A System-Based Approach to Colorectal Surgery SSI Reduction: Interventions Across the Episode of Care

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Minnesota SSI Reduction Effort
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Hospital Acquired Infections (HAI)

- 2 million American hospital patients develop HAI per year
- 90,000 deaths per year directly related to HAI
- Estimated direct costs of $5.7 billion dollars
- Top 4
  - Urinary catheter associated infections (CA-UTI)
  - Surgical site infections (SSI)
  - Catheter associated bloodstream infection (CA-BSI)
  - Ventilator associated pneumonia (VAP)
Surgical Site Infections (SSI)

• According to the CDC
  • 2.6% of 30 million operations per year are complicated by SSI
  • SSI are the second most common healthcare associated infection accounting for 17% of all hospital acquired infections
• In surgical patients, SSI are the most common healthcare associated infection (38%)
Colon and Rectal Surgery SSI

• Colon and rectal surgery (CRS) is associated with the highest rate of SSI in the literature
  • Range 3-30%

• Multiple studies have identified
  • Patient specific risk factors
    • Malnutrition, DM, Obesity, Immuno-suppressed, Elderly
  • Disease specific risk factors
    • Inflammatory diseases, Cancer, Concurrent infections
  • Procedure specific risk factors
    • Emergent, Open v. minimally invasive, Duration, Surgeon

• Variable success of reduction efforts
  • No “Magic Bullet”
Surgical Site Infections (SSI)

• Implications of SSI
  • Increased length of hospital stay (2-4 days on average)
  • Increased costs
    • Mayo Clinic CRS data
      • Superficial SSI increased cost by $2,000 (median)
      • Deep wound SSI increased cost by $11,000 (median)
      • Organ space SSI increased cost by $14,000 (median)
  • Increased readmission rates
  • Increased patient morbidity, pain, and discomfort
  • Pose a risk to other patients
Mayo Colorectal Surgery Practice

• Full spectrum of CRS
  • Benign anorectal to recurrent rectal cancers
  • >50% of colectomies performed using a minimally invasive approach

• Eight board certified colorectal surgeons
  • General surgery residents
  • 4 colorectal surgery fellows

• Dedicated CRS operating rooms and allied health staff

• Two dedicated CRS post-operative nursing floors
Quality Improvement

- Health care outcomes are the result of an interaction between natural and health care delivery processes
  - **Common cause variation**
    - Phenomena constantly active within the system
    - Variation predictable
    - Irregular variation within an historical experience base
    - Lack of significance in individual high or low values
  - **Special cause variation**
    - Stems from external sources that influence the process
Quality Improvement

• In any complex system, successful QI requires reducing as much variation within the system as possible.

Uniformity leads to predictability, improved process control, and efficiency.
Quality Improvement as a Process

DMAIC Method: process improvement based upon a Lean/Six Sigma approach

Define
Measure
Analyze
Improve
Control

Project selected by sponsor

Improvement cycle

Project either closed or transitioned to operational owner
Where were we starting?

• We knew we needed SSI rates but which data was the one to base the reduction effort?
  • Institutional IPAC data
    • Quarterly evaluation
    • Culture based
    • Follow-up requires notification
    • Weighted towards deep infections
  • National Surgical Quality Improvement Program (NSQIP)
    • Chart abstraction by trained abstractors
    • Mandated 30 day follow-up with active outreach to patient
SSI Surveillance Systems

• **IPAC triggers**
  - Positive culture
  - Readmission to hospital with diagnosis implying a wound or organ space infection
  - Return to the OR with preop diagnosis of wound or organ space infection
  - Call from provider indicating a SSI
  - NHSN definition and risk adjustment
    - Superficial SSI
    - Deep incisional SSI
    - Organ / Space SSI

• **NSQIP abstraction guidelines**
  - Only *sample* of patients
  - 30 day post-op follow up
  - Standard definitions
    - Wound cellulitis
    - Superficial SSI
    - Deep incisional SSI
    - Organ / Space SSI
Comparison of CRS SSI Events

To verify the representation of the sample in both the groups
Time Frame: Jan 2009 to April 2010
IPAC data identified 79 SSI
NSQIP data identified 45 SSI
“As Expected” in NSQIP CRS SSI
Define Phase

- **Goal:** Reduce colorectal surgical site infections by 50% and improve OE ratio from 4\(^{th}\) decile to 2\(^{nd}\) decile by December 2011. 2009 overall SSI rate was 10.5%.

- **Unit of Improvement:** Colorectal Surgical Procedures
  - All patients undergoing colorectal surgery (emergency and elective) at Rochester Methodist Hospital. NSQIP CPT codes for colorectal surgery.
  - All types of Surgical Site Infections (Superficial Incisional, Deep Incisional, and Organ/Space).
  - Excludes: Trauma and Primary Transplant patients. Patients under 18 years of age
  - **Defect:** Any Surgical Site Infections  **Data source:** NSQIP Data Set
Measure Phase
Already done thanks to NSQIP
Analyze Phase

![Graph showing percentages of different SSI types](image.png)
Analyze Phase
Important MCR Variables

130+ NSQIP Variables

40 NSQIP Variables
- Age
- Gender
- BMI
- Wound Class
- Diabetes
- Transfusion
- Various Labs
- CPT4 Codes
- Disease

Significant Variables
- Age (p = .0002)
- BMI (p = .0495)
- Wound Class (p = .0004)
- Diabetes (p = .046)
- Laparscopic (p = .0005)
- Open (p = .0005)
- Intra-op Blood (p = .0024)
- Duration (p = .0005)
- Sepsis (p = .026)
- Steroid use (p = .001)
- CPT-4 code (p = .024)
Analyze Phase
Major Variables for Mayo CRS SSI

- Diagnosis
  - Crohn's Disease
  - Diverticular disease
  - Ulcerative Colitis
    - Represented over half of all identified NSQIP Mayo Clinic SSIs

- BMI

- Operative time

Diagnoses Influence Surgical Site Infections (SSI) in Colorectal Surgery: A Must Consideration for SSI Reporting Programs?
What About the Surgeon?

Survey of surgeon practices for “relevant” items

1. Do you routinely order a bowel preparation?
2. If you use a bowel preparation, do you order oral antibiotics with the bowel preparation?
3. If you do not use a bowel preparation, do you still order oral antibiotics?
4. Do your patients routinely receive an enema prior to arriving in the operating room?
5. Do you routinely provide your patients with a medicated soap (antibacterial) to shower with prior to surgery?
6. For left-sided colectomies/rectal surgery, do you irrigate the rectum?
7. What skin preparation do you routinely use?
8. Do you routinely use an Ioban type drape over the prepared abdomen during your procedures?
9. Do you routinely use wound protectors during the operation? (i.e., sponges under fixed retractors or a wound protector product)
10. Do you routinely use saline or antibiotic irrigation of the abdomen?
11. Do you routinely air test all colorectal anastomoses?
12. For small bowel or colon anastomoses, what type anastomosis do you routinely perform?
13. Do you routinely have antibiotics re-dosed at four hours for your longer cases?
14. Your routine fascial closure is what style?
15. Do you use fresh clean instruments that had not been on the table during the case to close the abdomen?
16. Do you have the team members change gloves and/or gowns just prior to abdominal closure?
17. Do you routinely irrigate the subcutaneous space prior to skin closure with saline and/or antibiotic irrigation?
18. Do you routinely use a subcutaneous drain at the site of the primary incision closure?
19. Do you routinely use a subcutaneous drain at the site of an ostomy?
20. When do you remove the dressing applied in the operating room if it is not soiled?
21. Do you have your patients shower/bathe with medicated (antibacterial) soap while in the hospital?
Surgeon Survey Results

- Demonstrated
  - Wide variability amongst the surgeons on most elements (28% 100% concordance)
    - We all trained at the Mayo Clinic but all do something different
  - Started a conversation on the “best” practice
  - Gained consensus to move towards more standardization on specific surveyed items
Principles of Our Reduction Effort

- Interventions across the episode of care
  - Pre-op, Intra-op, Post-op
- Multi-disciplinary
- *Engage* staff, patient, and families
- *Standardize* as many processes as possible
- Ensure high *compliance* with elements
  - Quick audits
- *Build the elements into the system*
- Frequent feedback and communication
The Team

• Gene Dankbar, Black Belt Lead, Systems and Procedures
• Kimberly Aronhalt, RN, Infection Control and Prevention
• Diane Foss, RN, Kim Gaines, RN, Nursing, Pamela Grubbs, RN,
• Pamela Maxson, RN, PhD, Jennifer Wolforth, RN, Nursing
• Sharon Nehring, RN, Roxanne Hyke, RN, Diane Tyndale, RN, NSQIP
• Jenna Lovely, PharmD, Pharmacy Services
• Sarah Pool, RN, Surgical Services, Lynn Quast, RN, Surgical Services
• Jim Rogers, Systems and Procedures
• Rajesh Pendlimari, MBBS, Research Fellow, CRS
• Karen Piotrowicz, RN, Mid-level Provider, CRS
• Robert Cima, MD, Project lead
Critical to Quality Tree: Surgical Site Infections for Colorectal Surgery

Pre-operative Processes

Patient Skin Cleansing

Hibiclens® shower night before and day of surgery

Ensure patient understanding by reading pamphlet “Preventing SSI”

Antibiotic Administration

Ensure SCIP compliance
1. Right antibiotics
2. Administer 60 min prior to incision
3. Discontinued within 24 hours

Ensure re-dose of ceftazolin with in 3-4 hours after incision

Intra-operative Processes

Chloraprep® applied – use appropriate amount to ensure complete coverage of incisional area

Closing Protocol at Time of Fascia Closure

Use closing tray for closure of fascia and skin

Glove change by staff before closure of fascia

Post-operative Processes

Patient, Visitor, and Staff Hand Hygiene

Hand hygiene education – Patient, Visitor, and Staff

Patient shower with Hibiclens® following dressing removal

Hand cleansing agent readily available – Patient and Staff

Place room sign for “Moments of Hand Hygiene”

Purell® hand wipes made available to patients

Ensure dressing removal within 48 hours

Post-hospitalization Process

Dismiss patient with 4 oz. bottle of Hibiclens®

Patient education on wound care and recognizing infection symptoms

Follow-up phone call from nurses

Reduce SSI by 50% (10% → 5%)
Improve Phase
Preoperative Elements

• Pre-operative Chlorhexidine packets
  o Provided to all patients preoperatively with instructions
  o Use monitored morning of admission
  o If not reported as not being used, SAGE wipes used on the entire body

• Patients with BMI > 30
  o SAGE wipes applied even if preoperative bath performed
  o Procedure listing software automatically identifies patients with BMI > 30
Improve Phase
BMI Trigger for Admissions Unit

Additional Instructions
Height recorded upon admission
Weight recorded upon admission
UCI in OR
Sequential Compression Devices bilateral lower extremity placed in OR

BMI is > 30, Cleanse total body w/chlorhexidine 2% cloths upon admission

Skin Preparations
Clip nipples to pubis
Improve Phase
Pre-operative Elements

- Pre-op antibiotic ordering
  - Procedure scheduling software automatically provides SCIP appropriate choices
- Weight-based dosing
- Software automatically orders intra-operative re-dosing dose if historical data for the specific procedure and surgeon demonstrated an average case duration >3 hours
Surgical Hospital Assignment System

Surgery Information
Clinic Nbr:  
Patient Name:  
Sex/Age/DOB:  
Type of Admission: Routine  *OCC*
Patient Admission: Outpatient, Same Day (OP-RMH)  Location:   
First Case:  YES - 08:15  Planned Post Op Level of Care: No Information
Listing Completed by: Schilling, Aaron C. on Jan 14 2011  7:41AM
Listing Status: Finalized By SGL

Surgeon Information (CRF Supervisor) * indicates the primary physician
Surgeon:  *KIKAR, SANJEEV - ORTS/46101

Surgery Description
Diagnosis:  left carpal tunnel.
Indication:  pain relief.
Procedure:  Left wrist carpal tunnel open; left open carpal tunnel release.
             (Estimated OR Time:  0:43 + 0:20 = 1:03)

Anesthesia
Anesthesia Approval:  No PAPE - Anesthesia Review
Anesthesia Type:  Monitored Anes. Care (Attd. Local)

Transfusion Medicine
Transfusion:  No Transfusion

Preoperative Surgical Orders
Preop Orders:  Completed by Schilling, Aaron (Pager: ) on Jan 14 2011  7:41AM
Preop NPO After:  12:00 AM
Enema:  Enema Not Required

Medication(s)
Cefazolin (Ancef) IV IN OR within 60 minutes prior to incision, repeat
in 3 hours; 40 - 79 kg 1 gram with 1 gram repeat; 80 - 119 kg 2 gram
with 2 gram repeat; 120 kg and above 3 gram with 2 gram repeat.

Lidocaine 1%/Bupivacaine 0.25% INJECTION IN OR used as local anesthetic
(Dispense Unit 30 mL vial)

Medical Condition
Diabetes
Pacemaker:  Manufacturer-Guidant; Model#: 1290
Call Heart Rhythm Services to determine if HRS Nurse is required.

Drug Allergies:  See MICS Allergies Module for allergy information.
Improve Phase
Intra-operative Elements

• Hair removal by electric clipper
  • Outside of the operating room

• Standardized to Chlorhexidine-Alcohol (Chloraprep™) skin preparation for all abdominal cases
  • Surgical assistant applies skin preparation
    • All in-serviced on appropriate application
  • Must dry for 3 minutes before drapes applied
Improve Phase
Intraoperative Elements

• Pre-procedural pause includes confirming appropriate timing of antibiotics administered and documented

• Re-dosing of cefazolin for cases longer than 3 hours.
  • Circulating nurse has the preop order and pulls medication at the beginning of the case
  • Reminder window on anesthesia provider’s computer screen
    • Triggered off time of first dose administration
  • Appropriate weight-based dosing
Improve Phase
Anesthesia Antibiotic Reminder Screen

For example:

- The initial Cefazolin dose was documented at 11:00, current time is 14:00
- The reminder window appears, prompting re-dosing of “Cefazolin”
- The reminder can be delayed up to 30 minutes
- The reminder resets to 3 hours once the dose is charted
Improve Phase
Intraoperative Elements

• “Closing” Process
  • At the time of fascia closure
    • All staff change gloves
      • Gowns if soiled
    • Field re-blocked with fresh sterile towels
  • Instruments used during case removed and “closing tray” brought onto the field
Improve Phase
Postoperative Elements

- All order-sets discontinue SCIP compliant antibiotics after two postop doses or single dose when appropriate
  - Pharmacist part of team and queries service
- Hand hygiene essential on floor
  - Physician/Nursing initiative
  - Patient and Family initiative
- Sterile dressing on until morning of POD 2
  - Document removal in nursing flow sheet; electronic audits
- Chlorhexidine shower/wipes daily after dressing removal
- Standard postop order-sets orders urinary catheter removal at 8am the morning after surgery
- Dismiss with chlorhexidine soap bottle for use at home
Improve Phase
Process audits

• Audits of elements to determine compliance
  • Use different data sources
    • SCIP UHC data
    • Institutional hand hygiene compliance
    • OR process data

• Assess counterbalance effects
  • Does closing process increase operative times?
Improve Phase
Process audits

- Cefazolin re-dose after 3-4 hours if Op time > 3 hours
- Antibiotic “watcher” effective after 1/1/11
- Re-dosing after 4 hour improved from 8/12 (66%) in 2/2010 to 17/17 (100%) in 2/2011
Improve Phase
Process audits

• Analysis of Operative times: 1/2010 to 12/2011
• All CPT-4 Codes in project
• No differences in operative times
# Improve Phase
Comparison 2009/2010 to 2011 Demographics

<table>
<thead>
<tr>
<th></th>
<th>2009-2010 (Baseline)</th>
<th>2011</th>
<th>Total / Overall</th>
<th>p-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampled Cases</td>
<td>532</td>
<td>199</td>
<td>731</td>
<td></td>
</tr>
<tr>
<td>Number of Infections</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Superficial</td>
<td>28 (5.3%)</td>
<td>3 (1.5%)</td>
<td>33</td>
<td></td>
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<tr>
<td>Organ Space</td>
<td>28 (5.3%)</td>
<td>5 (2.5%)</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Deep</td>
<td>1 (0.2%)</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>57.3 +/- 17.1</td>
<td>56.8 +/- 18.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age &gt; 60</td>
<td>255 (47.9%)</td>
<td>97 (48.7%)</td>
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<td></td>
</tr>
<tr>
<td>Women</td>
<td>260 (48.9%)</td>
<td>91 (45.7%)</td>
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<tr>
<td>Body Mass Index</td>
<td>27.1 +/- 6.1</td>
<td>26.9 +/- 5.9</td>
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<tr>
<td>BMI ≥ 30</td>
<td>145 (27.4%)</td>
<td>50 (25.1%)</td>
<td>195 (26.7%)</td>
<td>0.544</td>
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<tr>
<td>BMI ≥ 40</td>
<td>20 (3.8%)</td>
<td>7 (3.5%)</td>
<td>27 (3.7%)</td>
<td>0.877</td>
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## Improve Phase
### Comparison 2009/2010 to 2011 Demographics

<table>
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<th>2009-2010 (Baseline)</th>
<th>2011</th>
<th>Total / Overall</th>
<th>p-values</th>
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<tr>
<td><strong>BMI</strong></td>
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<tr>
<td>&lt;18.5</td>
<td>20 (3.8%)</td>
<td>6 (3%)</td>
<td>26 (3.6%)</td>
<td>0.677</td>
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<tr>
<td>18.5 – 24.9</td>
<td>185 (34.9%)</td>
<td>79 (39.7%)</td>
<td>264 (36.1%)</td>
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<tr>
<td>24.9 – 29.9</td>
<td>179 (33.8%)</td>
<td>63 (31.7%)</td>
<td>242 (33.1%)</td>
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<tr>
<td>&gt;30</td>
<td>146 (27.6%)</td>
<td>51 (25.6%)</td>
<td>197 (27%)</td>
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<tr>
<td><strong>Wound Class:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Clean Contaminated</td>
<td>465 (87.4%)</td>
<td>155 (77.9%)</td>
<td>620 (84.8%)</td>
<td>0.001</td>
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<tr>
<td>Contaminated</td>
<td>16 (3%)</td>
<td>18 (9%)</td>
<td>34 (4.6%)</td>
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<tr>
<td>Dirty / Infected</td>
<td>51 (9.6%)</td>
<td>26 (13.1%)</td>
<td>77 (10.5%)</td>
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<tr>
<td><strong>ASA Class</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>ASA 1 - No Disturb</td>
<td>23 (4.3%)</td>
<td>10 (5%)</td>
<td>33 (4.5%)</td>
<td>0.013</td>
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<tr>
<td>ASA 2 - Mild Disturb</td>
<td>333 (62.2%)</td>
<td>127 (63.8%)</td>
<td>458 (62.6%)</td>
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<tr>
<td>ASA 3 - Severe Disturb</td>
<td>177 (33.3%)</td>
<td>57 (28.6%)</td>
<td>234 (32%)</td>
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<tr>
<td>ASA 4 - Life Threat</td>
<td>1 (0.2%)</td>
<td>5 (2.5%)</td>
<td>6 (0.8%)</td>
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<tr>
<td><strong>Diabetes</strong></td>
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<td></td>
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<td></td>
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<tr>
<td>Insulin</td>
<td>20 (3.8%)</td>
<td>6 (3%)</td>
<td>26 (3.6%)</td>
<td>0.24</td>
</tr>
<tr>
<td>No</td>
<td>484 (91%)</td>
<td>176 (88.4%)</td>
<td>660 (90.3%)</td>
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<tr>
<td>Non-Insulin</td>
<td>28 (5.3%)</td>
<td>17 (8.5%)</td>
<td>45 (6.2%)</td>
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<tr>
<td><strong>Operative Duration (minutes)</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Average</td>
<td>203.1 +/- 93.1</td>
<td>191.5 +/- 88.5</td>
<td></td>
<td>0.12</td>
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Control Phase
Results

Tests performed with unequal sample sizes

P Chart of Total Observed SSI by Phase

- Proportion
- Month and Year
- UCL=0.1837
- LCL=0
- P=0.0388

Jan-09 May-09 Sep-09 Jan-10 May-10 Sep-10 Jan-11 May-11 Sep-11 Jan-12

2009 2010 2011
Control Phase

Results

Tests performed with unequal sample sizes
Control Phase
Results

Tests performed with unequal sample sizes
Control Phase

Results

• **Goal:** Reduce colorectal surgical site infections by 50% and improve OE ratio from 4\textsuperscript{th} decile to 2\textsuperscript{nd} decile by December 2011. 2009 overall SSI rate was 10.5%.

• **Result:** ACS NSQIP Semiannual Report: January 1, 2011 - December 31, 2011
Lessons Learned

• **Multidisciplinary** approach is essential
  • Engage all staff

• Reliable, timely, actionable data

• **Data in depth**
  • Details to be readily available

• **Walk the process; make no assumptions**
  • Policies and practice are not the same

• Look at the entire episode
  • Pre, intra, and postoperative elements may influence SSI rates
  • Interventions designed for each phase

• Introduce elements of change and **audit compliance**

• Build improvements **into the system** to increase compliance
The Needs of the Patient Come First- W.J. Mayo

Questions & Discussion