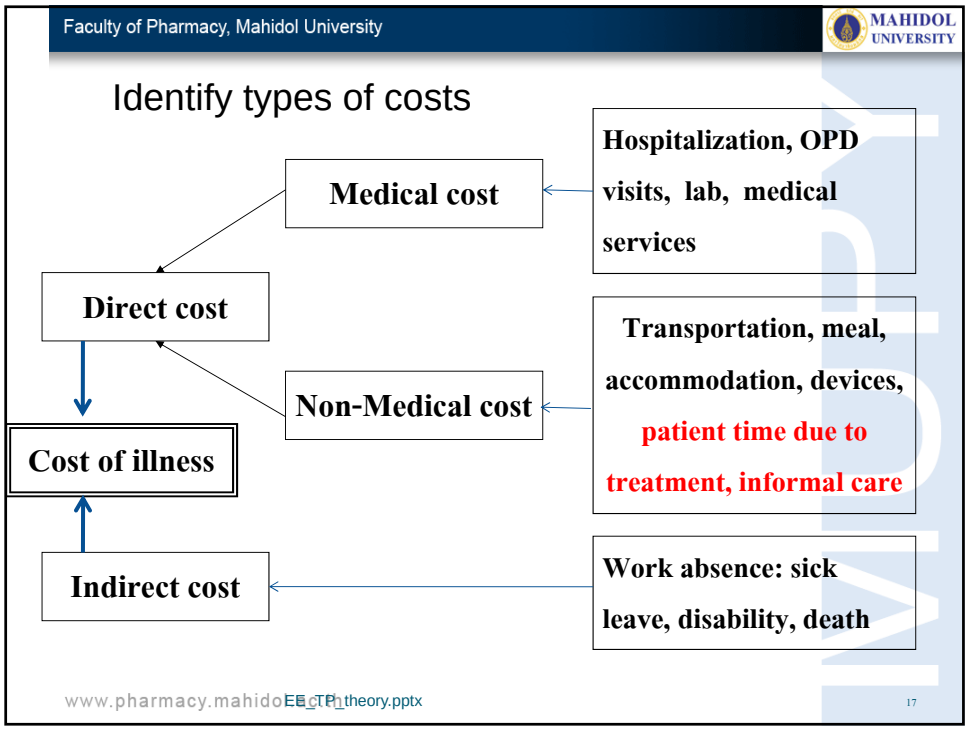
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Identify types of costs
Medical cost
Hospitalization, OPD visits, lab, medical services
Direct cost
Non-Medical cost
Transportation, meal, accommodation, devices, patient time due to treatment, informal care
Cost of illness
Indirect cost
Work absence: sick leave, disability, death
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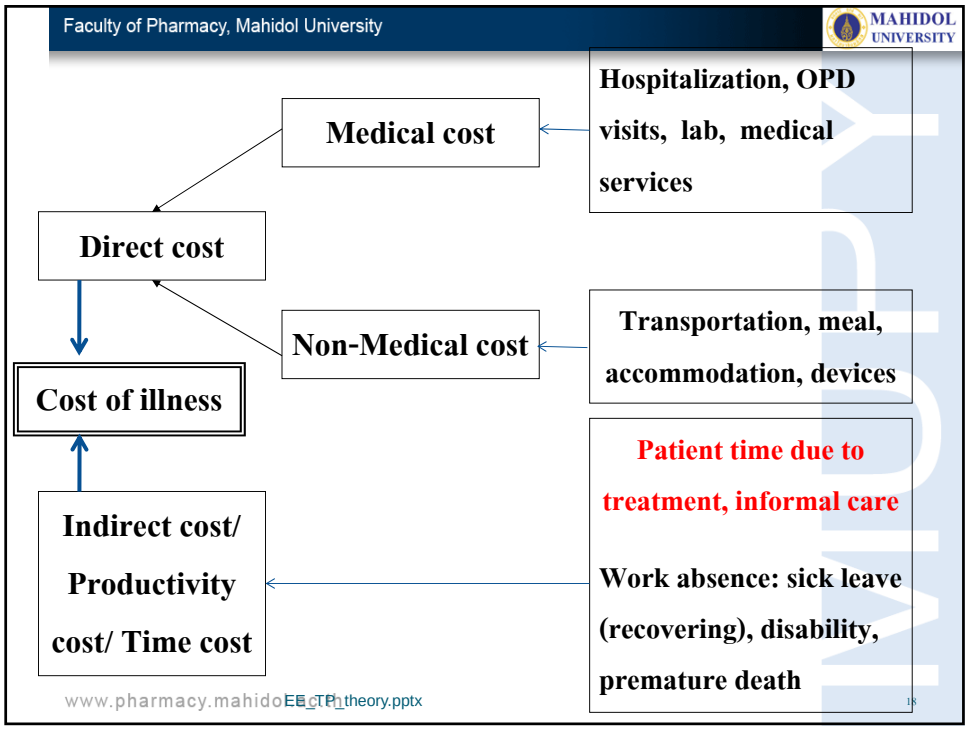
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Medical cost
Hospitalization, OPD visits, lab, medical services
Direct cost
Non-Medical cost
Transportation, meal, accommodation, devices
Cost of illness
Patient time due to treatment, informal care
Indirect cost/ Productivity cost/ Time cost
Work absence: sick leave (recovering), disability, premature death
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Cost of informal care

- In formal care is the name given to the care provided by people from a care recipient's social network: family, friends, acquaintances or neighbors.
- Providing informal care entails opportunity costs in various forms: e.g. giving up paid work time or leisure time; investing energy; and, in some cases, possibly even making fewer social contacts.

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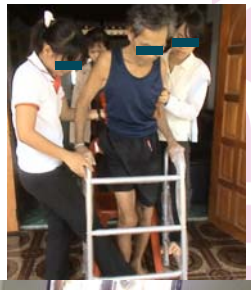
Category of informal care

- Health care activities: aiding patient in health care and rehabilitation
- Daily living activities: aiding patient with personal care, visiting the toilet, moving around within the house, eating and drinking



Category of informal care

- Household activities: preparation of food and drinks, shopping, house cleaning, washing, ironing or sowing, gardening, caring for and playing with own children.
- Instrumental activities: aiding patient in traveling outside the house, visiting and in excursions, financial matters.

Third step: collect resources and services use.

- **Medical service utilization** data which included inpatient stay, outpatient visit, emergency, laboratory, traditional medicine, dental services, drug use, materials use, etc. were collected by the study team members by **reviewing the medical record** of every study participant for the study period (October 2007 to September 2008),

- while information on **direct non-medical cost** and **time and productivity cost** was collected from all study participants through **direct personal interviews**. A structured questionnaire was administered to the study participants to obtain their information.

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Measurement of resource use/ data collection

Data	Source	Method
Medical service utilization for DMC	-Medical record for study hospital -Pt/ family for Rx from other facilities	-Chart review/ prospective record - Interview, diary
Time of care giving for cost of informal care	Care givers	Interview, diary
Cost of meal, transportation	-Pt/ family	Interview, diary
Cost of time loss for IDC	-Pt/ family	Interview

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Explanatory (predictor or independent) variables

Data	Source	Method
Demographics	-Medical record/ CRF -Patient/ family	-Chart review/ prospective record - Interview
Clinical symptoms, outcomes	-Medical record/ CRF	-Chart review/ prospective record - Interview
Treatment regimen/ technology	-Medical record/ CRF	-Chart review/ prospective record - Interview
Health system/ facilities	-Hospital staff/ document	Review

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Fourth step: covert quantity of resources and services to monetary value.

- Valuation of medical service used
  (for number of test x unit cost of the test)
  Source of unit cost
- Hospital unit cost from direct measurement (economic cost or financial cost)
- Standard or reference unit cost
- Unit price of hospital (cost at charge)
- Unit price from private services
- Estimated unit cost

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Standard unit costs: Thailand

- Medical services; Standard cost menu/ reimbursement/ prices
- Procedure/ treatment; DRGs
- Drugs; Drug and Medical Supply Information Center (DMSIC)

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Opportunity cost method

Opportunity costs were determined following two approaches:

- The productivity cost approach only covers the time of caregivers who still work.
- The time cost approach, on the other hand, covers the time spent by all caregivers.
- Using real income or reference income/ productivity.

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Proxy good method

The proxy good method values informal care time by the wage rate of close substitutes in the labor market, e.g., professional caregivers or house workers. Wage rates used in the calculation were from a national survey.

- Selected wage rates were matched with informal care activities as follows:
- Health and social work wage rates were used for both health care activities (HCA) and activities of daily living (ADL).
- Household worker wage rates were used for both household activities of daily living (HDL) and instrumental activities of daily living (IADL).

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Indirect cost of illness

The value of production loss associated with the symptoms and treatments due to the disease

Can be the consequence of :

- temporary absence from work
- disablement
- premature mortality
- working at lower level

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Methods of estimating indirect costs

Human-capital cost method

- The most popular method
- “Potentially” production loss until retirement
- Usually use the market wage rates or GDP or NI per capita

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Human-capital cost method

Assumptions: a vacant position will never be filled with.
(No unemployment)

The critical comment:
The real production losses < the potential losses because the workers who are sick can often be replaced at a small payment.

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Cost of Morbidity

Cost of morbidity = *(N)(E)*

N = total number of patient-days loss from work due to illness

E = average earnings per day

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Cost of Mortality or Disablement

- Cost of mortality = $S\sum_{1}^{n} Yi(1+r)^{-i}$

  S = number of lives loss due to illness

  Yi = expected GDP per capita at year i

  n = number of years of expected earnings

  = age at retirement - average age of patient

  i = time in terms of year (1^{th} - n^{th} year)

  eg i = 1 for the first year after the study year

  r = discount rate

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Year	2011	2012	2013	2014	2015
Patient age	56	(57)	(58)	(59)	(60)
	died				
per capita GDP($)	1,000	1,100	1,210	1,331	1,464
n = year from 2011	0	1	2	3	4
r=discount rate=3%					
GDP value in 2011	1,000	1,068	1,141	1,218	1,301
Mortality cost in 2011	5,727				

Ref: mortal.xlsx

Friction-cost method

Developed by Koopmanschap MA et.al.(1992)

The worker replacement by

- other internal workers
- the unemployed pool

Short-term work absence

- make up when return
- taken care by internal workers
- may be canceled or postponed

Long-term work absence ⟶ permanently replaced

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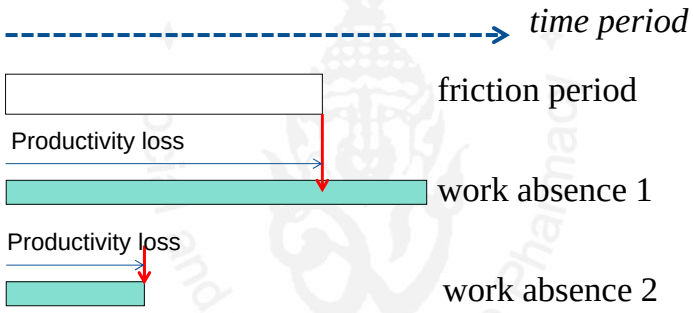
Friction-cost method (cont.)

- The period of time required for worker replacement is called *"Friction period"*



- Friction period has the role of a cut-off point

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Fifth step: calculate the cost

- Resource use and unit cost
- Incidence approach: Cost/ episode
- Prevalence approach: Cost/ case/year
- Cost component
- Cost classified by independent variables
- Cost function analysis

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Table 3 Unit cost of drugs and medical services* (US$ at 2005 prices)

	per 100 units	per unit
Aspirin, enteric-coated tablet, 1 grain	0.47	n/a
Desferrioxamine injection, 500 mg	452.26	n/a
Deferasirox tablet, 250 mg	1243	n/a
Folic acid tablet, 5 mg	0.22	n/a
Furosemide injection, 20 mg/2 ml	11.64	n/a
Furosemide tablet, 40 mg	0.67	n/a
Multivitamin syrup, 60 ml	25.48	n/a
Multivitamin tablet	0.52	n/a
Penicillin V tablet, 250 mg	1.86	n/a
LPRC	n/a	13.67
Pre-storage filtered PRC	n/a	11.93
NAT LPRC	n/a	21.13
NAT Prestorage filtered PRC	n/a	19.39
Complete blood count (CBC)	n/a	1.49
Cross-matching	n/a	1.99
Ferritin	n/a	7.71
Hematocrit (Hct)	n/a	0.75
Hemoglobin (Hb)	n/a	2.49
Hemoglobin typing	n/a	6.71

LPRC = leukocyte-reduced packed red cell
Prestorage filtered PRC = leukocyte-depleted packed red cell (LDPRC)
NAT LPRC = nucleic acid-tested LPRC
* From the prices of services of health facilities under the Ministry of Public Health [25].

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Table 2 Average service utilization classified by type of services, patient characteristics, and hospitals

Category	Outpatient service (visits, SD)	Hospitalization (%)	Average length of stay (days, SD)		Blood transfusion (times, SD)	Desferrioxamine (vials, SD)
			Per all patients	Per hospitalized patients		
Hospital						
Saraburi (N = 72)	6.74 (3.31)	15 (20.8%)	0.68 (1.76)	3.27 (2.58)	3.69 (3.59)	3.43 (20.42)
Phramongkutklao (N = 42)	9.76 (4.44)	-	-	-	8.64 (5.74)	93.95 (105.41)
Chulalongkorn (N = 87)	11.05 (4.37)	7 (8.0%)	0.69 (3.48)	8.57 (9.74)	9.86 (5.44)	53.77 (82.50)
Disease type						
Beta-thal/Hb E (N = 183)	8.86 (4.31)	20 (10.9%)	0.57 (2.64)	5.25 (6.39)	6.94 (5.57)	39.59 (79.17)
Homozygous beta-thal (N = 18)	13.06 (4.30)	2 (11.1%)	0.22 (0.73)	2.00 (1.41)	12.06 (4.32)	90.33 (83.78)
Severity						
Severe (N = 94)	10.41 (4.14)	16 (17.0%)	0.95 (3.53)	5.56 (7.07)	9.35 (4.93)	58.63 (89.75)
Nonsevere (N = 106)	8.26 (4.46)	6 (5.7%)	0.19 (0.92)	3.33 (2.25)	5.74 (5.72)	31.70 (70.03)
Ferritin level						
≤ 2,500 ng/ml (N = 77)	10.60 (3.51)	5 (6.5%)	0.17 (0.80)	2.60 (2.07)	8.96 (4.55)	51.38 (88.92)
> 2,500 ng/ml (N = 50)	11.76 (3.91)	5 (10.0%)	1.20 (4.60)	12.00 (9.82)	11.24 (4.94)	96.02 (92.76)
Complications						
Yes (N = 18)	11.83 (3.92)	3 (16.7%)	0.56 (1.54)	3.33 (2.52)	10.39 (4.84)	113.44 (123.39)
No (N = 183)	8.98 (4.44)	19 (10.4%)	0.54 (2.61)	5.21 (6.56)	7.10 (5.65)	37.32 (72.18)
Total	201	22 (10.9%)	201	22	201	201
Mean	9.23	n/a	0.54	4.95	7.40	44.13
Standard deviation (SD)	4.46	n/a	2.53	6.16	5.65	80.69
Median	9.00	n/a	0.00	3.00	8.00	0.00
95% CI						
Lower	8.61	n/a	0.19	2.22	6.61	32.91
Upper	9.85	n/a	0.89	7.69	8.18	55.36

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Table 2 Public cost of illness of diabetes in 2008 US$ (n = 475)

Cost components	Total	Percent of total cost of illness	Mean	Median
Outpatient visit	7 711.07	17.14	16.23	17.88
Inpatient care	10 629.37	23.63	22.38	0.00
Dispensing cost	4 573.11	10.17	9.63	8.43
Drug cost	11 234.52	24.97	23.65	3.98
Cost of medical devices	178.74	0.40	0.38	0.00
Laboratory cost	6 281.09	13.96	13.22	9.05
Emergency service cost	4 121.38	9.16	8.68	0.00
Dental service cost	184.25	0.41	0.39	0.00
Traditional medicine service cost	75.26	0.17	0.16	0.00
Total public treatment cost	44 988.78	100.00	94.71	45.44

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Table 2 Cost of illness of diabetes (USD at 2008 prices) [$N = 475$]

Cost components	Total	% of total COI	Mean	Median
Direct medical cost	94878.88	22.6	199.75	62.46
Outpatient visit	12042.40	2.9	25.35	22.56
Hospital care	46627.30	11.1	98.16	0.00
Dispensing cost	4573.11	1.1	9.63	8.43
Drug cost	13684.65	3.2	28.81	7.73
Laboratory cost	8608.66	2.1	18.12	14.32
Other service utilisation cost	5951.03	1.4	12.53	0.00
Expenditure at other health facilities	3391.72	0.8	7.14	0.00
Direct non-medical cost	166932.53	39.7	351.44	54.84
Transportation	8137.65	1.9	17.13	3.70
Accommodation	371.88	0.1	0.78	0.00
Meal	1630.00	0.4	3.43	0.00
Cost of personal facilities	3118.44	0.7	6.57	0.00
Other expenses	22237.63	5.3	46.82	0.00
Time loss of patient	10536.22	2.5	22.18	17.34
Time loss of accompanied person	3394.98	0.8	7.15	0.00
Payment to paid caregivers	956.25	0.2	2.01	0.00
Cost of informal care	116549.49	27.8	245.37	0.00
Total direct cost	261811.40	62.3	551.18	138.56
Total indirect cost	156885.04	37.5	330.28	0.00
Work absence/leisure time lost	5332.63	1.3	11.23	0.00
Mortality cost	73285.63	17.5	154.29	0.00
Cost of permanent disability	78266.78	18.7	164.77	0.00
Total cost of illness	418696.45	100.0	881.47	139.79

Table 3 – Time foregone and monetary value of informal care (N = 190).

Time spent on (hours per month)	Mean	SD	Median
HCA	5.80	10.13	0.00
ADL	6.79	15.45	0.00
HDL	42.21	39.94	30.00
IADL	9.28	25.90	2.00

Cost per month (USD)	Mean	Median	Inter-quartile range
Opportunity cost method	37.17	26.77	9.28–52.20
Proxy good method	33.54	22.63	6.53–50.29
Sensitivity – opportunity cost method	39.80	28.67	9.94–55.90
Sensitivity – proxy good method	38.89	28.15	10.24–53.78

HCA = health care activities, e.g. taking medicines; ADL = activities of daily living, e.g. eating and dressing; HDL = household activities of daily living, e.g. shopping and preparing food; IADL = instrumental activities of daily living, e.g. visit to the clinic and relatives.

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Table 3 Diabetic complications, disability and cost of illness for a group of 475 patients in a public district hospital in Thailand (US$ at 2008 prices)

	Number (%)	Cost of illness*			*P* value**
		Mean	Median	SD	
Complications					
With complications	148 (31.16)	1488.33	479.93	3022.57	<0.001
Without complications	327 (68.84)	606.80	115.12	2647.87	
Number of complications					
One complication	96 (20.21)	1059.44	261.32	2505.05	<0.001
Two complications	44 (9.26)	2162.16	758.09	3846.47	
Three and above complications	8 (1.68)	2929.03	2131.34	2838.38	
Types of complications					
Microvascular	59 (12.42)	1977.59	641.20	3337.73	0.001
Macrovascular	11 (2.32)	2000.26	366.55	3028.60	
Micro- and macrovascular	11 (2.32)	3222.06	666.42	6760.88	
Microvascular and cataract	23 (4.84)	1137.86	745.44	1187.62	
Cataract	44 (9.26)	454.07	151.06	629.28	
Physical impairment					
Level 1	26 (5.47)	1716.03	1500.19	1771.69	0.359
Level 3	9 (1.89)	3464.69	3260.12	3397.00	
Level 4	11 (2.31)	4376.07	2212.99	6881.33	
Impairment in eyesight					
Level 1	37 (7.79)	764.83	289.57	1409.01	0.082
Level 2	4 (0.84)	1141.34	393.61	1693.55	
Level 3	3 (0.63)	2025.04	1776.46	1276.43	
Barthel index score					
Independent	411 (86.53)	598.24	123.51	2152.47	<0.001
Disabled	64 (13.47)	2700.29	810.83	4981.79	
Levels of disability					
Mildly disabled	51 (10.74)	1806.23	668.22	3848.08	0.008
Moderately disabled	7 (1.47)	5548.26	2373.91	7939.95	
Severely disabled	1 (0.21)	4891.30	4891.30	0.00	
Very severely disabled	5 (1.05)	7394.27	4377.57	7622.19	
Total	475	881.47	139.79	2796.86	

*Cost data covered the period from October 2007 to September 2008. **Subgroup comparisons were done by using Kruskal–Wallis test. SD, standard deviation.

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Table 5 Predicted cost of various components ($n = 475$)

Components	Mean cost (US$)	Cost increase (US$)
Not hospitalized	1 358.95	–
Hospitalized	9 236.96	7 878.01
Not visited provincial hospital	1 586.47	–
Visited provincial hospital	10 531.42	8 944.95
Diabetes without complications	1 597.70	–
Diabetes with complications	3 918.78	2 321.08
Diabetes without disability	1 575.18	–
Diabetes with disability	7 109.85	5 534.67
Diabetes with mild disability	4 755.81	3 180.63
Diabetes with moderate disability	14 608.56	13 033.38
Diabetes with severe disability	12 878.80	11 303.62
Diabetes with very severe disability	19 469.10	17 893.92

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References (1)

- Kobelt G. Health economics: an introduction to economic evaluation. Second ed. London: Office of Health Economics; 2002.
- Drummond MF, Sculpher MJ, Torrance GW, O'Brien BJ, Stoddart GL. Methods for the economic evaluation of health care programmes third edition. Oxford: Oxford University Press; 2005.
- Drummond MF. Cost-of-Illness Studies: a major headache? Pharmacoeconomics 1992;2(1):1-4.
- Pritchard C, Sculpher M. Productivity costs: principles and practice in economic evaluation. London: Office of Health Economics; 2000.
- Riewpaiboon A, Chatterjee S, Piyauthakit P. Cost analysis for efficient management: diabetes treatment at a public district hospital in Thailand. Int J Pharm Pract 2011;19(5):342-9.

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References (2)

- Riewpaiboon A, Chatterjee S, Riewpaiboon W, Piyauthakit P. Disability and cost for diabetic patients at a public district hospital in Thailand. Int J Pharm Pract 2011;19(2):84-93.
- Chatterjee S, Riewpaiboon A, Piyauthakit P, Riewpaiboon W, Boupaijit K, Panpuwong N, et al. Cost of diabetes and its complications in Thailand: a complete picture of economic burden. Health Soc Care Community 2011;19(3):289-98.
- Chatterjee S, Riewpaiboon A, Piyauthakit P, Riewpaiboon W. Cost of informal care for diabetic patients in Thailand. Prim Care Diabetes 2011;5(2):109-15.
- Riewpaiboon A, Nuchprayoon I, Torcharus K, Indaratna K, Thavorncharoensap M, Ubol B. Economic burden of beta-thalassemia/Hb E and beta-thalassemia major in Thai children. BMC Res Notes 2010;3(1):doi:10.1186/1756-0500-3-29.
- Riewpaiboon A, Riewpaiboon W, Ponsoongnern K, van den Berg B. Economic valuation of informal care in Asia: a case study of care for disabled stroke survivors in Thailand. Soc Sci Med 2009;69(4):648-53.

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