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## Measuring and valuation of treatment costs: utilization, unit costs, discounting

Part 4

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## Costing for Cost and Outcomes Studies

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## The Numerator of the CEA Ratio

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- Weinstein and Stason (NEJM 1977)  
Costs = A + B - C + D
- A. Direct medical and health care costs
- B. Costs associated with treatment of adverse consequences of the intervention
- C. Cost savings associated with prevention and alleviation of illness
- D. Costs of treating future disease

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## What's not in the numerator?

- Direct Nonmedical costs (caregiver costs, travel and waiting time)
- Indirect costs (absenteeism and production loss)
- Psycho-social costs (pain, suffering, other impairments)
- Perspective (out-of-pocket, reimbursement, charge, actual cost)

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## Cost Analysis

- Direct cost analysis
  - Types of cost studies
  - Types of costs (average, marginal, incremental, fixed, variables, accounting and economic)
- Allowance for differential timing
- Allocating overhead costs
- How accurate does costing have to be?
- Productivity and premature mortality.
  - Methods (human capital, replacement, WTP)
  - Rice and Max method of productivity loss values

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## Types of Cost Studies

- Strategy for estimating costs depends upon the type of study:
  1. Retrospective study - researcher attempts to determine the costs after the program has been implemented or is completed. Often, no data are collected prospectively and some data (participant costs) are not collectible, but may be estimable. Cost analyses as part of retrospective studies should contain explicit assumptions and extensive sensitivity analyses both on data and on the components of the included cost elements.

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## Types of Cost Studies

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2. Models - are designed to predict the cost impact of interventions before (or after) implementation. Models are based on estimates because cost data are not available. Same caveat on assumptions and sensitivity analyses apply.
3. Prospective study - Consistent and reliable cost estimates may be obtained since actual cost data can be collected during the intervention. Accuracy of data depends on generalizability of estimates. Researcher must decide in advance what cost information is needed for the analysis.

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## Types of Costs

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- Sunk (fixed) Costs: Those costs that cannot be recovered by eliminating the activity. Physical plant, equipment, etc.
- Variable Costs: Those costs that can be recovered by eliminating the activity.
  - Are personnel costs fixed or variable?
  - Short-run or long-run?
  - What are joint production costs? (inputs produce more than one output)
  - Does learning affect the use and cost of inputs?
  - Should fixed costs be included in an incremental analysis?

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## Types of Costs

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- Accounting Costs - The money outlays for resources required to produce the intervention. For example, salaries of personnel, rent, office supplies, cost of complementary products and services.

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## Types of Costs

- **Economic Costs** - These are the opportunity costs of the resources used to implement the intervention. That is, the value of the resources if those resources had been used for another productive purpose. These include the actual accounting costs plus things like volunteer time, donated materials, donated space, etc. Drummond et al. recommend valuing all resource inputs using economic costs.

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## Types of Costs

- Types of Costs -
  - Direct Medical: costs borne by patients and care-givers as a consequence of disease
  - Indirect Medical: e.g. caregiver costs
  - Indirect non-medical: e.g. productivity loss, travel

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## Types of Costs

- Transfer Payments - Money transfers between sectors or groups that do not result in a net cost increase (or decrease) to society, e.g. worker's compensation.
- Total Cost (Expenditure) - Total quantity (Q) times price per unit (P)
  - $TC = P * Q$

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## Types of Costs

- Fixed Cost - Costs that do not change with a change in the quantity of use (or production). For example, facility costs are generally viewed as fixed costs.
- Variable Cost - Costs that change with a change in the quantity of use (or production). The cost of labor is generally viewed as variable.

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## Types of Costs

- Average Cost - The cost per unit of output represented mathematically as  $AC=TC/Q$ .
- Marginal Cost - The extra cost of using (or producing) one extra unit of output represent mathematically as  $MC=(TC \text{ of } X+1) - (TC \text{ of } X)$ .

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## Types of Costs

No. of Units (Q)	Total Costs (TC)	Avg Costs (AC)	Marg. Costs (MC)
20	4000	200	-
40	6000	150	100
60	7000	117	50
80	10000	125	150
100	15000	150	250

- Incremental Cost - Used to refer to the absolute difference in total cost between two or more programs. If A cost \$100 and B cost \$50, the incremental cost is \$50.

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## Costs and Perspective

- It is essential to specify the perspective since an item that may be a cost from one point of view may not be in another.
  - The most important example is that from the societal perspective, all medical and non-medical costs are relevant - even though the analyst may not be able to measure and value some of them. However, from the health care purchaser perspective, certain categories of costs may not be relevant such as patient and care-giver time and travel costs, indirect costs, etc.
- The societal perspective requires valuation of resources using the economic (opportunity) cost approach.

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## How should costs be estimated?

- Recall that costing has two components: measurement of the quantity of resources consumed (q) and assignment of the unit cost or price (p).
  - Measurement of quantity (q) of resources consumed can be done:
    - retrospectively - using databases, chart review, small surveys of similar patients, or using a practice pattern survey of physicians
    - prospectively - using standard data collection forms or patient diary cards.

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## How should costs be estimated?

- Recall that costing has two components: measurement of the quantity of resources consumed (q) and assignment of the unit cost or price (p).
  - Prices are available for many of the resources. The pragmatic approach is to select market prices as an approximation of opportunity costs.
  - To arrive at costs, multiply Q and P.

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## Valuing non-market resources

- Non-market resource inputs such as volunteer time, leisure time, travel and waiting time can be estimated using marketplace proxies. There are two approaches - **human capital** and **replacement cost**.
  - For example, volunteer time could be valued using a market wage rate (per hour) for the volunteering individual. That is, use the labor opportunity cost for the individual.

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## Valuing non-market resources

- The replacement cost approach is to value time based upon the cost of a replacement worker. For example, the value of homecare services for a spouse who provides these resources would be based on the cost of hiring a worker to perform those duties.
- Friction cost method: cost involved in replacing a worker (e.g., recruiting, training).

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## When should prices be adjusted: hospital charges vs costs

- Health care markets are not perfectly efficient and competitive. Thus, market prices do not accurately reflect opportunity costs.
  - Example - Hospital charges do not reflect long run average prices when hospitals have a local monopoly or cross-subsidize services. Thus, the hospital charge is not an accurate assessment of price. To price hospital services, use DRG reimbursement rates or use published cost/charge ratios (Federal Register).

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**When should prices be adjusted:  
hospital charges vs costs**

- Example - Physician fees suffered from the same problem prior to the Medicare Physician Relative Value Fee Scale reform. To price MD services, use RB-RVS fee scales.
- Note that adjustment will change the absolute value of the price AND possibly the relative value of other prices. Both will change CEA ratios.

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**Allowance for Differential  
Timing**

- Some allowance must be made for the differential timing of costs and consequences.
- Even with zero inflation and no financial interest available for investment, there is inherent benefit to receiving benefits and money earlier than later.
- The risk-free "interest" rate associated with this notion is called the time preference rate and is separate from the inflation rate and risk rate.

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**Allowance for Differential  
Timing**

- Time Preference:
  - A positive rate of time preference is one where - with no inflation and no bank interest rate - individuals prefer money today to money in the future OR would prefer to postpone costs into the future.
  - If competing programs have different cost streams into the future, a method must be used to adjust these cost data to allow for comparison.

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## Allowance for Differential Timing

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- Time Preference:
  - Present Value = Future Cost/(1+r)<sup>n</sup>
    - r = time preference rate (discount rate)
    - n = number of years
  - What are accepted discount rates for cost analysis?
    - 3% as base case with 5% and 0% in sensitivity analyses (US)
    - 7% for costs, 5% for benefits (UK - variable)

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## Discount rate spreadsheet

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## Allocating Overhead Costs

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- Overhead cost is an accounting term for those shared resources that serve many different departments and programs. In some studies it is necessary to allocate a portion of these overhead costs to the program or intervention.
  1. There is no universally accepted way to allocate shared costs.

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## Allocating Overhead Costs

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2. There really are two approaches:
  - Determine those shared costs that change (increase or decrease) because of the program or intervention. Include those in the analysis.
  - Determine all resources used as part of the program or intervention. Value those resources using an allocation methodology.

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## How accurate does costing have to be?

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- Costing can be time consuming, thus it is necessary to limit the effort one expends on any given study.
  - Concerns related to necessity, precision and accuracy need to be worked-out prior to undertaking the costing portion of the study.
    - For example, with medical technologies (drugs, devices, procedures) the result of the study will likely be extremely sensitive to the price of the products. Care should be taken to accurately estimate the use and costs of the products.

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## How accurate does costing have to be?

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- Costing can be time consuming, thus it is necessary to limit the effort one expends on any given study.
  - Concerns related to necessity, precision and accuracy need to be worked-out prior to undertaking the costing portion of the study.
    - However, in a study of change in hospital days, it may not be necessary to perform a micro-costing exercise that requires measurement of individual resources within the stay.

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## **Costing productivity loss and premature mortality**

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- The most widely accepted method for costing work absence and premature mortality is that published by Dorothy Rice and Wendy Max in 1990.
  - Production losses by participants are wages the participant does not receive because of time off from work due to illness or due to participation in a particular program. These data are frequently collected via self-report. Note there is NO validated instrument to determine work days (or school days) missed due to illness or participation in a program.

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## **Costing productivity loss and premature mortality**

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- The most widely accepted method for costing work absence and premature mortality is that published by Dorothy Rice and Wendy Max in 1990.
  - Production losses are valued using average earnings (labor force and non-labor force home production) based on national population-based data. See Appendix I from Haddix et al.

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## **Costing productivity loss and premature mortality**

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- Premature mortality results from earlier than expected death due to illness.
  - The resources lost to society are the earnings generated by the individual.
  - The method for valuation includes the following:
    - 1) Determine the total life expectancy lost due to premature mortality from age and sex-specific life tables.
    - 2) Use the “Present Value of the Expected Future Lifetime Earnings” data by age and gender.

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## Issues to consider in the numerator

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- What is the perspective of the analysis -
  - Which costs to measure?
- What is the hypothesis about cost differences between the interventions?
  - Will drive decisions about how accurate to be with cost exercise.
- Should costs be adjusted for differential timing? What is the impact of not-discounting prevention interventions?

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## Issues to consider in the numerator

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- Should future unrelated costs be included in the numerator?
  - Cost of new diseases?
- In costing studies and cost-of-illness studies, how are disease attributable costs determined?
  - Regression models
  - Expert opinion

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## Takeaway Points

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1. Decide on the perspective as it determines the components of the numerator.
2. Carefully consider those costs that may be important to the study and spend the time collecting these data accurately.

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## **Part 2:**

### **Practical tips for costing**

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### **Adjusting for inflation**

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- Source of inflation adjustments
  - The Bureau of Labor Statistics –
  - Website: <http://stats.bls.gov/sahome.html>
  - CPI for all urban consumers
  - Not seasonally adjusted
  - US city average
  - Current base
  - Search for "medical":
    - there are 7 categories, including medical care, medical care services, prescription drugs and equipment, etc.

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### **Data retrieved for prescription drugs**

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- Consumer Price Index-All Urban Consumers
- Series Catalog:
- Series ID : CUUR0000SEMA
- Not Seasonally Adjusted
- Area : U.S. city average
- Item : Prescription drugs and medical supplies
- Base Period : 1982-84=100

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## Data retrieved for prescription drugs

- Year    Annual CPI
- 1995    235.0
- 1996    242.9
- 1997    249.3
- 1998    258.6
- 1999    273.4
- 2000    287.3 (latest)
- So, 1995 -> 2000 =  $1 + (287.3 - 235.0) / 235.0 = 1 + 0.22 = 1.22$

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## HCFA data

- Medicare Payment Systems
  - <http://www.hcfa.gov/medicare/payment.htm>
- Hospital Outpatient Prospective Payment System:
  - <http://www.hcfa.gov/medicare/hopsmain.htm>
- Public Use Files (provider ID's, CCR's)
  - <http://www.hcfa.gov/stats/pufiles.htm>
- HCFA innovation research grant web site:
  - <https://www.health-mart.net/details.cfm>
- Medicare relative weights, LOS for DRG's
  - <http://www.hcfa.gov/stats/pufiles.htm#payrates>

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## Steps in determining a PPS payment

- **Step 1** - Hospitals submit a bill for each Medicare patient they treat to their Medicare fiscal intermediary (a private insurance company that contracts with Medicare to carry out the operational functions of the Medicare program). Based on the information provided on the bill, *the case is categorized into a diagnosis related group (DRG), which determines how much payment the hospital receives.*

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## Steps in determining a PPS payment

- **Step 2** - The base payment rate is comprised of a standardized amount, which is divided into a labor-related and nonlabor share. The labor-related share is *adjusted by the wage index* applicable to the area where the hospital is located and if the hospital is located in Alaska or Hawaii, the nonlabor share is *adjusted by a cost of living* adjustment factor. This base payment rate is multiplied by the *DRG relative weight*.

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## Steps in determining a PPS payment

- **Step 3**- If the hospital is recognized as serving a disproportionate share of *low-income patients*, it receives a percentage add-on for each case paid through the PPS. This percentage varies depending on several factors, including the percentage of low-income patients served. It is applied to the DRG-adjusted base payment rate, plus any outlier payments received.

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## Steps in determining a PPS payment

- **Step 4**- If the hospital is an approved *teaching hospital* it receives a percentage add-on payment for each case paid through the PPS. This percentage varies depending on the ratio of residents-to-beds.

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## Steps in determining a PPS payment

- **Step 5-** Next, the costs incurred by the hospital for the case are evaluated to determine whether it is eligible for additional payments as an *outlier case*. This additional payment is designed to protect the hospital from large financial losses due to unusually expensive cases. Any outlier payment due is added onto the DRG-adjusted base payment rate.

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## Costs included in PPS payments

- The direct costs of medical education for interns and residents is paid based on a per resident payment amount.
- The following costs continue to be paid on a reasonable cost basis:
  - Hospital bad debts attributable to nonpayment of the Medicare deductible and coinsurance.
  - Heart, liver, lung and kidney acquisition costs incurred by an approved transplant facility.

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## Drug costs

- Often use Average Wholesale Price (AWP), or AWP - 15%
- Look up prices in the “Redbook”

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**Productivity losses**

- See chapter by Dorothy Rice and Wendy Max in “Prevention Effectiveness”, Haddix, ed.

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**Medicaid State data**

- Cost to charge rates:  
– <http://maa.dshs.wa.gov/download/index.html>

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**Procedure costs**

- CPT codes (look up in CPT codes book)  
– <http://www.hcfa.gov/stats/pufiles.htm>

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