Implementing Surgical Site Infection Prevention Bundles Across Large Healthcare Systems

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Disclosure

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- The sponsors had no role in the conduct of the study; in the collection, management, analysis, and interpretation of the data; or in the preparation of this talk.
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Outline

- STOP SSI Study
  - Quantitative methods
  - Qualitative methods
  - Quantitative results
  - Qualitative results
- Summary & Conclusions
STOP SSI: Introduction

- Our prior meta-analysis: a bundle of practices should decrease *S. aureus* SSIs significantly.
- The bundle elements were:
  - Screening patients’ nares for *S. aureus*
  - Decolonizing carriers with intranasal mupirocin & chlorhexidine bathing
  - Using vancomycin & cefazolin for perioperative prophylaxis among MRSA carriers
- The effectiveness of the entire bundle had not been tested.

STOP SSI: Purpose

• To evaluate whether implementing an evidence-based bundle prevents *S. aureus* SSIs in patients undergoing cardiac operations or hip/knee arthroplasties (HA/KA)

• To identify facilitators of & barriers to implementation
STOP SSI: Eligibility Criteria

- A Hospital Corporation of America (HCA) hospital that performed the procedures of interest.
- The hospital had not incorporated all algorithm elements into its practice.
- The hospital could provide data on SSIs for ≥ 2 years preceding implementation.
- Staff from interested sites completed an electronic survey about current surgical infection prevention practices.

STOP SSI: Site Selection

• 45 HCA hospitals expressed interest
• 25 hospitals completed the electronic survey
  – 5 hospitals declined the invitation to participate
  – 1 hospital withdrew after a training session
• 1 hospital joined 1 month after the training session
• 20 hospitals participated in the quasi-experimental study
STOP SSI: Preliminary Training

- **April 2012: 1½-day in-person meeting.**
- **Meeting objectives**
  - Share detailed information about the protocol.
  - Build enthusiasm & relationships among sites & the leadership team.
  - Allow site liaisons to develop implementation plans for the multidisciplinary teams at their sites.
  - Allow liaisons interact face-to-face with the content experts & to ask the experts questions.
STOP SSI: Ongoing Support

- Created & updated a modular electronic procedure manual on HCA’s intranet.
- Conducted frequent (biweekly, then monthly) interactive “coaching” webinars to:
  - Answer questions,
  - Disseminate study updates,
  - Allow sites to discuss challenges & share facilitating strategies,
  - Promote rapid implementation & “hardwiring” of the algorithm.
- Distributed frequently asked questions (FAQ) document & supported an electronic mailbox to facilitate communication.
STOP SSI: Activities

- Preparatory activities:
  - Establish processes for identifying patients,
  - Obtain necessary equipment & supplies,
  - Obtain local medical staff approval,
  - Establish a multidisciplinary implementation team & plans,
  - Organize & provide training materials for staff, patients, & physicians’ offices,
  - Work with local information technology staff to ensure that study-specific charting screens were available.
STOP SSI: Activities

- Implementation activities:
  - Educate patients
  - Swab patients’ nares
  - Provide mupirocin & chlorhexidine for carriers

- Maintenance activities:
  - Monitor 10–15 eligible cases/month to determine if the algorithm was applied consistently & documented in the electronic health record (EHR).
  - Submit audit forms & review results during one-on-one telephone calls between liaisons & project staff.
STOP SSI: Methods

- Pragmatic quasi-experimental effectiveness study
- Study population
  - 20 HCA affiliated hospitals
  - Adult patients having primary HA/KA or primary cardiac operations through median sternotomies
STOP SSI: Exclusions

- Arthroplasty revisions, cardiac revisions, cardiac transplants, trans-apical valve implantations
- Patients with infections before their operations
- Pregnant women
STOP SSI: Methods

- SSI surveillance:
  - Infection Preventionists (IPs) used the CDC NHSN SSI definitions & followed patients for 90 days postop.
  - An experienced IP validated 10% of SSIs.

- Primary outcome:
  - Rate of complex (deep incisional or organ-space) MSSA or MRSA SSIs
STOP SSI: Statistical Methods

- Intention-to-treat analysis
- Analysis of SSI rates
  - Poisson regression to assess change in the monthly SSI rates
  - Used generalized estimating equations (GEE) to account for hospital-level clustering & temporal autocorrelation
Analysis of Postop LOS & readmissions

- Postop LOS (log-transformed): Linear regression
- Readmissions for SSIs: Logistic regression
- Used GEE to accommodate patient-level confounders & hospital-level clustering effects
Monthly coaching calls were recorded & transcribed.

A qualitative research team:
- Reviewed transcriptions & developed a coding structure based on thematic content.
- Coded minutes using MAXQDA.
- Created a report based on the coding analysis.
STOP SSI: Qualitative Methods

- At the end of the study, a focus group was conducted by video conference with study champions.
  - The report was presented to the champions.
  - The champions provided additional details & feedback on the report.
  - Comprehensive notes were recorded.
- Focus group notes were analyzed for additional thematic content.
- An analytic framework was used to organize thematic codes.
S. aureus Positive

- **MRSA +**
  - Yes: Decolonize with intranasal Mupirocin*** ointment BID x 5 days
  - CHG*** bathing (daily x5 days, using wipes or liquid)
  - Cefazolin* plus Vancomycin**

- **MSSA +**
  - Yes: Decolonize with intranasal Mupirocin*** ointment BID x 5 days
  - CHG*** bathing (daily x5 days, using wipes or liquid)
  - Cefazolin*
**S. aureus** Negative or Unknown

**S. aureus** Negative

- Positive for *Staph aureas*?
  - No, *SA* negative
    - CHG*** bathing (night before & morning of surgery using wipes or liquid)
      - Cefazolin*

Unknown

- Pre-op screening results known prior to incision?
  - No, not screened or results unknown at the time of surgery
    - Decolonize with intranasal Mupirocin*** ointment (start BID x 5 days; discontinue if negative screen)
      - CHG*** bathing (start daily bath 5 days before operation if possible; at a minimum bathe the night before & morning of surgery using wipes or liquid)
      - Cefazolin* plus Vancomycin**
STOP SSI: Pre-Intervention Practice

- MRSA screening: 20/20
- CHG bathing:
  - Scheduled operations: 20/20
  - Urgent/emergent operations: 13/20 (65%)
- Intranasal mupirocin:
  - Scheduled operations: 9/20 (45%)
  - Urgent/emergent: 6/20 (30%)
STOP SSI: Participation

- Hospitals & procedures:
  - Joint arthroplasties alone: 8 hospitals
  - Cardiac operations alone: 4 hospitals
  - Joint arthroplasties & cardiac procedures: 8 hospitals
- Median pre-intervention period: 39 months (range 39-43).
- Median intervention period: 21 months (range 14-22).
- One hospital stopped the intervention on March 31, 2013; 19 continued through March 31, 2014.
STOP SSI: Implementation

Number of hospitals ready to implement by the end of month*

2012
STOP SSI: Results

- 42,534 operations among 38,049 patients
  - Pre-intervention 28,218 operations
  - Intervention 14,316 operations
- Patients undergoing operations during both periods were similar.
- After a 3-month phase-in period, bundle adherence: 83%:
  - Fully adherent: 39%
  - Partially adherent: 44%
  - Not adherent: 17%
STOP SSI: Complex *S. aureus* SSIs

- **Pooled rate of complex *S. aureus* SSIs:**
  Pre-Intervention 0.36% vs. Intervention 0.20%

- **Number of months with no complex *S. aureus* SSIs:** Pre-intervention 2/39, 5.1% vs. Intervention 8/22, 36.4%; *P* = 0.006

- The median rate & range became 0 by intervention month 4.
Results: Complex *S. aureus* SSIs

<table>
<thead>
<tr>
<th></th>
<th>Pre-Intervention</th>
<th>Intervention</th>
<th>Rate Ratio (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Entire Cohort</strong></td>
<td>28,218</td>
<td>14,316</td>
<td>0.58 (0.37, 0.92)</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Hip/Knee</strong></td>
<td>20,642</td>
<td>11,059</td>
<td>0.48 (0.29, 0.80)</td>
<td>0.005</td>
</tr>
<tr>
<td><strong>Cardiac</strong></td>
<td>7,576</td>
<td>3,257</td>
<td>0.86 (0.47, 1.57)</td>
<td>0.63</td>
</tr>
</tbody>
</table>
Complex *S. aureus* SSI Rate by Month

- Complex *S. aureus* SSI Rate
- Poisson Regression Line

Hospitals began implementing intervention in June 2012
STOP SSI: Subgroup Analyses

- Scheduled operations: Rate ratio (RR) 0.55 (0.35, 0.86); \( P = 0.009 \)
- Fully adherent: RR 0.26 (0.10, 0.69); \( P = 0.007 \)
- Surgeon implemented at least some bundle elements: RR 0.54 (0.34, 0.88); \( P = 0.01 \)
- Complex SSIs caused by any pathogen: RR 0.67 (0.44, 1.00); \( P = 0.05 \)
- Gram negative SSIs: RR 0.86 (0.41, 1.75); \( P = 0.67 \)
STOP SSI: Other Outcomes

• Postop LOS:
  – Median was 3 days for both periods
  – After adjustment: NS

• Readmissions for SSIs within 90 days
  – Pre-intervention vs. Intervention: 0.21% vs. 0.12%
  – After adjustment: OR = 0.58; NS

• Adverse events
  – 4 patients reported mild skin irritation after CHG bathing
STOP SSI: Early Barriers

- Delays in obtaining medical executive committee approval for new preoperative orders.
- Delays in obtaining surgeons’ agreement to participate.
- Difficulty establishing reliable processes for screening & decolonizing patients who bypassed the usual pre-admission process:
  - Admitted through the emergency department for urgent/emergent procedures
  - Admitted on weekends or holidays.
STOP SSI: Qualitative Framework

Institutional Context

Organizational Context

Individual Action

Patterns of Interaction

by author
Facilitators:
- Corporate physician champion who had interacted with surgeons & local champions
- Infrastructure & resources (e.g., centralized IRB & training, shared EHR, supply chain, prior implementation of MRSA screening)
- Project team support (e.g., site visits)

Barriers:
- Time needed to resolve hospital-level barriers (e.g., developing order sets & reports in EHR)
STOP SSI: Organizational Context: Hospital

- **Facilitators:**
  - Establishing order sets in local EHRs
  - Educating & cross-training personnel

- **Barriers:**
  - Obtaining committee approval
  - Developing processes for urgent/emergent operations
  - Hardwiring practice across shifts
  - Documenting bundle adherence
  - Ensuring supplies were available
STOP SSI: Individual Action

- Facilitators:
  - Strong local champion
  - Personalized education/training

- Barriers:
  - Resistance & autonomous decision making
  - Time constraints (e.g., documenting, auditing)
STOP SSI: Patterns of Interaction

• Facilitators:
  – Communication & partnerships among surgeons, clinics, & hospitals
  – Information technology used for alerting & documenting
  – Solutions (e.g., patient education material & checklists) shared during coaching calls

• Barriers:
  – Priorities conflict
  – Decentralized offices
  – Complex communication channels among patients & providers, & among care sites
  – Demands of the healthcare network or hospital
STOP SSI: Additional Lessons

Sufficient time & resources were needed for:

- Information technology staff to develop standardized orders & documentation in the EHR to facilitate adherence monitoring & data collection.
- Educators to develop educational materials & conduct initial & ongoing training for all staff, including those on all shifts, new staff, & temporary staff.
- Project liaisons to develop systems that allow staff in different departments to coordinate new activities.
- Providers to consider & adopt practice changes.
STOP SSI: Bundle Summary

- Implementation of the SSI prevention bundle:
  - Was associated with significantly lower rates of complex *S. aureus* SSIs in the total cohort & in the hip/knee arthroplasty group.
  - Was not associated with an increase in gram negative SSIs.
- Use of the full bundle was associated with significantly lower rates of complex *S. aureus* SSIs.
The complexity of the bundle (intervention) may have affected adherence rates.

The bundle is relatively simple to maintain because it does not require expensive technology or additional staff.
STOP SSI: Study Limitations

- SSI surveillance varied among hospitals.
- May not be generalizable to large academic health centers or to hospitals without strong infrastructures for quality improvement.
- Neither patients nor facilities were randomized
  - Regression to the mean is unlikely because we compared rates over a long time period
  - Seasonal effects are unlikely:
    - No evidence of long-term trends or seasonal effects
    - Rolling implementation reduced the bias
Some barriers & facilitators were shared among hospitals.

Combinations of barriers & facilitators differed among hospitals.

Hospitals & staff differed in their capacity to overcome barriers.

Strong local champions & a corporate physician champion helped overcome barriers.
Collaborators

- **University of Iowa**
  - MA Ward
  - H-Y Chiang
  - DJ Diekema
  - ML Schweizer
  - JE Cavanaugh
  - EN Perencevich

- **HCA**
  - J Moody
  - J Hickok
  - JB Perlin
  - E Septimus
  - Staff from 20 HCA hospitals

- **TJC**
  - B Braun
  - J Hafner
  - CL Richards
Thank you!
Number of Patients Receiving Each Bundle Component

14,316 Operations Done in 20 Participating Hospitals during Intervention Period

1,189 (8.3%) Underwent Urgent/Emergent Operations

- Of 1,189:
  - 177 (14.9%) Received Perioperative Vancomycin and Cefazolin
  - 214 (18.0%) Received Perioperative Vancomycin
  - 57 (4.8%) Received ≥ 1 Day of Mupirocin
  - 19 (1.6%) Fully Adherent
  - 598 (50.3%) Partially Adherent

13,127 (91.7%) Underwent Scheduled Operations

367 (2.8%) MRSA Carriers

- Of 367:
  - 147 (40.1%) Received ≥ 3 Days of Mupirocin
  - 262 (71.4%) Received CHG
  - 168 (45.8%) Received Perioperative Vancomycin and Cefazolin
  - 76 (20.7%) Received Perioperative Vancomycin
  - 81 (22.1%) Fully Adherent
  - 241 (65.7%) Partially Adherent

2,411 (18.4%) MSSA Carriers and MRSA Unknown

- Of 2,411:
  - 84 (3.5%) Received ≥ 3 Days of Mupirocin
  - 604 (25.1%) Received CHG
  - 202 (8.4%) Received Perioperative Vancomycin and Cefazolin
  - 226 (9.4%) Received Perioperative Vancomycin
  - 12 (0.5%) Fully Adherent
  - 986 (40.9%) Partially Adherent

1,455 (11.1%) MSSA Carriers and MRSA Negative

- Of 1,455:
  - 858 (59.0%) Received ≥ 3 Days of Mupirocin
  - 1,295 (89.0%) Received CHG
  - 1,216 (83.6%) Received Perioperative Cefazolin
  - 753 (51.8%) Fully Adherent
  - 684 (47.0%) Partially Adherent

2,494 (19.0%) MSSA Unknown and MRSA Negative

- Of 2,494:
  - 29 (1.2%) Received ≥ 3 Days of Mupirocin
  - 572 (22.9%) Received CHG
  - 1,953 (78.3%) Received Perioperative Cefazolin
  - 21 (0.8%) Fully Adherent
  - 2,085 (83.6%) Partially Adherent

6,400 (48.8%) S. aureus Negative

- Of 6,400:
  - 5,407 (84.5%) Received CHG
  - 5,173 (80.8%) Received Perioperative Cefazolin
  - 4,435 (69.3%) Fully Adherent
  - 1,721 (26.9%) Partially Adherent
## Bundle Adherence Definition

<table>
<thead>
<tr>
<th>Scheduled</th>
<th>Urgent/Emergent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full Adherence</strong></td>
<td></td>
</tr>
<tr>
<td>MRSA + or ?</td>
<td>MRSA -</td>
</tr>
<tr>
<td>Any MSSA Status</td>
<td>MSSA + or ?</td>
</tr>
<tr>
<td>Received CHG bathing, mupirocin for ≥ 3 days, and vancomycin plus cefazolin*</td>
<td>Received CHG bathing, mupirocin for ≥ 3 days, and cefazolin*</td>
</tr>
<tr>
<td><strong>Partial Adherence</strong></td>
<td></td>
</tr>
<tr>
<td>Received CHG bathing, any mupirocin, or vancomycin or vancomycin plus cefazolin*</td>
<td>Received CHG bathing, any mupirocin, or cefazolin*</td>
</tr>
<tr>
<td><strong>No Adherence</strong></td>
<td></td>
</tr>
<tr>
<td>Did not receive CHG bathing, mupirocin, or vancomycin or vancomycin plus cefazolin*</td>
<td>Did not receive CHG bathing, mupirocin, or cefazolin*</td>
</tr>
</tbody>
</table>

* Cefazolin can be replaced by cefuroxime