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Impact of rapid identification of gram negative blood cultures in a community hospital system

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Impact of Rapid Identification of Gram Negative Blood Cultures in a Community Hospital System

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Fort Wayne, Indiana

The speaker has no actual or potential conflict of interest in relation to this presentation
Blood Culture Identification (BCID)

- Rapid polymerase chain reaction (PCR)
- Technology identifies select pathogens and resistance genes
- Multiple versions of this technology are utilized across the country
- Results within 1-3 hours of testing
- Important tool for antimicrobial stewardship (AMS) teams

Rapid PCR BCID at Parkview

- Gram negative pathogens identified:
  - *Escherichia coli*
  - *Klebsiella pneumoniae*
  - *Pseudomonas aeruginosa*
  - *Enterobacter cloacae complex*
  - *Enterobacteriaceae*
  - *Proteus spp.*
  - *Acinetobacter spp.*
  - *Haemophilus influenzae*
  - *Neisseria meningitides*
  - *Serratia marcescens*

- Gram negative resistance gene identified:
  - *Klebsiella pneumoniae* carbapenemase (KPC) gene

- Does not provide susceptibilities or MIC values

MIC = minimum inhibitory concentration

Rapid PCR BCID at Parkview

- Integrated at Parkview Health in November 2015
- Providers are alerted of gram stain results while awaiting PCR
- Pharmacy notified 24/7 of all rapid PCR BCID results for adequate coverage and recommend if needed
- Results then sent to AMS pharmacists to evaluate for de-escalation (Monday–Friday, day shift)
Assessment Question #1

Which of the following best describes the capabilities of rapid PCR blood culture identification technology for gram negative bacteremia?

A. Identifies all gram negative species
B. Recognizes select antimicrobial resistance genes
C. Identifies antimicrobial susceptibility and MIC values
D. Replaces the need for traditional blood cultures
McVane SH, Nolte FS.

- Conducted at an academic hospital in 2015
- Gram positive and gram negative bloodstream infections
- Control, AMS, and rapid PCR BCID plus AMS
- 364 subjects
- Results
  - Improved time to first de-escalation
  - No statistical difference in cost, length of stay, or mortality

Box MJ, et al.

- Conducted at a community-based hospital system in 2014
- Gram positive bloodstream infections only
- Control vs. rapid PCR BCID, both utilized AMS
- 167 subjects
- Results
  - Improved time to targeted therapy
  - Decrease in median length of stay
  - Decrease in median total direct variable costs

Assessment Question #2

Hospitals that utilize rapid PCR blood culture testing in conjunction with antimicrobial stewardship programs can:

A. Increase time to de-escalation of antibiotic therapy
B. Decrease overall mortality
C. Increase overall cost for the patient
D. Improve time to targeted therapy
Impact of Rapid Identification of Gram Negative Blood Cultures in a Community Hospital System
Parkview Health

- 2 hospitals located in Allen County, Indiana
  - Parkview Regional Medical Center
  - Parkview Randallia
- 5 community hospitals in the surrounding counties
Study Purpose

• To evaluate the impact of rapid PCR BCID on the de-escalation of antibiotic therapy in patients with gram negative bacteremia in multiple community hospitals

• Limited gram negative literature

• Previous resident conducted a study evaluating impact of rapid PCR BCID on coagulase negative *Staphylococcus*
Design

- Retrospective chart review
- Approved by Institutional Review Board

May 1, 2014 - April 30, 2015

Control Group
- Traditional blood cultures only

November 2015

Rapid PCR BCID introduced

May 1, 2016 - April 30, 2017

Study Group
- Rapid PCR BCID
Inclusion Criteria

- > 18 years old
- Positive blood culture with gram negative bacteria
- Admission to Parkview Health hospital

Note: If there were multiple gram negative bacteremia admissions, only the first admission was evaluated
Exclusion Criteria

• Hospice
• Polymicrobial bacteremia
• Immunocompromised
  • Neutropenic
  • Transplant patients
  • Immunosuppressants
• Not receiving gram negative coverage at time blood culture result

• Immunosuppressants
  • Monoclonal antibodies
  • Chemotherapy
  • Chronic steroids
Outcomes

• Primary Outcomes
  • Difference in time to first de-escalation
    • *Removal of a single agent or reduction in the spectrum of activity*
  • Difference in time to targeted therapy
    • *De-escalation to antibiotic with the narrowest spectrum of activity appropriate for the pathogen*
Outcomes

• **Secondary Outcomes**
  • Incidence of first de-escalation
  • Incidence of gram-positive removal
  • Incidence of targeted therapy
  • Difference in time to removal of gram-positive coverage
  • Intensive care unit length of stay
  • Hospital length of stay
  • Survival
  • Percent de-escalation recommended by pharmacy
Statistical Analysis

- $\alpha = 0.05$
- **Primary outcomes**
  - Mann-Whitney U Test
- **Secondary outcomes and baseline characteristics**
  - Chi square
  - Student’s t test
Subjects

535 Subjects Screened

240 Subjects Excluded
- 58 immunocompromised
- 54 hospice
- 45 repeat admissions
- 31 no initial antibiotics
- 26 not hospitalized*
- 22 polymicrobial bacteremia
- 6 <18 years old*
- 2 non-gram negative bacteremia*

*Control group only

295 Subjects Included in Analysis

Control
147 Subjects

Study
148 Subjects
## Baseline Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Study Group</th>
<th><strong>P-value</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Control Group (n = 147)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, mean (SD)</td>
<td>66.7 (17)</td>
<td>67.3 (16.7)</td>
<td>0.72</td>
</tr>
<tr>
<td>Sex, male, n (%)</td>
<td>56 (37.8)</td>
<td>60 (40.8)</td>
<td>0.60</td>
</tr>
<tr>
<td>Weight, kg, median (IQR)</td>
<td>80.4 (67.6, 95.3)</td>
<td>83 (68.9, 105.8)</td>
<td>0.10</td>
</tr>
<tr>
<td>Antibiotic Allergy, n (%)</td>
<td>46 (31)</td>
<td>50 (34)</td>
<td>0.59</td>
</tr>
<tr>
<td>Hospital Location, n (%)</td>
<td></td>
<td></td>
<td>0.86</td>
</tr>
<tr>
<td>Allen County</td>
<td>121 (81.8)</td>
<td>119 (81)</td>
<td>--</td>
</tr>
<tr>
<td>Non-Allen County</td>
<td>26 (18.2)</td>
<td>29 (19)</td>
<td>--</td>
</tr>
</tbody>
</table>
Baseline Characteristics

Control Group Source of Infection
- Urine: 79%
- IV Catheter: 3%
- Skin: 0%
- Respiratory: 2%
- Other: 7%
- Unidentified: 9%

Study Group Source of Infection
- Urine: 77%
- IV Catheter: 3%
- Skin: 1%
- Respiratory: 1%
- Other: 11%
- Unidentified: 7%
## Baseline Characteristics

<table>
<thead>
<tr>
<th>Bacteria Identified</th>
<th>Control Group (n = 147)</th>
<th>Study Group (n = 148)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Escherichia coli</strong></td>
<td>95 (64.6)</td>
<td>101 (68.2)</td>
</tr>
<tr>
<td><strong>Klebsiella pneumoniae</strong></td>
<td>25 (17)</td>
<td>22 (14.9)</td>
</tr>
<tr>
<td><strong>Proteus spp.</strong></td>
<td>13 (8.8)</td>
<td>5 (3.4)</td>
</tr>
<tr>
<td><strong>Pseudomonas aeruginosa</strong></td>
<td>8 (5.4)</td>
<td>6 (4)</td>
</tr>
<tr>
<td><strong>Enterobacter cloacae</strong></td>
<td>3 (2)</td>
<td>10 (6.8)</td>
</tr>
<tr>
<td><strong>Serratia marcescens</strong></td>
<td>3 (2)</td>
<td>3 (2)</td>
</tr>
<tr>
<td><strong>Haemophilus influenzae</strong></td>
<td>0 (0)</td>
<td>1 (0.7)</td>
</tr>
</tbody>
</table>

Reported n, percent
## Primary Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Control Group ( n=102 )</th>
<th>Study Group ( n=119 )</th>
<th>Difference</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time to First De-escalation, days, median (IQR)</strong></td>
<td>1.63 (0.51, 2.47)</td>
<td>1.58 (0.73, 2.46)</td>
<td>0.04 (0.96 hr)</td>
<td>0.92</td>
</tr>
<tr>
<td><strong>Time to Targeted Therapy, days, median (IQR)</strong></td>
<td>2.60 (1.95, 3.76)</td>
<td>2.65 (1.84, 3.89)</td>
<td>0.05 (1.2 hr)</td>
<td>0.68</td>
</tr>
</tbody>
</table>
## Secondary Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Study Group</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incidence of First De-escalation, n (%)</td>
<td>102 (69.4)</td>
<td>119 (80.4)</td>
<td>0.03</td>
</tr>
<tr>
<td>Incidence of Gram-Positive Removal, n (%)</td>
<td>47 (32)</td>
<td>55 (37.2)</td>
<td>0.35</td>
</tr>
<tr>
<td>Incidence of Targeted Therapy, n (%)</td>
<td>95 (64.6)</td>
<td>115 (77.7)</td>
<td>0.42</td>
</tr>
<tr>
<td>Time to Gram-Positive Removal, days (hr), median</td>
<td>1.2 (28.8)</td>
<td>0.92 (22.1)</td>
<td>0.13</td>
</tr>
</tbody>
</table>
## Secondary Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Control Group</th>
<th>Study Group</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ICU Length of Stay, median (IQR)</strong></td>
<td>3.19 (2.1, 5.1)</td>
<td>3.15 (1.6, 4.3)</td>
<td>0.93</td>
</tr>
<tr>
<td><strong>Hospital Length of Stay, median (IQR)</strong></td>
<td>4.94 (3.2, 7.8)</td>
<td>4.99 (3.4, 7)</td>
<td>0.90</td>
</tr>
<tr>
<td><strong>Survival, n (%)</strong></td>
<td>143 (97.3)</td>
<td>146 (98.6)</td>
<td>0.45</td>
</tr>
<tr>
<td><strong>Pharmacist Intervention, n (%)</strong></td>
<td>19 (13.3)</td>
<td>79 (52.7)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Conclusions

- Rapid PCR technology did not have a significant effect on time to first de-escalation or time to targeted therapy
  - 52 total subjects were already receiving targeted therapy, 33 in the control group and 19 in the study group
- Rapid PCR technology resulted in a clinically significant decrease in time to removal of gram positive coverage
- Rapid PCR implementation increased opportunities for pharmacist recommendations
Discussion

• Primary etiology of gram-negative bacteremia was UTI, where presentation may have influenced empiric therapy

• Gram-negative rapid PCR BCID has limited resistance identification, which can restrict the ability to de-escalate

• The current protocol encourages appropriate initial coverage and not de-escalation of therapy

• AMS pharmacist coverage was limited to 40 hours/week
Limitations

• Retrospective chart review

• Did not account for the other benefit of rapid PCR BCID – addition of initial coverage

• Study stopped in the Spring of 2017 and physicians may be getting more comfortable with the technology
Future Direction

- Education of practitioners on:
  - The benefits of rapid PCR BCID technology
  - Regional *E. coli* susceptibility profile
- Make local antibiogram more easily accessible with an electronic version
- Publication
Acknowledgements

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- Robert Beckett, PharmD, BCPS
References


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