“Reducing the Risk of Surgical Site Infections: Will Evidence-Based Practices Lead Us to the Promised Land”

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Implementation of a Wisconsin Division of Public Health Surgical Site Infection Prevention Champion Initiative

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ABSTRACT
Approximately 900 surgical site infections (SSIs) were reported to the Wisconsin Division of Public Health annually from 2013 to 2015, representing the most prevalent reported health care-associated infection in the state. Personnel at the Wisconsin Division of Public Health launched an SSI prevention initiative in May 2015 using a surgical care champion to provide surgical team peer-to-peer guidance through voluntary, nonregulatory, fee-exempt onsite visits that included presentations regarding the evidence-based surgical care bundle, tours of the OR and central processing areas, and one-on-one discussions with surgeons. The surgical care champion visited 10 facilities from August to December 2015, and at those facilities, SSIs decreased from 83 in 2015 to 47 in 2016 and the overall SSI standardized infection ratio decreased by 45% from 1.61 to 0.88 (P = .002), suggesting a statewide SSI prevention champion model can help lead to improved patient outcomes.

Key words: surgical champion, surgical care bundle, SSI prevention, peer collaboration, evidence-based practice.
Items For Discussion Today

- Fiscal and Morbid Risk of Surgical Site Infections
- Complexity of Surgical Site Infections
- SSI Prevention Guidelines – Mechanistic Considerations
- Demystifying the Surgical Care Bundle in the Prevention of Surgical Site Bundle
“When They Say it’s Never About the Money – It’s Always About the Money” – Morbidity versus Fiscal Risk for the Patient and Institution
Projected Trends and it is not Pretty

1.8 million TJRs by 2030

Tisosky et al. J Am Acad Orthop Surgeons 2017;1:e34
4-4.5 Million Total Joint Implantations per Year by 2030 – Assuming a 2.18% Infection Rate

Translates into ~80,000-90,000 PJI

Baseline

Conservative estimate≈$100,000 = 8-9 Billion USD
Less Conservative ≈ $400,000 = 32-36 Billion USD

- PJI is associated with a mortality rate of between 2 – 7%.
- Experts report that the five-year survival rate of patients with PJI is worse than with most cancers.

Edmiston et al, AJIC 2019: Online In Press
Economic Cost of Colorectal Infections

- A retrospective study of patients undergoing CS between 2014 and 2017 was conducted using IBM® MarketScan® Commercial, Multi-State Medicaid and Medicare Supplemental databases.
- A total of 83,691 patients were included in the analysis, with mean age 56 years (SD:17.3), 53.6% female.
- 27.4% cancer patients of which 5.3% with metastatic neoplasms.
- 21.5% Medicare and 21.60% Medicaid (all others commercially insured).
- 21.2% patients presented with infection: ~84% were identified within 60 days of surgery.
- 51% of postoperative infections were deep or organ/space.
- Adjusted total payments in patients with commercial insurance mean cost $185,435 (95% CI: $163,586-$210,202) for deep/organ space infections ($1.7e9 national cost / $2.6e6 institutions at risk).

“The practice of evidence-based medicine means integrating individual clinical expertise with the best external evidence from systematic reviews.”

“…all surgical wounds are contaminated to some degree at closure – the primary determinant of whether the contamination is established as a clinical infection is related to host (wound) defense”

Belda et al., JAMA 2005;294:2035-2042
Recognition of the surgical locus of infection influences the development of specific interventional strategies


The Complexity of Risk - Classification of Surgical Site Infections (SSI)

Skin
Subcutaneous Tissue
Deep Soft Tissue (fascia & muscle)
Organ/Space

Major Barriers to Improvement
- Poor compliance
- Lack of shared goals and priorities
- Poor communication
- Less than robust institutional commitment

So what is the weakest link?
• Patient who smoked (7.4% vs 4.8%; \( p = 0.04 \)),
• Patients who abused alcohol (10.6% vs 5.7%; \( p = 0.04 \))
• Patients with type 2 diabetics (8.8% vs 5.5%; \( p = 0.046 \))
• Obese patients (11.7% vs 4.0%; \( p < 0.001 \)).
• Surgical site infection rates higher Operation duration longer than 140 minutes (7.5% vs 5.0%; \( p = 0.05 \)).

These risk factors were also associated with an increase in SSI rates as a compounded score (\( P < 0.001 \)).

• Patients with 1 or fewer risk factors (n = 427) - SSI rate of 2.3%
• Patients with 2 risk factors (n = 445) – SSI rate 5.2%
• Patients with 3 factors (n = 384) had a 7.8% SSI rate
• Patients with 4 or more risk factors (n = 198) > 13.5%
A More Than a Typical Scenario – What is the True Risk of Infection?

High Risk Patient:

- Immunosuppressive meds - RA
- Diabetes
- Advanced age
- Prior surgery to same joint
- Psoriasis
- Malnourished
  - morbid obesity
  - sAlb<35
  - low sTransferrin
- Remote sites of infection
- Smokers
- ASA ≥3
Risk is a Myriad of Events - SSI Fishbone Diagram

The 8th Domain - Anesthesia

**Pre-Operative Factors**
- Lack of Hand Hygiene
- Patient Body Colonization
- Lack of Pre-Op Shower

**Peri-Operative Team Factors**
- Lack of Traffic Control - Too Many in room
- Improper Surgical Hand Antisepsis
- Improper Surgical Attire
- Unsterile Instruments
- Use of Staples or Steri-Strips
- Contaminated Environment
- Inadequate Surgical Prophylaxis
- Surgical Irrigation
- Non-Coated Sutures

**Organizational and Management Factors**
- Poor Communication Among Team
- Financial Constraints
- Poor Leadership
- Increase Hospitalization Days

**Patient Factors**
- MRSA or MSSA Nasal Colonization
- Infection at Another Site
- Obese
- Diabetic
- Smoker
- Immunosuppressive Agents

**Surgeon Technique**
- Use of Drains
- Lack of Re-Dosing of Antibiotic
- Poor Surgical Technique

**Work Environment Factors**
- Poor Staff levels
- Design, Availability and Maintenance of Equipment
- Workload and Shift Patterns
- Environment and Physical Plant Problems (Air Handling System)

**Care Delivery Problems (CDP’s)**
- Lack of Discontinuation of Antibiotics at 24 hrs
- Contaminated Environment
- Lack of Hand Hygiene
- Contamination of Incision Post-Op
- Inadequate Staffing for Post-Op Care
- Lack of Foley Catheter removal Within 48 hrs

Courtesy of Maureen Spencer
Need for different skills at different stages

- Ability for rapid upsizing or downsizing
- Adapt to high turnover
- Promote vigilant communication

Fluid Team = work toward a common goal but unstable membership

Barriers to Effective Team Functioning
- Loss of individual knowledge
- Lack of shared mental model
- Low individual commitment to group success

Barriers to Effective Operative Performance
- Environmental distraction
- Inadequate communication
- Exchange of personnel with less technical skill and/or experience

Advantages
- Provide career development opportunity
- Avoid collusive behavior
Are SSI Prevention Guidelines Helpful – A Mechanistic Basis
## Comparative Analysis of WHO, Proposed CDC, ACS and Wisconsin SSI Prevention Guidelines

<table>
<thead>
<tr>
<th>INTERVENTION</th>
<th>WHO Guidelines</th>
<th>CDC Guidelines</th>
<th>ACS Guidelines</th>
<th>WISCONSIN SSI Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normothermia</td>
<td>Maintain normothermia</td>
<td>Maintain normothermia</td>
<td>Maintain normothermia</td>
<td>Maintain normothermia - FAW reduces incidence of SSI = 1A</td>
</tr>
<tr>
<td>Wound Irrigation</td>
<td>No recommendation</td>
<td>Intraoperative irrigation recommended - povidone iodine</td>
<td>No recommendation</td>
<td>Recommend – 0.05% CHG (Professional Expertise)</td>
</tr>
<tr>
<td>Antimicrobial Prophylaxis</td>
<td>Short duration</td>
<td>Short duration</td>
<td>Short duration</td>
<td>Short duration – Follow ASHP weight-based dosing = 1A</td>
</tr>
<tr>
<td>Glycemic Control</td>
<td>Recommended</td>
<td>Recommended – No recommendation for HA1c</td>
<td>Highly beneficial</td>
<td>Highly beneficial HbA1c ≤7 (≤154), ≤8 (&lt;183) = 1A</td>
</tr>
<tr>
<td>Perioperative Oxygenation</td>
<td>Recommended</td>
<td>Administer increased FIO₂ during surgery after extubation, immediate postop period</td>
<td>Recommended</td>
<td>Recommended – Strongest (High – 1A) for colorectal surgery</td>
</tr>
<tr>
<td>Preadmission Showers</td>
<td>Advised patients to bathe or shower with soap</td>
<td>Advise patients to bathe or shower with soap or antiseptic agent – at least night before surgery</td>
<td>Advise patients to shower with CHG</td>
<td>Two standardized shower/cleansing with 4% or 2% CHG night before/morning (High)</td>
</tr>
<tr>
<td>Antimicrobial Sutures</td>
<td>Use antimicrobial sutures independent of type of surgery</td>
<td>Consider use of triclosan-coated sutures for prevention of SSI</td>
<td>Recommended for clean and clean-contaminated abdominal procedures</td>
<td>The use of triclosan sutures represents = 1A clinical evidence</td>
</tr>
</tbody>
</table>
Does BMI Increase Risk?

Perioperative Antimicrobial Prophylaxis in Higher BMI (>40) Patients: Do We Achieve Therapeutic Levels?

Percent Therapeutic Activity of Serum / Tissue Concentrations Compared to Surgical Isolate (2002-2004) Susceptibility to Cefazolin Following 2-gm Perioperative Dose

<table>
<thead>
<tr>
<th>Organisms</th>
<th>n</th>
<th>Serum</th>
<th>Tissues</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>70</td>
<td>68.6%</td>
<td>27.1%</td>
</tr>
<tr>
<td><em>Staphylococcus epidermidis</em></td>
<td>110</td>
<td>34.5%</td>
<td>10.9%</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>85</td>
<td>75.3%</td>
<td>56.4%</td>
</tr>
<tr>
<td><em>Klebsiella pneumoniae</em></td>
<td>55</td>
<td>80%</td>
<td>65.4%</td>
</tr>
</tbody>
</table>

*Edmiston et al, Surgery 2004;136:738-747*
• “Measured and dose-normalized subcutaneous cefoxitin concentrations and AUCs in the obese patients were significantly lower than in the normal-weight subjects.

• There was an inverse relationship between cefoxitin tissue penetration (AUC tissue/ AUC plasma ratio) and body mass index.

  ❖ Tissue penetration was substantially lower in the obese patients compared to normal weight controls ($p = 0.05$).”

• “This occurred despite 2-fold-higher cefoxitin dosage (1 to 2 gms).

  ❖ Diminished tissue antibiotic concentrations in morbid obesity may influence the incidence of SSIs.”

Toma et al., Anesthesia Analgesia 2011;113:730-737
Clinical practice guidelines for antimicrobial prophylaxis in surgery

DALE W. BRATZLER, E. PATCHEN DELLINGER, KEITH M. OLSEN, TRISH M. PERL, PAUL G. AUWAERTER, MAUREEN K. BOLON, DOUGLAS N. FISH, LENA M. NAPOLITANO, ROBERT G. SAWYER, DOUGLAS SLAIN, JAMES P. STEINBERG, AND ROBERT A. WEINSTEIN

These guidelines were developed jointly by the American Society of Health-System Pharmacists (ASHP), the Infectious Diseases Society of America (IDSA), the Surgical Infection Society (SIS), and the Society for Healthcare Epidemiology of America (SHEA). This work represents an update to the previously published ASHP Therapeutic Guidelines on Antimicrobial Prophylaxis in Surgery, as well as guidelines from IDSA and SIS. The guidelines are intended to provide practitioners with a standardized approach to the rational, safe, and effective use of antimicrobial agents for the prevention of surgical-site infections (SSIs) based on currently available clinical evidence and emerging issues.

Prophylaxis refers to the prevention of an infection and can be characterized as primary prophylaxis, secondary prophylaxis, or eradication. Primary prophylaxis refers to the prevention of an initial infection. Secondary prophylaxis refers to the prevention of recurrence or reactivation of a preexisting infection. Eradication refers to the elimination of a colonized organism to prevent the development of an infection. These guidelines focus on primary perioperative prophylaxis.

Guidelines development and use

Members of ASHP, IDSA, SIS, and SHEA were appointed to serve on an expert panel established to ensure the validity, reliability, and utility of the revised guidelines. The work of the panel was facilitated by faculty of the University of Pittsburgh School of Pharmacy and University of Pittsburgh Medical Center Drug Use and Disease State Management Program who served as contract researchers and writers for the project. Panel members and contractors were required to disclose any possible conflicts of interest before their appointment and throughout the guideline development process. Drafted documents for each surgical procedural section were reviewed by the expert panel and, once revised, were available for public comment on the ASHP website. After additional revisions were made to address reviewer comments, the final document was
Microbial Ecology of Skin Surface

- Scalp: $6.0 \log_{10} \text{cfu/cm}^2$
- Axilla: $5.5 \log_{10} \text{cfu/cm}^2$
- Abdomen: $4.3 \log_{10} \text{cfu/cm}^2$
- Forearm: $4.0 \log_{10} \text{cfu/cm}^2$
- Hands: $4.0-6.6 \log_{10} \text{cfu/cm}^2$
- Perineum: $7.0-11.0 \log_{10} \text{cfu/cm}^2$

Surgical Microbiology Research Laboratory – Medical College of Wisconsin
Mean Chlorhexidine Gluconate (CHG) Skin Surface Concentrations (µg/ml±SD) Compared to MIC$_{90}$ (5 µg/ml) for Staphylococcal Surgical Isolates Including MRSA$^a$

<table>
<thead>
<tr>
<th>Subgroups (mean C, µg/ml)</th>
<th>Pilot$^b$ (4%)</th>
<th>1 (4% Aqueous)</th>
<th>2 (2% Cloths)</th>
<th>$[C_{\text{CHG}}/\text{MIC}_{90}]$</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A (20)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>evening (1X)</td>
<td>3.7±2.5</td>
<td>24.4±5.9</td>
<td>436.1±91.2</td>
<td>0.9</td>
<td>4.8</td>
</tr>
<tr>
<td>Group B (20)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>morning (1X)</td>
<td>7.8±5.6</td>
<td>79.2±26.5</td>
<td>991.3±58.2</td>
<td>1.9</td>
<td>15.8</td>
</tr>
<tr>
<td>Group C (20)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>both (2X)</td>
<td>9.9±7.1</td>
<td>126.4±19.4</td>
<td>1745.5±204.3</td>
<td>2.5</td>
<td>25.3</td>
</tr>
</tbody>
</table>

$^a$ N = 90

$^b$ Pilot group N = 30


Edmiston et al, AORNJ 2010;92:509-518
Looking at the Preadmission Shower from a Pharmacokinetic Perspective

Dose
Duration
Timing
To Maximize Skin Surface Concentrations of CHG – A Standardize Process Should Include

4% Aqueous CHG

- Dose - 4-ozs. for each shower
- Timing - 1-minute pause before rinsing (4% CHG)
- Duration - TWO SHOWERS (CLEANSINGS) – NIGHT BEFORE/MORNING OF SURGERY
- An SMS, text or voicemail reminder to shower
- A standardized regimen – instructions – Oral and written

\[ \text{CHG conc} \geq 1000 \, \mu g/ml \]

Remember the devil is always in the details

Edmiston et al. JAMA Surg 2015;150:1027-1033
Making an Evidence-Based Argument – Can We Validate the Efficacy of an Antimicrobial (Triclosan) Wound Closure Technology?
Late-Onset Vascular Graft Infection
Mean Microbial Recovery from Standard Polyglactin Sutures Compared to Triclosan (Antimicrobial)-Coated Polyglactin Closure Devices

Exposure Time 2 Minutes

CONTINUOUS SUTURING TECHNIQUES

Two strands knotted at each end and knotted in the middle

INTERrupted SUTURING TECHNIQUES

Simple interrupted
Presence of Biofilm on Selected Sutures from Non-infected and Infected Cases

Non-infected nylon suture segments were randomly selected for microscopy, culture positive

Infected braided suture segments were randomly selected for microscopy

Infected monofilament suture segments were randomly selected for microscopy

Edmiston, Krepel, Marks, Rossi, Sanger, Goldblatt, Seabrook. J Clin Microbiol 2013;51:417
Is there an evidence-based argument for embracing an antimicrobial (triclosan)-coated suture technology to reduce the risk for surgical-site infections?: A meta-analysis

Charles E. Edmiston, Jr, PhD, Frederic C. Daoud, MD, and David Leaper, MD, FACS, Milwaukee, WI, Paris, France, and London, UK

Background. It has been estimated that 750,000 to 1 million surgical-site infections (SSIs) occur in the United States each year, causing substantial morbidity and mortality. Triclosan-coated sutures were developed as an adjunctive strategy for SSI risk reduction, but a recently published systematic literature review and meta-analysis suggested that no clinical benefit is associated with this technology. However, that study was hampered by poor selection of available randomized controlled trials (RCTs) and low patient numbers. The current systematic review involves 13 randomized, international RCTs, totaling 3,568 surgical patients.

Methods. A systematic literature search was performed on PubMed, Embase/Excelline, Cochrane database group, (Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Health Economic Evaluations Database/Database of Health Technology Assessments), and www.clinicaltrials.gov to identify RCTs of triclosan-coated sutures compared with conventional sutures and assessing the clinical effectiveness of antimicrobial sutures to decrease the risk for SSIs. A fixed- and random-effects model was developed, and pooled estimates reported as risk ratio (RR) with a corresponding 95% confidence interval (CI). Publication bias was assessed by analyzing a funnel plot of individual studies and testing the Egger regression intercept.

Results. The meta-analysis (13 RCTs, 3,568 patients) found that use of triclosan antimicrobial-coated sutures was associated with a decrease in SSIs in selected patient populations (fixed effect: RR = 0.734; 95% CI: 0.590-0.913; P = .005; random-effect: RR = 0.693; 95% CI: 0.533-0.920; P = .011). No publication bias was detected (Egger intercept test: P = .145).

Conclusion. Decreasing the risk for SSIs requires a multifaceted “care bundle” approach, and this meta-analysis of current, pooled, peer-reviewed, randomized controlled trials suggests a clinical effectiveness of antimicrobial-coated sutures (triclosan) in the prevention of SSIs, representing Center for Evidence-Based Medicine level 1a evidence. (Surgery 2013;154:89-100.)

Systematic review and meta-analysis of triclosan-coated sutures for the prevention of surgical-site infection

Z. X. Wang1,2, C. P. Jiang1,2, Y. Cao1,2 and Y. T. Ding1,2

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Correspondence to: Professor Y. T. Ding, 321 Zhong Shan Road, Nanjing, Jiangsu Province, China 210008 (e-mail: dingytzao@yahoo.com.cn)

Background: Surgical-site infections (SSIs) increase morbidity and mortality in surgical patients and represent an economic burden to healthcare systems. Experiments have shown that triclosan-coated sutures (TCS) are beneficial in the prevention of SSI, although the results from individual randomized controlled trials (RCTs) are inconclusive. A meta-analysis of available RCTs was performed to evaluate the efficacy of TCS in the prevention of SSI.

Methods: A systematic search of PubMed, Embase, MEDLINE, Web of Science®, the Cochrane Central Register of Controlled Trials and internet-based trial registries for RCTs comparing the effect of TCS and conventional uncoated sutures on SSIs was conducted until June 2012. The primary outcome investigated was the incidence of SSI. Pooled relative risks with 95% confidence interval (c.i.) were estimated with RevMan 5.1.6.

Results: Seventeen RCTs involving 3720 participants were included. No heterogeneity of statistical significance across studies was observed. TCS showed a significant advantage in reducing the rate of SSI by 30 per cent (relative risk 0.70, 95 per cent c.i. 0.57 to 0.85; P < 0.001). Subgroup analyses revealed consistent results in favour of TCS in adult patients, abdominal procedures, and clean or clean-contaminated surgical wounds.

Conclusion: TCS demonstrated a significant beneficial effect in the prevention of SSI after surgery.
What Do the Various Meta-Analyses Tell Us About Triclosan Suture as a Risk Reduction Strategy?

- **2013 - Sajid et al, Gastroenterol Report 2013:42-50: 7 RCT (1631 patients)** – Odds of SSI 56% less in triclosan suture group compared to controls ($p<0.04$)
- **2013 - Wang et al, BJS 2013;100-465: 17 RCT (3720 patients)** – 30% decrease in risk of SSI ($p<0.001$)
- **2013 - Edmiston et al, Surgery 2013;154:89-100: 13 RCT (3568 patients)** – 27% to 33% decrease in risk of SSI ($p<0.005$)
- **2014 - Daoud et al, Surg Infect 2014;15:165-181: 15 RCT (4800 patients)** – 20% to 50% decreased risk of SSI ($p<0.001$)
- **2015 - Apisarnthanarak et al. Infect Cont Hosp Epidemiol 2015;36:1-11: 29 studies (6,930 patients)** – 26% reduction in SSI ($p<0.01$)
- **2016 - Guo et al, Surg Research 2016; doi:10.1016/j.jss.2015.10.015 – 13 RCT (5256 patients)** (risk ratio [RR] 0.76, 95% confidence interval [CI] 0.65–0.88, $p<0.001$)
- **2017 – Wu et al, Eur J Clin Microbiol Infect Dis 2017;36:19-32: 13 RCT (5,346 patients)** (risk ratio [RR] 0.72, 95% confidence interval [CI] 0.59–0.88, $p<0.001$)
- **2017 – De Jonge et al, BJS 2017;104:e118-e133: 21 RCT (6,462 patients)** (risk ratio [RR] 28% reduction, 95% confidence ratio [CI] 0.60–0.88, $p<0.001$)
Multiple Clinical Studies Have Documented That Triclosan-Coated Sutures Provide A Significant SSI Risk Reduction For:

- Clean
- Clean-Contaminated
- And Contaminated Surgical Procedures
How Does One Evaluate An Antimicrobial Risk - Reduction Technology – The Triclosan Suture Story?

Safety (~ 1 Billion strands)

Microbicidal Activity (Spectrum)
- Gram-positive and Gram-negative antimicrobial activity - No published studies have demonstrated that use of triclosan coated sutures are associated with the emergence of resistant surgical pathogens.

Evidence-based Clinical Effectiveness (Meta-Analysis)
- Currently 13 meta-analysis in the peer-literature document clinical efficacy of triclosan (antimicrobial) suture technology.

Cost-Effectiveness
17 Year Evidence-Based Journey
Embracing a Surgical Care Bundle
Mitigating Risk - Surgical Care Improvement Project (SCIP) – An Evidence-Based Approach

- Timely and appropriate antimicrobial prophylaxis
- Glycemic control in cardiac and vascular surgery
- Appropriate hair removal
- Normothermia in general surgical patients

Is this the Holy Grail?
Developing an argument for bundled interventions to reduce surgical site infection in colorectal surgery

Seth A. Waits, MD,1 Danielle Fritze, MD,1 Mousumi Banerjee, PhD,1,2 Wenying Zhang, MA1
James Kubus, MS,1 Michael J. Englesbe, MD,1 Darrell A. Campbell, Jr, MD,1 and
Samantha Hendren, MD, MPH,1 Ann Arbor, MI

Background. Surgical site infection (SSI) remains a costly and morbid complication after colectomy. The primary objective of this study was to investigate whether a group of perioperative care measures previously shown to be associated with reduced SSI would have an additive effect in SSI reduction. If so, this would support the use of an “SSI prevention bundle” as a quality improvement intervention.

Methods. Data from 24 hospitals participating in the Michigan Surgical Quality Collaborative were included in the study. The main outcome measure was SSI. Hierarchical logistic regression was used to account for clustering of patients within hospitals.

Results. In total, 4,085 operations fulfilled inclusion criteria for the study (Current Procedural Terminology codes 44140, 44160, 44204, and 44205). A “bundle score” was assigned to each operation, based on the number of perioperative care measures followed (appropriate Surgical Care Improvement Project-2 antibiotics, postoperative normothermia, oral antibiotics with bowel preparation, perioperative glycemic control, minimally invasive surgery, and short operative duration). There was a strong stepwise inverse association between bundle score and incidence of SSI. Patients who received all 6 bundle elements had risk-adjusted SSI rates of 2.0% (95% confidence interval [CI], 7.9–0.5%), whereas patients who received only 1 bundle measure had SSI rates of 17.5% (95% CI, 27.1–10.8%).

Conclusion. This multi-institutional study shows that patients who received all 6 perioperative care measures attained a very low, risk-adjusted SSI rate of 2.0%. These results suggest the promise of an SSI reduction intervention for quality improvement; however, prospective research are required to confirm this finding. (Surgery 2014;155:602-6.)

From the Departments of Surgery1 and Biostatistics,b University of Michigan, Ann Arbor, MI
The Preventive Surgical Site Infection Bundle in Colorectal Surgery
An Effective Approach to Surgical Site Infection Reduction and Health Care Cost Savings

Jeffrey E. Keenan, MD; Paul J. Speicher, MD; Julie K. M. Thacker, MD; Monica Walter, DNP; Maragatha Kuchibhatla, PhD; Christopher R. Mantyh, MD

RESULTS Of 559 patients in the study, 346 (61.9%) and 213 (38.1%) underwent their operation before and after implementation of the bundle, respectively. Groups were matched on their propensity to be treated with the bundle to account for significant differences in the preimplementation and postimplementation characteristics. Comparison of the matched groups revealed that implementation of the bundle was associated with reduced superficial SSIs (19.3% vs 5.7%, \( P < .001 \)) and postoperative sepsis (8.5% vs 2.4%, \( P = .009 \)). No significant difference was observed in deep SSIs, organ-space SSIs, wound disruption, length of stay, 30-day readmission, or variable direct costs between the matched groups. However, in a subgroup analysis of the postbundle period, superficial SSI occurrence was associated with a 35.5% increase in variable direct costs ($13,253 vs $9779, \( P = .001 \)) and a 71.7% increase in length of stay (7.9 vs 4.6 days, \( P < .001 \)).

CONCLUSIONS AND RELEVANCE The preventive SSI bundle was associated with a substantial reduction in SSIs after colorectal surgery. The increased costs associated with SSIs support that the bundle represents an effective approach to reduce health care costs.
An Effective Bundled Approach Reduces Surgical Site Infections in a High-Outlier Colorectal Unit

Emre Gorgun, M.D. \(^1\) • Ahmet Rencuzogullari, M.D., F.T.B.S. \(^1\) • Volkan Özben, M.D., F.T.B.S. \(^1\) • Luca Stocchi, M.D. \(^1\) • Thomas Fraser, M.D. \(^2,3\) • Cigdem Benlice, M.D. \(^1\) • Tracy Hull, M.D. \(^3\)

\(^1\) Department of Colorectal Surgery, Digestive Disease Institute, Cleveland Clinic, Cleveland, Ohio
\(^2\) Department of Infectious Disease, Cleveland Clinic, Cleveland, Ohio
\(^3\) Department of Quality, Quality & Patient Safety Institute, Cleveland Clinic, Cleveland, Ohio

**BACKGROUND:** Surgical site infections are the most common hospital-acquired infection after colorectal surgery, increasing morbidity, mortality, and hospital costs.

**OBJECTIVE:** The purpose of this study was to investigate the impact of preventive measures on colorectal surgical site infection rates in a high-volume institution that performs inherent high-risk procedures.

**DESIGN:** This was a prospective cohort study.

**SETTING:** The study was conducted at a high-volume, specialized colorectal surgery department.

**PATIENTS:** The Prospective Surgical Site Infection Prevention Bundle Project included 14 preoperative, intraoperative, and postoperative measures to reduce surgical site infection occurrence after colorectal surgery. Surgical site infections within 30 days of the index operation were examined for patients during the 1-year period after the surgical site infection prevention bundle was implemented. The data collection and outcomes for this period were compared with the year immediately before the implementation of bundle elements. All of the patients who underwent elective colorectal surgery by a total of 17 surgeons were included. The following procedures were excluded from the analysis to obtain a homogeneous patient population: ileostomy closure and anorectal and enterocutaneous fistula repair.

**MAIN OUTCOME MEASURES:** Surgical site infection occurring within 30 days of the index operation was measured. Surgical site infection–related outcomes after implementation of the bundle (bundle February 2014 to February 2015) were compared with same period a year before the implementation of bundle elements (prebundle February 2013 to February 2014).

**RESULTS:** Between 2013 and 2015, 2258 abdominal colorectal surgical procedures were performed, including 986 (43.8%) during the prebundle period and 1264 (56.2%) after the bundle project. Patient characteristics and comorbidities were similar in both periods. Compliance with preventive measures ranged between 75% and 99% during the bundle period. The overall surgical site infection rate decreased from 11.8% prebundle to 6.6% at the bundle period (P < 0.001). Although a decrease for all types of surgical site infections was observed after the bundle implementation, a significant reduction was achieved in the organ-space subgroup (5.5%–1.7%; P < 0.001).

**LIMITATION:** We were unable to predict the specific contributions that the constituent bundle interventions made to the surgical site infection reduction.

**CONCLUSIONS:** The prospective Surgical Site Infection Prevention Bundle Project resulted in a substantial decline in surgical site infection rates in our department. Collaborative and enduring efforts among multiple providers are critical to achieve a sustained reduction. See Video Abstract at http://links.lww.com/

Dis Colon Rectum 2018; 61: 89–98
Do surgical care bundles reduce the risk of surgical site infections in patients undergoing colorectal surgery? A systematic review and cohort meta-analysis of 8,515 patients

Judith Tanner, PhD, Wendy Patley, MSc, Ojan Assadian, MD, David Leaper, MD, Martin Kieran, MPH, and Charles Edmiston, PhD, Nottingham, Leicester, Huddersfield, and London, UK, and Milton Keynes, WT

Background. Care bundles are a strategy that can be used to reduce the risk of surgical site infection (SSI), but individual studies of care bundles report conflicting outcomes. This study assesses the effectiveness of care bundles to reduce SSI among patients undergoing colorectal surgery.

Methods. We performed a systematic review and meta-analysis of randomized controlled trials, quasi-experimental studies, and cohort studies of care bundles to reduce SSI. The search strategy included database and electronic trials register searches from 2012 until June 2014, searching reference lists of retrieved studies and contacting study authors to obtain missing data. The Downs and Black checklist was used to assess the quality of all studies. Raw data were used to calculate pooled relative risk (RR) estimates using Cochrane Review Manager. The V2 statistic and funnel plot were performed to identify publication bias. Sensitivity analysis was carried out to examine the influence of individual data sets on pooled RRs.

Results. Sixteen studies were included in the analysis, with 13 providing sufficient data for a meta-analysis. Most study bundles included core interventions such as antibiotic administration, appropriate hair removal, glycemic control, and normothermia. The SSI rate in the bundle group was 7.0% (328/4,649) compared with 15.1% (585/3,866) in a standard care group. The pooled effect of 13 studies with a total sample of 8,515 patients shows that surgical care bundles have a clinically important impact on reducing the risk of SSI compared to standard care with a CI of 0.55 (0.39–0.77; P = .0005).

Conclusion. The systematic review and meta-analysis documents that use of evidence-based, surgical care bundle in patients undergoing colorectal surgery significantly reduced the risk of SSI. (Surgery 2015;158:66-77.)

DOI: 10.1007/s11605-017-3465-3

REVIEW ARTICLE

Bundles Prevent Surgical Site Infections After Colorectal Surgery: Meta-analysis and Systematic Review

Aleksander Zywor1,2, Christine S.M. Lau1,2, H. Stephen Fletcher1, Subroto Paul1

Received: 29 December 2016 / Accepted: 23 May 2017 / Published online: 15 June 2017
© The Society for Surgery of the Alimentary Tract

Abstract

Introduction. Colorectal surgeries (CRS) have one of the highest rates of surgical site infections (SSIs) with rates 15 to >30%. Prevention “bundling” or sets of evidence-based interventions are structured ways to improve patient outcomes. The aim of this study is to evaluate CRS SSI prevention bundles, bundle components, and implementation and compliance strategies.

Methods. A meta-analysis of studies with pre- and post-implementation data was conducted to assess the impact of bundles on SSI rates (superficial, deep, and organ/space). Subgroup analysis of bundle components identified optimal bundle designs.

Results. Thirty-five studies (51,413 patients) were identified and 23 (17,557 patients) were included in the meta-analysis. A SSI risk reduction of 40% (p < 0.001) was noted with 44% for superficial SSI (p < 0.001) and 34% for organ/space (p = 0.048).

Bundles with sterile closure trays (58.6 vs 33.1%), MBP with oral antibiotics (55.4 vs 31.8%), and pre-closure glove changes (56.9 vs 28.5%) had significantly greater SSI risk reduction.

Conclusion. Bundles can effectively reduce the risk of SSIs after CRS, by fostering a cohesive environment, standardization, and reduction in operative variance. If implemented successfully and complied with, bundles can become vital to improving patients’ surgical quality of care.

Keywords. Surgical site infection, SSI, Bundle, Colorectal, which ranges from 15.1 to over 30%. In 2014, the Joint

Surgery 2015;158:66-77

Using Bundled Interventions to Reduce Surgical Site Infection After Major Gynecologic Cancer Surgery

Megan P. Johnson, PA-C, Sharon J. Kim, BA, Carrie L. Langstraat, MD, Sneha Jain, MHA, CSSBB, Elizabeth B. Habermann, PhD, Jean E. Wentink, RN, MPH, Pamela L. Grubbs, MS, APRN, Sharon A. Nehring, RN, BSN, Amy L. Weaver, MS, Michaela E. McGree, BS, Robert R. Cima, MD, Sean C. Dowdy, MD, and Jamie N. Bakkum-Gamze, MD

OBJECTIVE: To investigate whether implementing a bundle, defined as a set of evidence-based practices performed collectively, can reduce 30-day surgical site infections.

METHODS: Baseline surgical site infection rates were determined retrospectively for cases of open uterine cancer, ovarian cancer without bowel resection, and ovarian cancer with bowel resection between January 1, 2010, and December 31, 2012, at an academic center. A perioperative bundle was prospectively implemented during the intervention period (August 1, 2013, to September 30, 2014). Prior established elements were: patient education, 4% chlorhexidine gluconate shower before surgery, antibiotic administration, 2% chlorhexidine gluconate and 70% isopropyl alcohol coverage of incisional area, and cefazolin dosing 3-4 hours after incision. New elements initiated were: sterile closing tray and staff glove change for fascia and skin closure, dressing removal at 24-48 hours, dismissal with 4% chlorhexidine gluconate, and follow-up nursing phone call. Surgical site infection rates were examined using control charts, compared between periods using χ² or Fisher exact test, and validated against the American College of Surgeons National Surgical Quality Improvement Program decile ranking.

RESULTS: The overall 30-day surgical site infection rate was 38 of 635 (6.0%) among all cases in the preintervention period, with 11 superficial (1.7%), two deep (0.3%), and 25 organ or space infections (3.9%). In the intervention period, the overall rate was 2 of 190 (1.1%), with two organ or space infections (1.1%). Overall, the relative risk reduction in surgical site infection was 0.024 (P<0.01). The surgical site infection rate was 77.6% among ovarian cancer with bowel resection, 79.3% among ovarian cancer without bowel resection, and 100% among uterine cancer. The American College of Surgeons National Surgical Quality Improvement Program decile ranking improved from the 10th decile to first decile; risk-adjusted odds ratio for surgical site infection decreased from 1.6 (95% confidence interval 1.0-2.6) to 0.6 (0.3-1.1).

CONCLUSION: Implementation of an evidence-based surgical site infection reduction bundle was associated with substantial reductions in surgical site infection in high-risk cancer procedures.

From the Department of Obstetrics and Gynecology, Division of Gynecologic Surgery, the Division of Healthcare Policy and Research, Infection Prevention and Control, the Department of Nursing, the Surgery Research Office, the Division of Biomedical Statistics and Informatics, and the Department of General Surgery, Division of Colorectal Surgery, Mayo Clinic, and Mayo Medical School, Mayo Clinic, Rochester, Minnesota.


The authors thank Karen Rucker and Cary Heart of the Mayo Clinic Revenue Cycle for their expert technical help with International Classification of Diseases, 9th Revision and Current Procedural Terminology code identification as well as Whitney Bergstrom, PharmD, MBA, BCPP, for her assistance with pharmacy measure audits.

Corresponding author: Jamie N. Bakkum-Gamze, MD, Department of Obstetrics and Gynecology, Mayo Clinic, 200 1st Street SW, Rochester, Minnesota 55905-1003. E-mail: jnbakkumgamze@mayo.edu

DOI: 10.1097/00006250-201609000-00141

Johnson et al. Obstet Gynecol 2016;127:1135-1144
Putting it all Together – Demystifying the Surgical Care Bundle
Selecting an Evidence-Based (EB) Surgical Care Bundle

- **Normothermia**
- **Glycemic Control**
- **Antimicrobial Prophylaxis – Weight-based**
- **Triclosan Sutures**
- **Fascia/Subcuticular closure**
- **0.05% CHG Irrigation of Surgical Wound**
- **Staphylococcal Decolonization**
- **Wound Edge Protector**
- **Supplemental Oxygen**
- **Glove Change Prior to Fascia/Subcuticular Closure**
- **Separate Wound Closure Tray**
- **70% alc / 2% CHG Skin Antisepsis**
- **2% / 4% CHG Preadmission Shower/cleansing**
- **Limit OR Traffic**

**Moderate to High (1A) Level of Evidence-Based Documentation**
Again, So How Do We Use All of This Information?
Baseline Evidence-Based Interventions – Designated High-1A**

- Normothermia – 1A
- Perioperative antimicrobial prophylaxis – Weight-based – 1A
- Antimicrobial (triclosan) coated sutures (fascia / subcuticular closure) – 1A
- Preadmission CHG shower/cleansing – Standardized regimen – 1A
- Perioperative antisepsis – 2% CHG/70% alcohol – 1A
- Glycemic control – 1A
- Separate wound closure tray - High
- Glove change prior to fascia/subcuticular closure - High

Inclusive Evidence-Based Intervention for Consideration in 2019**

- Supplemental oxygen – Colorectal – 1A
- Oral antibiotics / Mechanical bowel prep – Colorectal – 1A
- Wound edge protector – Colorectal – 1A
- Staphylococcal decolonization – Orthopedic / CT - 1A
- Smoking cessation – 1A
- Irrigation with 0.05% CHG - Moderate
- OR traffic control – Device-related procedures – Low
<table>
<thead>
<tr>
<th>Baseline Interventions Evidence-Based</th>
<th>Class</th>
<th>Mechanistic Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normothermia</td>
<td>1A</td>
<td>Less bleeding / preserve immune function in wound bed / enhanced wound healing</td>
</tr>
<tr>
<td>Perioperative antimicrobial prophylaxis – “Weight-based”</td>
<td>1A</td>
<td>Tissue antisepsis / intraoperative conc &gt; MIC⁹⁰ wound pathogens</td>
</tr>
<tr>
<td>Glycemic control</td>
<td>1A</td>
<td>Preserve granulocytic immune function / enhance wound healing</td>
</tr>
<tr>
<td>Antimicrobial (triclosan) coated sutures (fascia / subcuticular closure)</td>
<td>1A</td>
<td>Mitigate nidus of infection / local tissue antisepsis</td>
</tr>
<tr>
<td>Preadmission CHG shower / cleansing</td>
<td>High-1A</td>
<td>Skin antisepsis / reduce skin bioburden</td>
</tr>
<tr>
<td>Perioperative skin-prep – 2% CHG / 70% alcohol</td>
<td>1A</td>
<td>Skin antisepsis / reduce skin bioburden</td>
</tr>
<tr>
<td>Separate wound closure tray</td>
<td>High</td>
<td>Mitigate instrument contamination</td>
</tr>
<tr>
<td>Glove change prior to fascia / subcuticular closure</td>
<td>High</td>
<td>Disrupt cross-contamination across tissue planes</td>
</tr>
</tbody>
</table>
Original Contribution

Unexpectedly high incidence of hypothermia before induction of anesthesia in elective surgical patients

Anna J. Wetz (Dr med) a, Thorsten Perl (PD Dr med) b, Ivo F. Brandes (PD Dr med) b, Markus Harden b, Martin Bauer (Prof Dr Dr med, MPH) a, Anselm Bräuer (Prof Dr med, DEAA) a

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Received 12 October 2014; revised 27 April 2015; accepted 16 March 2016

Keywords: Core temperature; Hypothermia; Hypothermia before induction of anesthesia; Incidence of hypothermia; Predictor of hypothermia

Abstract
Study objective: Perioperative hypothermia is a frequently observed phenomenon of general anesthesia and is associated with adverse patient outcome. Recently, a significant influence of core temperature before induction of anesthesia has been reported. However, there is still little existing data on core temperature before induction of anesthesia and no data regarding potential risk factors for developing preoperative hypothermia. The purpose of this investigation was to estimate the incidence of hypothermia before anesthesia and to determine if certain factors predict its incidence.

Design/setting/patients: Data from 7 prospective studies investigating core temperature previously initiated at our department were analyzed. Patients undergoing a variety of elective surgical procedures were included.

Interventions/measurements: Core temperature was measured before induction of anesthesia with an oral (34 patients), infrared tympanic (141 patients), or tympanic contact thermometer (56 patients). Available potential predictors included American Society of Anesthesiologists status, sex, age, weight, height, body mass index, admission, and loss body weight. Association with preoperative hypothermia was assessed separately for each predictor using logistic regression. Independent predictors were identified using multivariable logistic regression.

Main results: A total of 493 patients were included in the study. Hypothermia was found in 165 patients (21.5%; 95% confidence interval, 17.8%-25.2%). The median core temperature was 36.3°C (25th-75th percentiles, 36.0°C-36.7°C). Two independent factors for preoperative hypothermia were identified: male sex and age (5-52 years).

Conclusions: Thirty minutes was found to be the average suggested amount of time for prewarming among the literature; however, a minimum of 10 minutes of prewarming was suggested to significantly reduce rates of hypothermia in perioperative patients and decrease the adverse effects of hypothermia.

Keywords: Preoperative hypothermia, forced air warming. © 2016 by American Society of PeriAnesthesia Nurses
<table>
<thead>
<tr>
<th>Supplemental Interventions Evidence-Based</th>
<th>Class</th>
<th>Major Mechanistic Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suplemental oxygen – Colorectal</td>
<td>1A</td>
<td>Enhanced tissue oxygenation and immune function / metabolic benefits / wound healing</td>
</tr>
<tr>
<td>Oral antibiotics / Mechanical bowel prep –</td>
<td>1A</td>
<td>Reduce bioburden within the bowel lumen and on brush border surfaces</td>
</tr>
<tr>
<td>Colorectal</td>
<td></td>
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</tr>
<tr>
<td>Wound edge protector – Colorectal, vascular,</td>
<td>1A</td>
<td>Intraoperative wound antisepsis / minimizing wound contamination</td>
</tr>
<tr>
<td>OB/GYN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staphylococcal decolonization – Orthopedic</td>
<td>1A</td>
<td>Mitigate S. aureus and MRSA pathogenicity</td>
</tr>
<tr>
<td>and CT</td>
<td></td>
<td></td>
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<tr>
<td>Smoking cessation – Orthopedic, Neuro, CT -</td>
<td>1A</td>
<td>Preserve angiogenesis / reduce risk of dehiscence / enhance wound healing</td>
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<tr>
<td>likely all surgical procedures</td>
<td></td>
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<tr>
<td>Intraoperative irrigation of the surgical</td>
<td>Moderate</td>
<td>Mitigate wound contamination prior to closure</td>
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<tr>
<td>wound with 0.05% chlorhexidine gluconate</td>
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</tr>
<tr>
<td>OR traffic control – minimize door openings</td>
<td>Low to</td>
<td>Reduce OR air bioburden</td>
</tr>
</tbody>
</table>
The Mechanistic Benefit of Oral Antibiotics and Mechanical Bowel Prep
The Efficacy of Oral Antimicrobials in Reducing Aerobic and Anaerobic Colonic Mucosal Flora

Jonathan I. Groner, MD; Charles E. Edmiston, Jr, PhD; Candace J. Krepel; Gordon L. Telford, MD; Robert E. Condon, MD, MS

<table>
<thead>
<tr>
<th>Group</th>
<th>Proximal</th>
<th>Midcolon</th>
<th>Distal</th>
</tr>
</thead>
</table>
| Aerobes  
A | 8.6 ± 0.5 | 8.3 ± 0.6 | 8.7 ± 0.5 |
| B | 7.4 ± 1.6 | 6.7 ± 2.0 | 7.2 ± 1.7 |
| C | 5.5 ± 0.6 | 5.4 ± 0.8 | 5.7 ± 1.0 |
| D | 2.4 ± 0.7 | 3.1 ± 0.2 | 2.5 ± 1.2 |
| Anaerobes  
A | 9.5 ± 0.4 | 9.7 ± 0.4 | 9.8 ± 0.9 |
| B | 9.0 ± 0.9 | 8.6 ± 2.1 | 8.6 ± 1.6 |
| C | 8.2 ± 0.9 | 7.4 ± 0.7 | 7.4 ± 1.0 |
| D | 2.6 ± 1.0 | 3.0 ± 1.4 | 2.6 ± 1.1 |

*Expressed as log_{10} colony-forming units per milligram (wet weight) of tissue, mean ± SD. Group A (n = 6) received no bowel preparation; group B (n = 7), clear-liquid diet; group C (n = 8), mechanical preparation; and group D (n = 7), oral antimicrobial prophylaxis.


The Role of Bowel Preparation in Colorectal Surgery
Results of the 2012–2015 ACS-NSQIP Data

Aaron L. Kluger, MD,* Heather Green, MS,* Dominique J. Monlezun, MD, PhD, MPH† David Beck, MD,* Brian Karan, MD,* Herschel D. Vargas, MD,* Charles Whitekin, MD,* and David Margolin, MD*

Objective: To analyze potential benefits with regards to infectious complications with combined use of mechanical bowel preparation (MBP) and AEP in elective colorectal resections.

Background: Despite recent literature suggesting the MBP does not reduce infection rate, it is commonly used. The use of oral antibiotic bowel preparation (AEP) has been practiced for decades but is used less frequently.

Method: Patients undergoing elective colorectal resection in the 2012 to 2015 American College of Surgeons National Surgical Quality Improvement Program cohorts were assessed. Dodecyl polypropylene succinate-adjusted multiple logistic regression was conducted for infections and other postoperative complications.

Results: A total of 27,504 subjects were analyzed. 5,471 (23.46%) received no preparation, 957 (3.47%) received MBP only, 1,778 (6.59%) received AEP only, and 8,085 (37.89%) received both preparations. Compared to patients receiving no preparation, those receiving dual preparation had less surgical site infection (SSI) (odds ratio [OR] = 0.59, P < 0.001), organ space infection (OR = 0.59, P < 0.001), wound dehiscence (OR = 0.45, P = 0.001), and anastomotic leak (OR = 0.53, P < 0.001). AEP alone compared to no preparation was significantly lower rates of SSI (OR = 0.69, P < 0.001), organ space infection (OR = 0.59, P = 0.001), and anastomotic leak (OR = 0.33, P = 0.002). MBP showed no significant benefit to infections complications when used alone.

Conclusions: Combined MBP/AEP results in significantly lower rates of SSI, organ space infection, wound dehiscence, and anastomotic leak than no preparation and a lower rate of SSI than AEP alone. Combined bowel preparation significantly reduces the rates of infectious complications in colon and rectal procedures with increased risk of Chargionia difficile infection. For patients undergoing elective colon or rectal resection, we recommend bowel preparation with both mechanical agents and oral antibiotics whenever feasible.

Keywords: bowel preparation, antibiotic preparation, colorectal surgery, National Surgical Quality Improvement Program, surgical site infection

From the Department of Colon and Rectal Surgery, Oregon Medical Center, New Orleans, LA; and Oregon Health University School of Medicine, Portland, OR; and Department of Medicine, University of Texas Health Science Center, Houston, TX.

The American College of Surgeons National Surgical Quality Improvement Program and the hospitals participating in the ACS NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

The authors disclose no conflicts of interest.

Reprint: David Margolin, MD, PASC, FASC, Department of Colon and Rectal Surgery, Oregon Medical Center, 1554 Jefferson Highway, New Orleans, LA 70121. E-mail: dmargolin@ohsu.edu

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Clearing the bowel to limit the infectious complications of colorectal surgery is hardly a new concept. In fact, in 1887 Halsted noted that “the chief danger of infection of the peritoneal cavity is manifestly from the contents of the intestines.” Shortly after the discovery of penicillin, surgeons began using oral antibiotics in attempts to reduce intraluminal bacterial counts. This was usually used in conjunction with purgatives or bowel irrigation to reduce stool burden and further reduce the bacterial counts. At the time these methods were being developed, mortality rates for colorectal surgery were as high as 10% to 12% with as many as 90% of survivors developing surgical site infections (SSIs). By the 1950s patients began to receive perioperative antibiotics and would often demand them regardless of their surgeon’s recommendations. In 1972 Nussblatt et al.1 introduced their protocol, still commonly used today, consisting of mechanical bowel preparation (MBP) and doses of neomycin and erythromycin which they found to reduce rates of SSI from 4% to 9%.

In recent years, the benefit of MBP has been called into question in various clinical trials. In a 2011 Cochrane review Choe et al.2 analyzed more than 580 colorectal surgery patients from 20 trials. They compared patients receiving MBP to patients receiving no preparation and found no significant difference between these groups in rates of anastomotic leakage or wound infection in colon or rectal resection. In 2015 Ackerson et al.3 found AP alone to result in lower SSIs than no preparation and questioned whether combined bowel preparation is necessary. Others have questioned if antibiotic bowel preparation offers any benefit when systemic intravenous antibiotics have been provided.4,5,6 Furthermore, Wearn et al.7 found oral antibiotics to increase rates of Clostridium difficile infection.

The high rate of infections and other postoperative complications in colorectal surgery and the desire to reduce hospital costs has led many surgeons to follow “fast-track” or “enhanced recovery pathways” (ERPs). These pathways vary but generally consist of limited postoperative fasting with early postoperative feeding, careful intravascular fluid management, attempts to limit postoperative nausea, vomiting, and pain, and early discharge planning. Although some authors suggest using MBP as part of an ERP,7–9 others insist a key component of enhanced recovery is avoidance of MBP.10–13 In fact, recently published guidelines from the Society of American Colon and Rectal Surgeons and the Society of American Gastrointestinal and Endoscopic Surgeons recommend the use of combined MBP and AEP.14

Despite uncertainty guidelines calling for the use of MBP and AEP in addition to intravenous antibiotic prophylaxis, the use of preparation remains controversial.12 The Society of American Gastrointestinal and Endoscopic Surgeons recognizes this controversy and suggests that for colorectal resection, if MBP is to be used, AEP must also be used. They note a lack of data for elective rectal surgery and do not make any specific recommendations.15

Surveys of the American Society of Colon and Rectal Surgeons have shown a trend in recent years toward abandoning
## Enhanced Recovery After Surgery Protocol (ERAS)

<table>
<thead>
<tr>
<th>Preoperative</th>
<th>Day of Surgery</th>
<th>Intraoperative</th>
<th>Postoperative</th>
</tr>
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<tbody>
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<td>- Patient Education</td>
<td>- NPO</td>
<td>- Patient Warming</td>
<td>- Active warming</td>
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<tr>
<td>- Smoking Cessation</td>
<td>- Carbohydrate loading</td>
<td>- Skin preparation</td>
<td>- Glucose management</td>
</tr>
<tr>
<td>- Prehabilitation</td>
<td>- Hair management</td>
<td>- OR Traffic</td>
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<tr>
<td>- Care coordination</td>
<td>- Skin decontamination</td>
<td>- Antibiotics</td>
<td>- Ileus management</td>
</tr>
<tr>
<td>- Diabetes control</td>
<td>- Patient Warming</td>
<td>- IVF Management</td>
<td>- DVT prophylaxis</td>
</tr>
<tr>
<td>- Skin decontamination</td>
<td>- Ileus Prevention</td>
<td>- Glucose management</td>
<td>- Pain management</td>
</tr>
<tr>
<td>- Immunonutrition</td>
<td>- Glucose management</td>
<td>- Supplemental Oxygen</td>
<td>- Rehabilitation</td>
</tr>
<tr>
<td>- Bowel preparation</td>
<td>- Pain management</td>
<td>- PONV Prevention</td>
<td>- WOCN</td>
</tr>
<tr>
<td>- Carbohydrate loading</td>
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<td>- Pain management</td>
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</tr>
<tr>
<td>- NPO Status</td>
<td>- EPIC/Grease Board</td>
<td>- NGT / Drains</td>
<td>- Immunonutrition</td>
</tr>
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<td>- MIS</td>
<td>- IVF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Near infrared vascular imaging</td>
<td>- Urinary catheters</td>
</tr>
</tbody>
</table>

### Wound Closing Protocol
- Wound management
- Residual neuromuscular weakness
- Wound classification

### Source: Marc Singer, MD, FAC, SSI Symposium VI
September 21, 2018 – Wisconsin Dells, WI
A Brief Story
Surgical site infection: poor compliance with guidelines and care bundles

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Key words
Care bundles; Compliance; Guidelines; Surgical site infection

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Abstract
Surgical site infections (SSIs) are probably the most preventable of the health care-associated infections. Despite the widespread international introduction of level I evidence-based guidelines for the prevention of SSIs, such as that of the National Institute for Clinical Excellence (NICE) in the UK and the surgical care improvement project (SCIP) of the USA, SSI rates have not measurably fallen. The care bundle approach is an accepted method of packaging best, evidence-based measures into routine care for all patients and, common to many guidelines for the prevention of SSI, includes methods for preoperative removal of hair (where appropriate), rational antibiotic prophylaxis, avoidance of perioperative hypothermia, management of perioperative blood glucose and effective skin preparation. Reasons for poor compliance with care bundles are not clear and have not matched the wide uptake and perceived benefit of the WHO ‘Safe Surgery Saves Lives’ checklist. Recommendations include the need for further research and continuous updating of guidelines; comprehensive surveillance, using validated definitions that facilitate benchmarking of anonymised surgeon-specific SSI rates; assurance that incorporation of checklists and care bundles has taken place; the development of effective communication strategies for all health care providers and those who commission services and comprehensive information for patients.
Do Surgical Care Bundles Provide A Fiscal Benefit?
Colorectal Scenario: Is There A Fiscal Benefit For Implementing a Surgical Care Bundle A High/Low Estimate?

Scenario #1
$185,435 (mean cost of deep/organ space SSI) *
$50 per surgery (cost of surgical care bundle)
$185,435 / $50 = 3,708 procedures
3,708 / 200 cases ~ 18.5 years
4,635 / 500 cases ~ 7.4 years

* Edmiston et al. ISPOR May 2019, New Orleans, LA

Scenario #2
$25,000 (mean cost of superficial, deep and organ/space SSI)
$25,000 / $50 = 500 procedures
500 / 200 cases ~ 2.5 years
500 / 500 cases ~ 1 years

** CDC estimated cost
SSI Prevention Is Not a Solo Recital
But Rather a Symphony and We Are
All Part of the Orchestra