Economics of MRSA in ICU Settings: Infection and Prevention

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Overview

- Cost of hospital-acquired infections
- Review available economic analysis methods
  - Cost-effectiveness analysis
  - Business-case analysis
- Specific business-case example at Maryland
  - ICU-based active surveillance program for MRSA

Comment

- Can’t use literature to make business case for specific interventions
  - Few studies
  - Studies poor quality (simple quasi-experiments)
  - Cost-analyses not from hospital perspective
  - No sensitivity analysis - not generalizable
- Thus, individual hospitals or systems must complete their own business-case analyses

SHEA Position Paper

Raising Standards While Watching the Bottom Line:

Making a Business Case for Infection Control

2007

HAI Attributable Costs and Length of Stay*

Infection Type	Attributable Costs			Excess Length of Stay (Days)		
	Mean	Min	Max	Mean	Min	Max
Ventilator-associated pneumonia	22,875	9986	54,503	9.6	7.4	11.5
Catheter-related BSI	18,432	3592	34,410	12	4.5	19.6
CABG-associated Surgical Site Infection	17,944	7874	26,668	25.7	20	35
Catheter-associated UTI	1257	804	1710	-	-	-

***All dollar amounts in 2005 dollars; Perencevich et al. SHEA Paper (unpublished data)**

Attributable Costs of Resistance

- MRSA (vs MSSA)
  - Bacteremia[1]
    - Median LOS post-infection increased by 2 days
    - Median hospital charges increased $6916
  - Surgical site infection[2]
    - Median LOS post-infection increased by 5 days
    - Median hospital charges increased $13,901

FOR MORE INFO...

1. Cosgrove SE et al. Infect Control Hosp Epidemiol 2003

2. Engemann JJ et al. Clin Infect Dis 2003

Evaluating Interventions

- Cost-effectiveness
  - For publication
  - For societal and governmental choices
- Business-case analysis
  - Completed pre-intervention or post-intervention to inform hospital administration

Cost-Effectiveness Analysis

- Considers outcomes and costs
  - Cost per life-year saved
  - Cost per quality-adjusted life year (QALY)
- Perspective
  - Societal, hospital, HMO or individual

Cost-Effectiveness Comparison

- Allows comparison between interventions with differing health benefits and costs
  - Increased staffing vs. New surveillance software
- $\Delta C/\Delta E$ = change in cost/change in effectiveness
- Research Standard*

FOR MORE INFO...

*M. Gold et al. *Cost-effectiveness in health and medicine*, Oxford University Press, New York (1996).

Cost-Effectiveness Comparison

Life-Saving Intervention	Cost/Life-Year in 1999 Dollars
Annual stool guaiac colon cancer screening for people age > 55 y*	< $0
Infection control program †	$2,000–$8,000
Active surveillance for VRE in ICUs ‡	$5,900
Pap smears every 3 y §	$20,500
Mammograms yearly between 50 and 65 y §	$130,000

FOR MORE INFO...

*Tengs et al. Risk Anal. 1995;15: 369-390.
† Wenzel. J Hosp Infect. 1995;31:79-87.
‡ Perencevich. SHEA, 2001.
§ Russell. Science. 1989;246:892-896.

What is Cost-effective?

- Society must assess using an arbitrary cost/QALY threshold: $100,000/QALY (or $50,000/QALY)
- Pick intervention with biggest impact given your fixed budget
  - Shopping list
- Note: Cost-effective ≠ Cost-saving

Business Case Analysis

- Definition: Analysis of provider's expenditures for a program over a short period (often 1-3 years), including the effect of any offsetting savings*
- Profit vs. Loss from hospital perspective
- Leave out morbidity and mortality

FOR MORE INFO...

*Mark Smith, PhD and Paul Barnett, PhD, VA Health Economics Resource Center, Palo Alto CA

Time Horizon of Business Case

- Typically short horizon (*e.g.*, 1 year)
- Short-run costs and benefits only

- Bias against adoption of interventions that are cost-effective in the long run

Comment: The Cost-Saving Requirement

- Are infection-control interventions worthwhile only if they are cost-saving?
- Literature says “Yes”
- Currently, IC programs are described as cost-effective only if they are cost-saving
- Cost-saving requirement = human life <$0
- Kidney Transplant
- Need to change reimbursement to reward cost-effective infection-control (or QI) interventions

Economic Assessment of Infection Control Interventions

“Two” Types of Health Care-Associated Interventions

- Preventing “endogenous” infections
  - e.g. Catheter-associated bacteremia
- Population-level interventions
  - Interrupting transmissible diseases (MRSA)
  - Hospital-wide automated surveillance system

Endogenous Infections

- Patients you intervene on directly benefit
- Example: Inserting expensive antibiotic-coated central venous catheters to reduce blood stream infections
- Ideally, costs to prevent these should be billed to patient or built into reimbursement for hospital care since they directly benefit
- Complete cost-effectiveness analysis using standard methods*

FOR MORE INFO...

*M. Gold et al. *Cost-effectiveness in health and medicine*, Oxford University Press, New York (1996).

Population-level Interventions

- Those that benefit are not necessarily those that you intervene on
- Example: Active surveillance culturing for MRSA on ICU admission
- Public health problem – who pays?
- Should reimbursement be changed to encourage these interventions?

Example: Business-case

- MRSA control in ICU settings
  - Numerous potential interventions
  - Diverse clinical settings
    - Varying prevalence of MRSA
    - Community vs. Tertiary care

Determining Optimal Strategy

- Large clinical trial
  - Include ICUs that have high AND low MRSA prevalence
  - Test immediate vs delayed isolation strategies
  - Community and urban hospitals
- Quasi-experimental study
  - Complete in each hospital
  - Interrupted time-series regression analysis
- Decision analysis / mathematical models
  - Can test many strategies using existing data
  - Limited by existing data
  - Sensitivity analysis

The Maryland Example

- University of Maryland Medical Center obtains admission surveillance cultures for MRSA on all patients admitted to the Medical ICU (MICU)
- Since 2001, a study nurse has increased compliance to >90%
- Question: Should we keep doing what we are doing or change practice?

Generalizing the Maryland Experience

- Created individual-based mathematical model that simulates a cluster-randomized trial in 10-bed MICU
- Parameters
  - Systematic literature search
  - Existing active surveillance program
- Business-case from Maryland hospital perspective

FOR MORE INFO...

Perencevich et al. *ICAAC.* 2005;312. Abstract K-547

Three Surveillance Strategies

1. *Passive surveillance:* isolation patients with history of MRSA colonization or infection
2. Active surveillance using standard anterior nares cultures, with isolation only when cultures return positive in 48 *or* 72 hours
3. Active surveillance with rapid PCR-based test, 8-hour return

Perencevich et al. *ICAAC.* 2005;312. Abstract K-547.

Base Case ICU

Model Parameter	Parameter Estimate Used in Base Case
ICU Size	10 Beds
MRSA Prevalence on Admission	12.3%
Length of Stay in ICU	Median 2 days, Mean 4.6 days
Proportion of Beds Occupied	98%
Effectiveness of Isolation	70%
Daily Isolation Costs (gowns, gloves, time)*	$27.17#
Contract Rate (Beta)	0.00057

FOR MORE INFO...

*West TE et al. Infect Control Hosp Epidemiol 2006(27):233-238

#All costs inflated to 2006 dollars using Medical Care component of CPI

Comparator: Passive Surveillance

- Patients isolated if previous history of MRSA colonization or infection
- Sensitivity=38%
- Specificity=98%
- No test costs
- Just isolation costs of gowns/gloves

Tests Simulated: Standard Culture

- Patients isolated after standard anterior nares culture obtained on admission returns positive
- Sensitivity=80%
- Specificity=95%
- Turn around time: 48-hours, 72-hours
- Negative test = $7.73; Positive test $11.73*

FOR MORE INFO...

*West TE et al. Infect Control Hosp Epidemiol 2006(27):233-238

Tests Simulated: Rapid PCR

- Patients isolated after anterior nares swab obtained on admission returns positive
- Sensitivity=80%
- Specificity=95%
- Turn around time: 8-hours
- Cost estimate (materials and time)=$33.74

Which Program?

- Rapid screen is estimated to prevent 11 additional MRSA acquisitions per year vs. standard screen
- All active surveillance strategies were estimated to cost less than $1,500 per MRSA acquisition prevented
- Rapid test program costs $20,000 more

Hey! What if I'm Not at Maryland?

- Strength of a mathematical model is findings can be extended beyond one site or scenario (generalizability)
- Sensitivity analysis
  - Vary one, two or three
  - Best and worst case

Conclusion

- Healthcare-associated infections are costly and associated with significant excess mortality and length of stay
- Both business-case analyses and cost-effectiveness analyses are needed in order to optimize infection control practice
- MRSA control through use of active surveillance is cost-effective independent of method, will likely be cost saving when infection and infection-related costs are included

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