The Economics of Healthcare-Associated Infections
Dr. Doug Scott, CDC
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The Economics Of Healthcare-Associated Infections: How to Review The Literature

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Primary Objective

- Provide audience with some tools to help them assess the credibility of results from published papers on the economic impact of healthcare-associated infections and use them for their own institution.

Preliminary Terminology

- What is "economics"?

  The science which studies human behaviour as a relationship between ends and scarce means which have alternative uses. [Lionel Robbins, 1932]

- Fundamental dilemma

  How to allocate limited resources among individuals with unlimited desires.

Core Concept: Opportunity Costs

- Financial costs versus opportunity costs
  Financial cost (those found in a financial statement) are the expenses resulting from production) and help assess income

- Opportunity cost is the value of the next best alternative use forgone as the result of making a decision. (This is the value economists seek – encompasses the idea of 'efficiency' or getting the most for the resources we have).

Opportunity Cost Cont.

- If "the market" is functioning according to economic theory, product prices observed in the market place reflect the opportunity cost (the actual social value of the resources used).

- This is not the case for many healthcare resources – particularly hospital care.

Types of Economic Evaluation Methods

- As most of the research on the economics on the economics of HAI has focused on measuring just the benefits (or cost savings) of HAI prevention, there are not many studies that have done a complete cost-effectiveness analysis, cost-benefit analysis, or cost-utility analysis.

- These will become more prominent so please refer to the following texts and utilize the checklists to help you evaluate literature:

  Haddix AC, Teutsch SM, Corso PS. *Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation*. (2nd edition) New York: Oxford University Press, 2003.

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Are We Finding The Opportunity Costs of HAI?

Issues to consider:

(1) Is the perspective of economic analysis defined?

(2) Is the source and limitations of cost (cost savings) data identified (and appropriate)?

(3) Are the results (the estimates of cost savings) useful?

(4) Are the impacts of time on the results considered?

Perspective of Economic Analysis

- The market for healthcare resources does not work like markets for other goods and services – example of market failure.

- Why?
  There are 'asymmetries' in market structure and organization – in short, there are third party payers.

- Consequences?
  Results in a divergence of perspectives regarding the valuation of healthcare resources.

Table: The Social Cost of Hospital Associated Infections

Categories of Cost*	
Direct Hospital Costs	Fixed Costs: Buildings Utilities Equipment/Technology Labor (laundry, environmental control, administration, etc) **Variable Cost:** Medications Food Consultations Treatments Procedures Devices Testing (laboratory and radiographic) Supplies **Readmissions (?)**
Note: Up to 85% of hospital operating costs are fixed	

Table: The Social Cost of Hospital Associated Infections Cont.

Categories of Cost*	
Indirect Costs	Lost/Wages Diminished worker productivity on the job Short term and long term morbidity Mortality Income lost by family members Forgone leisure time Time spent by family/friends for hospital visits, travel costs, home care
Intangible Cost	Psychological Costs (i.e., anxiety, grief, disability, job loss) Pain and suffering Change in social functioning/daily activities

*Adapted from Haddix AC and Shaffer PA. Cost-effectiveness analysis. In Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation. Oxford University Press, 1996.

Implications of Opportunity Cost Measurement for:

- Hospital administration
  Direct medical costs of HAI not reimbursed
- Patient (insured)
  Indirect medical costs related to lost productivity, intangible costs
- Patient (uninsured)
  Direct + Indirect + Intangible costs
- Society
  Direct + Indirect + Intangible costs

  Reminder of this discussion will focus on costs from the perspective of hospital administration

Perspective and the Cost of Healthcare-Associated Infections in United States

Study Costs	Infection Sites (type)	Est. Annual
Haley et al. (1981,1985)	**SSI, pneumonia, UTI bacteremia, other**	**$4.5 billion** (1992 $)
ASM (1994) ($ resistant infections)	**All sites?**	**$4 billion**
Phelps(1989) ($ resistant infections)	**All sites**	**$0.1 to $30 billion**
OTA (1995) ($ resistant Infections)	**SSI, pneumonia, UTI bacteremia, other**	**$1.3 billion** (1992 $)

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Source and Limitations of Cost Data

Types of cost data to consider:

- Hospital Charges
  Overstates opportunity costs.
- Cost-to-Charge Ratios
  Charges adjusted to reflect hospital costs for services delivered.
- Micro-costing data (or cost accounting data)
  Most accurate measure of hospital resource costs.

Evaluating the Results of Published Studies

☎ Evaluating results from specific models
There are now a number of different modeling approaches used to measure the excess patient costs of HAI.

☎ Short history of the types of methods:
Initially:
(1) Crude Cost Comparisons of noninfected / infected patient groups
(2) Cost Comparisons of matched noninfected / infected patient groups
(3) Appropriateness Evaluation Protocols (AEP).

Early research showed that results from AEPs and matched group comparisons differ (excess HAI cost were less using AEPs). By 1990's, Haley recommends modeling of cost data.

Evaluating the Results of Published Studies Cont.

- Models of patient costs now used include:
  (1) Ordinary Least Squares Regression (OLS) - model assumes a constant (linear) relationship between increase services and costs (i.e. a continuous one percent increase in services rendered will always result in the same constant increase in costs).
  (2) OLS corrected for the presence of nonconstant variance in cost data (because hospital cost data are highly skewed).
  (3) Semi-log transformed cost model using OLS (because cost data are highly skewed). This is a nonlinear model

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Evaluating the Results of Published Studies Cont.

- Don't Panic – the pieces of information you need to see if the results are credible remain the same.
  (1) Is the variable representing HAI statistically significant?
      A. The p-value is below the *a priori* value for statistical significance (usually $p>0.05$).
      B. The standard error (of the estimate) representing the variability of the data around the estimated cost value (or parameter) is "tight".
  (2) The coefficient of determination or R-squared statistic (which shows the proportion of total patient costs (the dependent variable that is explained by the model) is reported.
      Expressed as a percentage, this statistic can be anywhere from 0 to 100%. No rule of thumb here, but with cross sectional data, an R-square approaching 50 percent is indicative of a model with strong predictive power.

Evaluating the Results of Published Studies Cont.

- Additional note on the semi-log model
  The result from this model is the percentage change in cost (as opposed an absolute dollar amount). This information is actually more useful – more on this later.

Evaluating the Results of Published Studies Cont.

- Other types of models you are going to see more of:
  (1) Proportional Hazards models where the outcome is excess length of hospital stay (LOS).   Many of these studies focus on ICU populations only.
  (2) Propensity score models (an alternative to the matched analysis of non-infected to infected patients).
  (3) Median Regression (or Quantile Regression) models that are designed to minimize the impact of extreme value observations (outliers). These models are used because there is concern about measurement error that results in outlier values.

Evaluating the Results of Published Studies Cont.

- How can you use this information for your institution? Here are two strategies using secondary information:

(1) Adjust the dollar amounts of the excess patient cost due to HAI into the percentages:

Example (based on Roberts RR et. al. The use of economic modeling to determine the hospital costs associated with nosocomial infections. *Clin Infect Dis* 2003;36:1424-32).

Average cost of care noninfected patient:	$ 7,333
Average cost of care infected patient:	$15,275*
Total cost of care for infected patient:	$22,608
Percentage change: [(22,608 -7,333) / 7333]*100=	208%

*Estimated

Evaluating the Results of Published Studies Cont.

Calculating the percent change factor w/o non-infected patient costs (X)

$$\frac{(22,608-X)}{X} * 100 = 208$$

Step One: Divide each side by 100
$$\frac{22,608-X}{X} = 2.08$$

Step Two: Multiply each side by X
22,608-X= 2.08X

Step Three: Add X to each side
22,608-X+X = 2.08X + X = 3.08X
22,608 = 3.08X (Conversion factor of total costs to non-infected patient costs)

Evaluating the Results of Published Studies Cont.

Take average total cost of infected patients and adjust to find excess cost.
ex: $22,608 / 3.08 = $7,340 is the base cost without infection while the remaining $15,268 is the excess cost of HAI.

If you only have total patient charges available, adjust these using cost- to-charge ratios available for hospitals in some states, or from AHRQ, or from Haddix reference.

Also, you should use a range of percentages (in effect, conduct a sensitivity analysis) that can come from the literature so that you are reflecting the range of published evidence. Protect your conclusions by being conservative.

Evaluating the Results of Published Studies Cont.

(2) Alternatively, take results from LOS studies. Excess LOS can then be multiplied using average costs per day that your institution should be calculating for their hospital cost report (filed with CMS). There should be calculations for general wards, ICU, burn center, trauma, and pediatric wards.

A Note of Caution:
Care must be taken with both approaches to make sure that you are aggregating the information properly. Many studies just focus on a particular organism or hospital location, so be careful of aggregation bias.

Considering the impacts of time on the results

Two things to mention here:
(1) Discount rate
Please see Haddix book for description of discounting but the short definition is that it is the time value of money. Most studies only use one discount rate – usually 3%. Federal government requires all research on regulations to also use a 7% discount rate (the appropriate rate for the private sector).

(2) Adjusting by the consumer price index
Cost estimates are usually adjusted (for inflation) to reflect value in current dollars. Most use the consumer price index for urban consumers. However, there is a consumer price index for inpatient hospital services that is available. Which adjustment that is the most appropriate is still an open question (see the cost document by Scott).

Summing Up

Presented some items to look out for when reading the literature.

Presented two approaches for using secondary data to estimate the cost of HAI in a hospital.

My email is provided on the title page – feel free to contact me if you need assistance.

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Final Note

■Remember Fixed Costs

These are cost incurred even before any patient is admitted. If hospital is operating at capacity, increase LOS by infected patients may delay treatment for other patients needing a hospital bed. These costs are also part of the opportunity costs resulting from an HAI and should be added to the other costs. Due to market failure, resource prices will not reflect these costs and thus will need to be measured.

THE NEXT FEW TELECLASSES

21 Oct. 09	(South Pacific Teleclass) National Work on the Prevention of Healthcare Acquired Infections in Australia Speaker: Dr. Marilyn Cruikshank, Australian Commission on Safety & Quality in Healthcare
22 Oct. 09	(Free Teleclass) Improving Infection Control in Developing Countries Speaker: Dr. Benedetta Allegranzi, World Health Organisation
29 Oct. 09	Prevention of Catheter-Associated Urinary Tract Infection: New Strategies from CDC/HICPAC Speaker: Russell Olmsted, St. Joseph Mercy Health System
05 Nov. 09	Viruses and Hand Hygiene Speaker: Prof. Syed Sattar, University of Ottawa
10 Nov. 09	(British Teleclass) Getting Guidelines Into Practice Speaker: Prof Carol Pellowe, Thames Valley University
12 Nov. 09	Clostridium difficile Associated Disease: A Financial Burden Analysis Speaker: Prof. Ralf-Peter Vonberg, Hanover Medical School, Germany

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