Introducing Hospital-Onset Bloodstream Infection (HOBSI) as a Tool to Evaluate Infection Prevention: Assessment of 50 US Hospitals

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Background:
Hospitals, health systems, many state hospital associations, and quality improvement networks struggle to evaluate their performance. The Centers for Disease Control and Prevention’s (CDC) National Healthcare Safety Network (NHSN) publicly reported infections measures. Many healthcare-associated infections (HAIs) are publicly reported, and some are tied to the Centers for Medicare & Medicaid Services (CMS) hospital-acquired conditions (HAC) penalty and value-based purchasing (VBP) programs. Still, publicly reported HAIs are a fraction of infections reported in the hospital. Our approach may help reflect the hospital’s infection prevention performance. Hospitals may benefit from additional measures that help them evaluate their performance over time and compare their performance to other hospitals in real-time.

Currently, publicly reported infections include a few types of events and do not provide a comprehensive picture of overall infection prevention practices. Hospital-onset bloodstream infections (HOBSI), regardless of source, reflect invasive infection of a site expected to be sterile (e.g., blood) for an at-risk patient population. Inpatient healthcare settings. We define HOBSI with the same CDC NHSN definition used for hospital-onset methicillin-resistant Staphylococcus aureus (MRSA) bacteremia LabID Events, where each event is counted once per patient, starting on the fourth day from admission (day 1 being the admission day). We report on using HOBSI as an aggregate of five different types of organisms commonly associated with invasive infection in the hospital setting and unlikely to represent contamination. We describe how the rate of infection with these organisms can be used as an aggregate to identify hospitals that may need further attention, as well as simply to identify potential risks for specific infections.

Methods:
Using one infection prevention surveillance system, we identified all positive blood cultures for five organisms commonly associated with healthcare infections (Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, and Candida species) using 18 months of data, Jan, 1, 2016-June 30, 2017, across 50 acute care hospitals. All unique blood source LabID Events identified >3 days after admission were included, if the patient had no prior event in the previous 14 days. Each HOBSI was counted once per patient and was classified based on the NHSN definition of the LabID Event. Commonly reported BSI (COBSI) were identified for patients admitted with BSI during the first three days. Validation was performed comparing laboratory order and electronic order data for the individual site to the surveillance system report. Rates for the individual organisms per 10,000 patient days were calculated per hospital, for small (<100 beds), medium (100-300 beds), and large (>300 beds) hospitals, and for the combined 50 facilities. In addition, we calculated an aggregate rate for HOBSI related to the five organisms per 10,000 patient days.

Results:
1,536 HOBSI events occurred over 4,233,384 patient days at an aggregate rate of 3.65 per 10,000 patient days. The ratio of HO/CO BSIs was 0.35. Small (<100 beds) hospitals had very low event rates. There were significant differences observed between medium (100-300 beds) and large (>300 beds) hospitals, specifically in candidemia rates (Table 1). Large hospitals had significantly higher HOBSI rates for Candida species and tended to be higher for E. coli, K. pneumoniae, and P. aeruginosa. On the other hand, similar rates were found for S. aureus HOBSI in medium and large hospitals. S. aureus and Candida species represented 57% of all HOBSI. HOBSI rates varied from 172 to 953 per 10,000 patient days for large hospitals and from 64 to 490 events per 10,000 patient days for medium hospitals. Outlier hospitals are easily identified and then directly engaged. Facility and System trends were entered monthly over time, for both individual organisms and all organisms combined, providing an objective assessment of infections may over time (Figures 1 and 2).

Discussion:
Currently, publicly reported measures are focused on specific HAIs and do not reflect the hospital’s overall infection prevention culture. We propose a new measure that encompasses the most common organisms associated with HAIs. We have not included enterococci, which potentially may be isolated as contaminants in blood cultures. Our results differ from a recent study reporting the rate of hospital-onset bacteremia in the intensive care unit (ICU) of around 115 events per 10,000 ICU days, where the study included any positive blood cultures, such as multiresistant and contaminants, obtained 48 hours after hospital admission. The population studied was intensive care patients, a high-risk population within the hospital. Our new suggested metric can be used for multiple purposes:
- 1. It provides a benchmark for hospitals of similar size on expected HOBSI rates, for either the five organisms combined or for each individual organism.
- 2. It trends HOBSI per hospital over time and helps identify any changes that may be related to a gap in infection prevention measures. For example, in our sample, increases in candidemia in two hospitals were associated with an increase in use of parenteral nutrition instead of enteral nutrition. In another hospital, an increase in E. coli S. aureus HOBSI was associated with increases in surgical site infections for specific surgeries.
- 3. It can be used as a global measure for the effectiveness of infection prevention practices, facility-wide and system-wide.

Conclusion:
Automated reporting of HOBSI for common organisms associated with invasive disease provides an objective method to evaluate infection prevention in medium and large hospitals and creates the potential to benchmark based on hospital characteristics in the future.

References:
3. The authors have no conflict of interest.

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Table 1: HOBSI event rates per 10,000 patient days over an 18-month period for 50 hospitals

<table>
<thead>
<tr>
<th>Organism</th>
<th>Mean rate</th>
<th>95% CI</th>
<th>Rank</th>
<th>Small (n=13) Mean rate</th>
<th>95% CI</th>
<th>Rank</th>
<th>Medium (n=17) Mean rate</th>
<th>95% CI</th>
<th>Rank</th>
<th>Large (n=20) Mean rate</th>
<th>95% CI</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. aureus</td>
<td>0.97</td>
<td>(0.76, 1.23)</td>
<td>2</td>
<td>0.57</td>
<td>(0.32, 0.93)</td>
<td>4</td>
<td>0.35</td>
<td>(0.24, 0.50)</td>
<td>5</td>
<td>0.21</td>
<td>(0.14, 0.33)</td>
<td>6</td>
</tr>
<tr>
<td>E. coli</td>
<td>0.34</td>
<td>(0.24, 0.46)</td>
<td>8</td>
<td>0.32</td>
<td>(0.24, 0.43)</td>
<td>7</td>
<td>0.27</td>
<td>(0.16, 0.42)</td>
<td>9</td>
<td>0.15</td>
<td>(0.09, 0.25)</td>
<td>11</td>
</tr>
<tr>
<td>K. pneumoniae</td>
<td>0.31</td>
<td>(0.23, 0.41)</td>
<td>10</td>
<td>0.15</td>
<td>(0.09, 0.22)</td>
<td>10</td>
<td>0.15</td>
<td>(0.10, 0.23)</td>
<td>11</td>
<td>0.08</td>
<td>(0.05, 0.13)</td>
<td>12</td>
</tr>
<tr>
<td>P. aeruginosa</td>
<td>0.31</td>
<td>(0.23, 0.41)</td>
<td>11</td>
<td>0.15</td>
<td>(0.09, 0.22)</td>
<td>10</td>
<td>0.15</td>
<td>(0.10, 0.23)</td>
<td>11</td>
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<td>12</td>
</tr>
</tbody>
</table>

Figure 1: HOBSI rate trend for the five organisms commonly associated with healthcare infections

Figure 2: ASHOBSI rate trend for the combined rate of all five organisms commonly associated with healthcare infections