Economic Analysis of VRE: Assessing Attributable Cost and Length of Stay

Dr. Marc Romney, Providence Health, Vancouver
A Webber Training Teleclass

Economic Analysis of VRE:
Assessing Attributable Cost and Length of Stay

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Hosted by
Nicole Kenny
Virox Technologies Inc

INFECTION PREVENTION AND CONTROL
Vancouver, BC, Canada

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Objectives

1. To review the published evidence supporting (or refuting) the de-escalation of VRE control programs
2. To appreciate the attributable impact of VRE on hospitalization costs
3. To appreciate the attributable impact of VRE on length of stay

Disclosures

• Participated in a Medical Advisory Board meetings for Pfizer (Canada)
• Participated in a lunch meeting sponsored by Sunovion Pharmaceuticals Canada

Background

1. Enterococci cause a range of illnesses, including:
   - bloodstream infections
   - urinary tract infections
   - other infections
2. Infections due to Vancomycin Resistant Enterococci (VRE) are usually healthcare-associated
3. VRE outbreaks in hospitals have been reported
4. Treatment options are limited
5. Enterococcus faecium > Enterococcus faecalis

Background (2)

• In 2013, US Centers for Disease Control and Prevention (CDC) released a report entitled: ‘Antibiotic Resistance Threats in the United States’
• Raise awareness regarding the threat of antibiotic resistance
• Immediate action to address this threat
• For the first time, CDC prioritized antibiotic resistant bacteria into 3 categories

Background (3)

- These are high-consequence antibiotic resistant threats because of significant risk identified across several criteria. These threats may not be currently prevalent but are causing concern and require urgent public health attention to identify infections and limit transmission.

- These are an emerging/emerging antibiotic resistant threats. They are not currently prevalent, but are less understood and may become significant without ongoing C & P (CDC) Health monitoring and state reporting.

- These are bacteria for which the threat of antibiotic resistance is low, and/or there are multiple therapeutic options for resistant infections. These bacterial pathogens cause severe illness, however in this category require monitoring and are not cases of rapid incident or mortality response.

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In Canada, there is considerable controversy over the value of VRE control programs in hospitals.

Some hospitals in British Columbia, Ontario, and other provinces have abandoned VRE prevention and control programs:

- VRE are not very virulent
- New antibiotics exist to treat VRE infections
- Serious VRE infections are uncommon (mostly colonization)
- VRE control programs are very expensive
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Background (4)
- Canadian data on the effectiveness of hospital-based VRE control programs are somewhat lacking
- Some hospitals in which VRE control programs had been discontinued did not perform (or publish) cost-effectiveness studies prior to discontinuation

The Study – Introduction
- Limited number of reports from US hospitals describing attributable costs and length of stay (LOS) due to VRE
- Mostly estimates and are highly variable
  - Small samples sizes
  - Inherent differences in the settings
  - Different study design
- Each study reported an increased cost and LOS for patients with VRE

Providence Health Care
- Largest Catholic health care organization in Canada
- Six facilities in Vancouver
  - 3 hospitals
  - 3 residential care facilities
  - 1 hospice
- ~1500 beds
- St. Paul’s Hospital
  - HIV/AIDS Program
  - Cardiac Program
  - Renal Program

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The Study – Methods (Data Source)
- Fiscal year 2008-2009
- All VRE positive patients (colonization or infection) from IPAC database
  - Incident cases only
- Cases required laboratory confirmation, N=217
- Controls were randomly identified, N=1075
- Acknowledged by the PHC / University of BC REB as quality improvement project

The Study – Methods (Variables and Outcomes)
- Variables chosen for investigation:
  - Surveillance database
  - Finance database
  - Those variables previously reported in the published literature
- Patient characteristics were stratified by the presence or absence of VRE colonization or infection
- Two outcomes for the analysis:
  - ATTRIBUTABLE COST
  - ATTRIBUTABLE LENGTH OF STAY (LOS)

The Study – Methods (Statistics 1)
- An attributable cost analysis determines patient costs had the infection (or colonization) never occurred
- Hospitalization costs attributable to VRE
- Attributable cost is NOT the money spent on controlling VRE
- Determined by “comparative attribution”
- Construction of a statistical model
- Relationship between cost and infection status
- Simultaneously controlling for other variables affecting patient cost

The Study – Methods (Statistics 2)
- Generalized Linear Modeling (GLM) approach was chosen for both cost and LOS analyses
- Non-normal distribution of data
- Cost variables were highly skewed
- GLM showed the best fit for the data
- GLM is a very flexible and robust statistical model

The Study – Results
- VRE patients had higher mean total cost and LOS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Controls</th>
<th>VRE patients</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years, mean ± SD)</td>
<td>62.4 ± 17.3</td>
<td>63.1 ± 17.3</td>
<td>0.049</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>59.69%</td>
<td>59.49%</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Acute care</td>
<td>49.2%</td>
<td>49.7%</td>
</tr>
<tr>
<td>Acute medical/medical-surgical</td>
<td>50.8%</td>
<td>50.3%</td>
<td>0.769</td>
</tr>
<tr>
<td>ICU stay</td>
<td>20%</td>
<td>24%</td>
<td>0.003</td>
</tr>
<tr>
<td>Negative transmural enterococci test</td>
<td>5.8%</td>
<td>5.5%</td>
<td>0.584</td>
</tr>
<tr>
<td>GI tract culture positive (mean ± SD)</td>
<td>29.0 ± 8.5</td>
<td>29.6 ± 7.9</td>
<td>0.581</td>
</tr>
<tr>
<td>Cost of hospital stay (mean ± SD)</td>
<td>$4,338 ± 3,738</td>
<td>$4,398 ± 3,708</td>
<td>0.491</td>
</tr>
</tbody>
</table>

The Study – Results

<table>
<thead>
<tr>
<th>Relative (%)</th>
<th>Absolute (dollars/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>95% CI</td>
</tr>
<tr>
<td>Attributable cost</td>
<td>81.9</td>
</tr>
<tr>
<td>Length of stay (days)</td>
<td>68.0</td>
</tr>
</tbody>
</table>

CI: confidence interval.
1 The estimated relative costs remain constant for each VRE case.
2 The estimated absolute costs will be different for each VRE case, depending on the reference costs. The numbers reported in this table are estimated at the average costs of a VRE patient.
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The Study – Results
• Attributable cost: 61.9% greater than the total hospital cost of a patient without VRE
• Absolute cost: $17,949 CAD greater than the total hospital cost of a patient without VRE
• The presence of VRE increases LOS by 68.0% in relative terms
• This translates to an additional 13.8 additional days of hospitalization

The Study – Results
• A smaller secondary analysis investigated attributable costs between VRE colonizations (N=200) and VRE infections (N=17)
• There was no statistically significant difference in the attributable cost or VRE between patients who were infected versus those who were colonized

The Study – Discussion
• GLM showed that VRE had a positive and highly significant impact on both cost and LOS
• These cost estimates are within the range of attributable costs reported in the US literature
  → albeit at the lower end of the range
• VRE sample contained 90% colonizations (lower costs)
• Of those patients infected with VRE, 60% had urinary tract infections (lower costs)

The Study – Discussion
• Secondary analysis was unable to discern a difference in attributable cost due to VRE infection versus VRE colonization
• Could be due to relatively small number of infections
• This suggests that VRE colonizations alone could carry significant cost and may prolong LOS
• VRE colonization may not be a totally benign event

The Study – Limitations
• Potential bias arising from the relationship between VRE and LOS
  → A longer LOS puts patients at higher risk for VRE
  → VRE positivity increases patients’ LOS
  “ENDOGENOUS VARIABLE BIAS”

The Study – Limitations
• Secondary analysis was conducted on a small sample size
  → Additional analyses with a larger number of VRE infections may help overcome this limitation
• Societal costs were not investigated as part of the study (e.g., lost productivity, excess mortality)
• These costs may triple attributable hospital costs
• The data from our study are conservative estimates

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The Study – Conclusions
• At St. Paul’s Hospital, VRE positivity is associated with:
  – Attributable cost of approximately $18,000 CAD
  – Attributable LOS of approximately 14 days
• VRE colonizations alone may account for significant cost and LOS implications
• These data can be used for future cost-effectiveness studies and broader rigorous economic evaluations of VRE control programs
• A cost-effectiveness study at St. Paul’s Hospital is currently underway

Relaxation of VRE Screening and Isolation Precautions
• Large, urban tertiary-care hospital in Montreal
• Retrospective, observational study performed over 13 years
• Analysis of microbiological data comparing two intervention periods:
  – “Pre-relaxation period” (2000 to May 2010)
    • Intensive VRE prevention and control program
  – “Post-relaxation period” (May 2010 to April 2013)
    • Intended to protect high-risk patients from VRE

Relaxation of VRE Screening and Isolation Precautions (2)
• Pre-relaxation interventions included:
  – Dedicated nursing staff for VRE positive patients (starting 2005/2006)
  – Temporary closure of wards with ongoing VRE transmission (starting 2005/2006)
  – PCR testing for rectal screening (starting 2005/2006)
  – Creation of a dedicated VRE cohort unit (2007 to May 2010)
  – Placement of security guard to enforce hand washing and compliance with personal protective equipment (2007 to May 2010)

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Relaxation of VRE Screening and Isolation Precautions (3)

- Post-relaxation period:
  - “Dramatic” rise in VRE colonization observed
  - Concurrent increase in VRE bacteremias and other VRE infections (definite and possible)
  - Subsequent incidence of VRE bacteremias and definite VRE infections eventually reached a plateau
  - Possible VRE infections remained elevated

Relaxation of VRE Screening and Isolation Precautions (4)

- Conclusions:
  - “Guarded” support for relaxation and de-escalation of VRE control programs
  - Focus on preventing VRE in patients who are at high risk
    - Immunocompromised patients
    - Severely ill patients
  - Not complete discontinuation of VRE control
  - Re-allocate infection control resources to other interventions
  - Study is limited by observational design and potential confounders spanning the 13 year study period

Propor$tionality$ in Infection Prevention and Control

- Many different infectious “threats” or “hazards”
- Response (interventions) should be proportionate to the threat
- Usually not an “all or none” approach
- Response should be based on:
  - An assessment of risk (including patient population)
  - Local epidemiology
  - Local resources (including financial resources)
- Responses should be coordinated and not implemented unilaterally

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- In a hospital with a large number of immunocompromised and medically complicated patients, VRE positivity was associated with:
  - Attributable cost of approximately $18,000 CAD
  - Attributable LOS of approximately 14 days
- Local data should guide the intensity of a VRE prevention and control program
- Response should be proportionate to the threat

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September 16 (Free ... WHO Teleclass – Europe)
KEY MEASURES FOR THE PREVENTION AND CONTROL OF
EBOLA VIRUS DISEASE
Dr. Sergey Romualdovich, World Health Organization

September 16 (Free Teleclass)
INFECTION PREVENTION AND CONTROL – THE ARGENTINA
EXPERIENCE
Carolina Giuffré, Buenos Aires British Hospital, Argentina

September 16 HEALTH ECONOMIC EVALUATION OF AN INFECTION PREVENTION
AND CONTROL PROGRAM
Dr. Elizabeth Bryce, Vancouver Hospital

September 20 (Free Teleclass ... Broadcast Live from IPS Conference)
THE TIMES THEY ARE A CHANGING
Dr. Evonne Curran, Health Protection Scotland

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