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*

<table>
<thead>
<tr>
<th>Infection Type</th>
<th>Attributable Costs</th>
<th>Excess Length of Stay</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Min</td>
</tr>
<tr>
<td>Venilator-associated pneumonia</td>
<td>22,875</td>
<td>9986</td>
</tr>
<tr>
<td>Catheter-related BSI</td>
<td>18,432</td>
<td>3592</td>
</tr>
<tr>
<td>CABG-associated Surgical Site Infection</td>
<td>17,944</td>
<td>7874</td>
</tr>
<tr>
<td>Catheter-associated UTI</td>
<td>1257</td>
<td>804</td>
</tr>
</tbody>
</table>

*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 SHEA Paper (unpublished data)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

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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

- \( \Delta C/\Delta E = \text{change in cost}/\text{change in effectiveness} \)

- Research Standard*

*FOR MORE INFO...

## Cost-Effectiveness Comparison

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

*For more info...

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

*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 bloodstream 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...
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...
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

## Base Case ICU

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


#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*

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.
Acknowledgments

University of Maryland
Anthony Harris
J. J. Furuno
Douglas Bradham
Michelle Shardell
Mary Claire Roghmann
Holly Gaff
Marin Schweizer
Kristin Kreisel
Kerri Thom
Simone Shurland
Judy Johnson
Colin Stine
Joan Hebden
Hal Standiford
Libby Fuss
Marilyn Algire
Rick Venezia
Kristie Johnson

Other Nice Places
Marc Wright—Evanston Northwestern Healthcare
Jessina McGregor – Oregon State, Portland
Glenn Morris – Univ. of Florida, Gainesville
David Hartley – Georgetown