Success at Reducing Contaminated Blood Culture Specimens from the ED

How Our Lab's Collaboration with Nurses and Use of New Technology Improved Specimen Quality in Support of Better Patient Care

Adult ED: Stefani Michael, RN, Noula Cumins, RN
Lab: Lori Gauld, Keisha Church, Gloria Palmer-Long, Lisa L. Steed
Financial disclaimer

- Magnolia Medical Technologies has paid my expenses to present posters and platform presentations on the MUSC experience at national meetings.
Medical University
of South Carolina

- Founded in 1824 as the 1st medical institution in the southern USA
- 700-bed tertiary/quaternary care hospital (MUSC Health)
  - 80,000 annual ED visits; Level 1 trauma center
  - Daily census 700 inpatients
    - Children’s Hospital
    - National Cancer Institute designation for Hollings Cancer Center
- ANCC Magnet Recognition Program®
Potential sources of blood culture contamination

- **Human factors**
  - Risk of contamination during assembly & preparation of supplies
  - Skin prep, education interventions on proper technique
    - monitoring technique & repeated training challenging in the ED due to time pressure & workflow constraints
    - Phlebotomy in ED increases time delays & costs
  - Skill level

- **Skin flora:** up to 20% of skin flora viable in the keratin even after skin preparation

- **Patients**
  - Difficult to draw due to dehydration or limited available sites for venipuncture
    - Increased patient discomfort
  - Argumentative, combative
  - Unclean
Impact of false positive blood cultures outside the lab

- **Antibiotic Stewardship**
  - Unnecessary antibiotic use
  - Potentially missed true pathogen

- **Patient Safety**
  - Increase risk of *C. difficile* infection
  - Increased risk of infections due to antibiotic-resistant organisms
  - Increased length of stay
  - Increased workload
  - Increased patient discomfort
    - Initiation of intravenous access
    - Imaging

- **Infection Prevention**
  - Reporting HACs to NHSN
Laboratory impacts of blood culture contamination

- Increased workflow
  - Unnecessary tests for 35% to 50% of positive blood cultures
  - Unnecessary communication with caregiver in the reporting of this “critical value”

- Unnecessary tests
  - Additional blood cultures
    - Microscopic analysis (Gram stain, etc.) and organism identification
    - Antimicrobial susceptibility testing (AST)
  - Antimicrobial serum level monitoring (e.g. vancomycin peak and trough levels)
  - Ancillary chemistry and hematology tests

- Decreases process, productivity, performance
  - Major contributor to overtime

- Significantly increases avoidable costs
MUSC experience

**Graph:**

- **Title:** Hospital Incremental Costs of Contaminated Blood Cultures

- **Axes:**
  - Y-axis: Incremental costs (in thousands)
  - X-axis: Blood culture contamination rate

- **Data Points:**
  - Cost: Various costs are plotted at different contamination rates.
  - No: Corresponding data points for uncontaminated cultures.

- **Legend:**
  - Cost
  - No

- **Notes:**
  - Projections based on 28,000 blood cultures/year and an estimated incremental cost of a contaminated blood culture of $5,765 (JAMA 1981:265:385) adjusted for inflation and assuming a cost/charge ratio of 1.5:1.

**Graph Legend:**
- **Total**
- **IP**
- **ED**

**% FPBC Prior to SteriPath Intervention:**

- **FY 2009**
- **FY 2010**
- **FY 2011**
- **FY 2012**
- **FY 2013**
- **FY 2014**
- **FY 2015**

The graph shows a decrease in the percentage of false positive blood cultures (FPBC) prior to the SteriPath intervention.
Steripath initial specimen diversion device

Steripath GEN2 has
- 21g or 23g safety needle; luer lock
- longer butterfly tubing
- Ambidextrous universal orientation
- UDI bar codes compatible with EMR system scanners
Steripath implementation

- ED nurses and Micro administration developed business plan
  - Dedicated ED nurses would be trained to use ISDD; floater nurses & CNAs would not (controls)
    - Magnolia Medical trained ED nurses for 1 month
  - Packaging label sent with blood culture set to lab
  - Nurse champion & Micro manager would collate data
- Plan presented to Products Evaluation Committee; 3 month trial granted
- Presented initial data; another 3 month trial granted
Steripath implementation

- Adult ED (started Nov. 2015)
  - With Steripath = 0.57%
  - Without Steripath = 4.17% (3.05% without outlier)
  - Compliance = 63% (for 3 months)
- Overall 75% reduction in FPBC
Steripath implementation

- Adult ED (started Nov. 2015)
  - With Steripath = 0.57%
  - Without Steripath = 4.17% (3.05% without outlier)
  - Compliance = 63% (for 3 months)
- Overall 75% reduction in FPBC

- Presented 6 month data to Products Evaluation Committee
  - Continued in Adult ED
  - Expanded evaluation to 2nd ED
Continue with the gain through FY 2019 (February)

- Adult ED (Nov. 2015-June 2018)
  - With Steripath = 0.87%
  - Without Steripath = 3.62%
  - Compliance = 68% (59-77%)

- Overall 86% reduction in FPBC
Continue with the gain through FY 2019 (February)

- Chest Pain Center (May 2016-June 2018)
  - With Steripath = 0.95%
  - Without Steripath = 2.59%
  - Compliance = 53% (36-69%)

- Overall 70% reduction in FPBC
Steripath compared with standard venipuncture

<table>
<thead>
<tr>
<th></th>
<th>Steripath</th>
<th>Standard Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = Organisms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contamination</td>
<td>2</td>
<td>CoNS, Coryne</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>CoNS (8), Prop (3), AHS (2), Micrococcus, Coryne</td>
</tr>
<tr>
<td>True bacteremia</td>
<td>143</td>
<td>143</td>
</tr>
<tr>
<td>Discordant cultures</td>
<td>11</td>
<td>Klebsiella (4), S. aureus (2), S. pneumo, E coli, Peptostrep</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>S. aureus (2), S. pneumo (2), E coli (2), Morganella (2), S. pyogenes, Enterobacter, H. influenzae, C albicans</td>
</tr>
</tbody>
</table>

Two sets of cultures critical to recovering pathogen

Contamination rate: 0.22% with Steripath, 1.78% with standard practice

Likelihood of positive culture being true positive: 97% with Steripath, 81% with standard practice

Reduction in vancomycin usage by 37%

Rupp et al
<table>
<thead>
<tr>
<th>Observation Period</th>
<th>Observed rate</th>
<th>Model Estimated Risk vs Intervention (95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All cultures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre 6 months (n = 3454)</td>
<td>33.0</td>
<td>1.4 (1.1-1.7)</td>
<td>0.01</td>
</tr>
<tr>
<td>Intervention</td>
<td>24.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post 6 months (n = 3596)</td>
<td><strong>28.1</strong></td>
<td>1.2 (0.9-1.5)</td>
<td>0.26</td>
</tr>
<tr>
<td><strong>Phlebotomist-drawn cultures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre 6 months (n = 2684)</td>
<td>26.5</td>
<td>1.3 (1.0-1.8)</td>
<td>0.08</td>
</tr>
<tr>
<td>Intervention</td>
<td><strong>20.3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post 6 months (n = 2905)</td>
<td><strong>28.2</strong></td>
<td>1.4 (1.0-1.9)</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Nurse-drawn cultures</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre 6 months (n = 3454)</td>
<td>55.8</td>
<td>1.4 (0.9-2.1)</td>
<td>0.11</td>
</tr>
<tr>
<td>Intervention</td>
<td>40.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post 6 months (n = 3596)</td>
<td>32</td>
<td>0.8 (0.4-1.4)</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Rupp et al
Steripath reduces false positive blood cultures

<table>
<thead>
<tr>
<th>Institution</th>
<th>Study Period</th>
<th>Starting or Control FPBC rate</th>
<th>Steripath FPBC rate</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Univ Nebraska Med Ctr (ED)</td>
<td>12 mo</td>
<td>1.8%</td>
<td>0.2%</td>
<td>88%</td>
</tr>
<tr>
<td>Lee Health System (ED)</td>
<td>7 mo</td>
<td>3.5%</td>
<td>0.6%</td>
<td>83%</td>
</tr>
<tr>
<td>San Antonio Military Med Ctr (ED)</td>
<td>5 mo</td>
<td>7.7%</td>
<td>0.6%</td>
<td>92%</td>
</tr>
<tr>
<td>Rush Univ Med Ctr (ED)</td>
<td>3 mo</td>
<td>4.3%</td>
<td>0.6%</td>
<td>86%</td>
</tr>
<tr>
<td>Beebe Healthcare</td>
<td>4 mo</td>
<td>3.0%</td>
<td>0.8%</td>
<td>75%</td>
</tr>
<tr>
<td>VA Houston</td>
<td>7 mo</td>
<td>5.5%</td>
<td>0.9%</td>
<td>83%</td>
</tr>
<tr>
<td>Shaare Zedek Med Ctr (IP)</td>
<td>6 mo</td>
<td>5.2%</td>
<td>1.0%</td>
<td>81%</td>
</tr>
<tr>
<td>VA No Texas Healthcare</td>
<td>5 mo</td>
<td>5.3%</td>
<td>1.7%*</td>
<td>68%</td>
</tr>
</tbody>
</table>

* Blended rate
Antibiotic Stewardship: decreased days of vancomycin therapy

- San Antonio Military Medical Center ER
  - Implemented positive blood culture PCR
    - Vancomycin days: 49.56 $\rightarrow$ 39.31 (20% drop)
  - Implemented Steripath 7 months later
    - Vancomycin days: 39.31 $\rightarrow$ 24.87 (37% drop)

Chang et al
Distribution of downstream costs based on results of blood cultures collected in the ED

<table>
<thead>
<tr>
<th></th>
<th>Microbiology</th>
<th>Pharmacy</th>
<th>Hospital indirect</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With RDT</td>
<td>Without RDT</td>
<td>LOS</td>
<td>ADRs</td>
</tr>
<tr>
<td>FPBC</td>
<td>477</td>
<td>275</td>
<td>423</td>
<td>10,500</td>
</tr>
<tr>
<td>Negative BC</td>
<td>119</td>
<td>118</td>
<td>295</td>
<td>7,500</td>
</tr>
<tr>
<td>Attributable to FPBC</td>
<td>358</td>
<td>158</td>
<td>127</td>
<td>3,000</td>
</tr>
</tbody>
</table>

Values are $ per culture

RDT = rapid diagnostic testing on positive blood cultures (multiplex PCR, MALDI-TOF, PNA-FISH)
ADRs = adverse drug reactions
HAIs = hospital acquired infections

Median LOS: extra 2 d over true negatives (7 d [4-11] vs 5 d [3-9])
True bacteremia: 9 d [7-9]
Estimated anticipated cost savings per blood culture using Steripath in the ED

<table>
<thead>
<tr>
<th>Baseline contamination rate prior to implementation</th>
<th>Microbiology</th>
<th>Pharmacy</th>
<th>Hospital indirect</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>With RDT</td>
<td>Without RDT</td>
<td>With RDT</td>
<td>Without RDT</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>74</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>117</td>
</tr>
<tr>
<td>4</td>
<td>13</td>
<td>6</td>
<td>4</td>
<td>160</td>
</tr>
<tr>
<td>6</td>
<td>21</td>
<td>9</td>
<td>7</td>
<td>244</td>
</tr>
<tr>
<td>8</td>
<td>28</td>
<td>12</td>
<td>10</td>
<td>330</td>
</tr>
</tbody>
</table>

Values are $ per culture unless otherwise indicated

Expected cost of a blood culture: $8,893 with SteriPath, $9,165 with conventional practices

RDT = rapid diagnostic testing on positive blood cultures

Skoglund et al
Incremental costs per FPBC (model)

- Used data from a 281-bed hospital, 135 FPBC & matched controls
  - Mean LOS: extra 2.35 d over true negatives (9.02 d vs 6.67 d)
- Calculated data for a medium sized hospital (250-400 beds)
  - About 39 HACs (range 15-87) attributable to FPBC
    - 3 additional cases of *C difficile*
  - Dedicated phlebotomy would reduce HACs by 23 cases; use of ISDD would reduce HACs by 34 cases
    - Phebotomists would save $125 per culture, ISDD would save $186 per culture excluding cost of device
  - 26% reduction in antibiotic use

Geisler et al
Alternatives to Steripath

- Kurin blood culture collection set—passively diverts <0.15 mL of blood
- Clean Collect blood collection system—manual sterile diversion tube
- Diversion tube—a blood drawing tube
Summary

- Steripath reduces FPBC by at least 80%
  - Primarily used in EDs
- Reduction in FPBC can be sustained below 1% for years
- Positive predictive value as high as 97%
- Reduction in days of vancomycin therapy up to 37%
- LOS shortened by an average of 2 days

- Factors dependent on the facility:
  - Reduced HAIs expected
  - Annualized cost savings
References

- **Publications**

References

- Abstracts
  - Chang, D et al. 2017. Impact of Blood Culture Diversion Device and Molecular Pathogen Identification on Vancomycin Use. SHEA