Technical and Logistical Issues in Incorporating Statistical Process Control into Healthcare-Associated Infection Surveillance Programs

Abstract

**Background:** Use of statistical process control (SPC) in healthcare is increasing but remains less common than in other industries. Healthcare-associated infections (HAIs) are important applications that can benefit from SPC methods, including use within existing surveillance programs to trigger investigation and intervention. The empirical value of SPC, however, typically is anecdotal and remains unclear to many practitioners.

**Methods:** We retrospectively applied Shewhart and Exponentially Weighted Moving Average (EWMA) SPC charts to 10 years (2003 to 2013) of de-identified surgical site infection (SSI) data, including eight known SSI outbreaks, from the Duke Infection Control Outreach Network (DICON) of 50 community hospitals. For both SPC methods, we computed the number of the eight known outbreaks detected and months of earlier detection versus traditional surveillance. To distinguish between minor unsustained versus major sustained HAI rate increases, for each of these eight outbreaks, we additionally calculated the number of months with signals during the year prior to the outbreak, monthly consecutive signals before the outbreak, and signals during the outbreak period. Finally, as a workload measure, we computed the total signals produced at each outbreak hospital for any procedure over the entire study period.

**Results:** All known outbreaks were detected by both types of SPC charts 0 to 12 months earlier than traditional surveillance. Baseline data, EWMA smoothing factor, and aggregation level (hospital, surgeon, procedure) affect SPC detection performance of SSI data.

<table>
<thead>
<tr>
<th>Performance</th>
<th>Shewhart</th>
<th>EWMA (λ = 0.2)</th>
<th>EWMA (λ = 0.4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Months of SPC detection before traditional detection</td>
<td>A0 B</td>
<td>A0 B</td>
<td>A0 B</td>
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<tr>
<td>Number of signals in 12 months before traditional detection</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
</tr>
</tbody>
</table>

NOTE: A: SPC control limits based upon Hospital A’s year 1 baseline data; B: Control limits based upon DICON average baseline data.

**Conclusion:** SPC methods appear useful and practical for augmenting current HAI surveillance programs, detecting SSI outbreaks several months earlier on average than traditional surveillance.

- Statistical design factors such as EWMA smoothing factor, aggregation level (hospital, surgeon, procedure), and baseline data affect detection performance of SPC.
- Further research is needed to address several technical and implementation considerations in order to maximize the potential benefits of complementing HAI surveillance with SPC.

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