The Role of Anesthesia Providers in Reducing Surgical Site Infections

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Objectives

• Discuss the epidemiology and pathophysiology of surgical site infections

• Review recent studies on the risk factors for surgical site infections

• Share best practices for anesthesiologists to reduce surgical site infections
Acknowledgments

• MPOG QI Team, led by Kate Buehler, RN, MSN
• Created and distributed SSI toolkit
• Available at the MPOG website
Surgical Site Infections (SSIs) Definitions

• CDC definition: an infection that occurs after surgery in the part of the body where the surgery took place\textsuperscript{12}

• SSIs are classified by depth and tissue spaces involved: \textsuperscript{4,12}
  – Superficial Incisional: Involves only skin and subcutaneous tissue
  – Deep Incisional: Involves the fascia or muscle tissue
  – Organ Space: Involves any part of the body opened or manipulated during a procedure (excluding the skin or muscle tissue)

(Anderson et al., 2014; CDC, 2010)
Impact of Surgical Site Infections

- Incidence: 2-5% in patients undergoing inpatient surgery\(^4\)
- Between 160,000 and 300,000 infections per year in the United States \(^4,31\)
- A single SSI is associated with 7-11 additional postoperative hospital days\(^4\)
- Greater than 90,000 readmissions annually in the US
- 75% of deaths among patients with SSI are directly attributable to SSI
- Annual cost of SSI in the US: $3.5 to $10 billion
- Increases cost of hospital admission by $20,000 per admission

\(^4\) Anderson et al., 2014; Magill et al., 2014
Pathophysiology Overview

• Surgical incision exposes tissue to:
  – Endogenous flora, including common bacteria of the skin, gastrointestinal tract, gynecologic tract
  – External bacteria from OR staff, equipment, environment, materials (implant or mesh) 11

• Predominant organisms causing SSI after clean procedures are skin flora, including Staphylococcus aureus (30%) and coagulase-negative staphyloccoci 20
  – Of the S. aureus infections, 49.2% were found to methicillin-resistant staphylococcus aureus (MRSA)
  – MRSA infections are associated with higher mortality rates, longer hospital stays, and higher hospital costs 55

• In clean-contaminated procedures (abdominal procedures, kidney, liver transplants): gram-negative rods and enterococci + skin flora are the most common isolates 11

(Bratzler et al., 2013; Hidron et al., 2008; Steiner & Strand, 2017; Weigelt et al., 2010)
Pathophysiology

• Temperature:
  – Hypothermia triggers vasoconstriction and subsequent tissue hypoxia which impairs wound healing. In addition, hypothermia may also impair neutrophil function, reducing the body’s natural protection against infection.\(^{41-43}\)

• Glucose:
  – Stress of surgery triggers cortisol release which creates an imbalance between hepatic glucose production/utilization resulting in hyperglycemia. Elevated blood glucose levels impair neutrophil function and cause an overproduction of inflammatory mediators and immune dysfunction. The amount of imbalance depends on the severity of surgery & type of anesthesia.\(^{13,15,17}\)

• Fluid Management:
  – Hypovolemia leads to insufficient circulation with decreased oxygen delivery to organs and peripheral tissues. Hypervolemia causes interstitial edema, local inflammation and impairs collagen regeneration. Either fluid imbalance in surgical patients can therefore result in impaired wound healing and subsequent surgical site infections.\(^{23}\)

• OR Traffic:
  – Each person sheds millions of particles per day and 5-10% of skin debris is known to carry bacteria and opening the OR door increases the number of bacteria in the air.\(^{40}\)

• Surgical Prep:
  – Shaving at the surgical site causes micro-abrasions on the skin’s surface, creating another opportunity for bacteria to enter the surgical site and cause an infection.\(^{32}\) Chlorhexidine gluconate (CHG) molecules are able to attach to bacterial cell walls, disturbing its osmotic equilibrium which inhibits further cell growth.\(^{16}\)

(Clarke, 1970; Duggan, Carlson, & Umpierrez, 2017; Edmiston et al., 2013; Farrokhi, Smiley, & Umpierrez, 2011; Jonsson et al., 1991; Mangram, Horan, Pearson, Silver, & Jarvis, 1999; Scaltriti et al., 2007; Sessler, 1997, 2000, 2016)
Risk Factors: Intrinsic

Modifiable

- Smoking Status
- Obesity
- Low Albumin
- Glycemic Control

Non-Modifiable

- Age
- Recent Radiotherapy
- History of skin/soft tissue infection

(Ban et al., 2017)
Impact of Smoking

• Smoking increases oxidative stress which reduces tissue perfusion/oxygenation, impairs the bactericidal mechanisms of neutrophils and decreases overall proliferation of inflammatory cells.

• Inflammatory cellular response is delayed, chemotaxis and migration of neutrophils is impaired.

• Cigarette smoke significantly impairs the phagocytic activity of neutrophils

(Sorensen, 2012)
Impact of Smoking Cessation

- Within one hour of smoking cessation, tissue oxygenation, aerobe metabolism and blood flow are normalized.

- Within 3-4 weeks of smoking cessation inflammatory cell function is restored increasing proteolytic enzyme release and oxidative killing mechanism.

- The damage to fibroblasts, epidermal regeneration and collagen degradations from smoking is not affected by smoking cessation.

(Sorensen, 2012)
Impact of Obesity

• Patients who are obese (BMI 30-40 kg/m2) or morbidly obese (BMI ≥ 40 kg/m2) have a higher incidence of both deep and superficial SSIs when compared to patients with a normal weight.

• A retrospective analysis of ACS-NSQIP data ($n = 89,148$) found obese/morbidly obese patients undergoing clean or clean-contaminated procedures to have a significant increased risk of developing superficial or deep tissue SSIs. There was no significant increase in organ/space SSIs.

• BMI has been shown to influence an increased risk of deep SSIs in 6 surgery types.
  – Cardiothoracic, Breast, Gastrointestinal, Orthopedics, Gynecology/Obstetrics, Neurosurgery

• Increased thickness of subcutaneous tissue raises the risk of SSIs. Adipose tissue is less vascularized and therefore poorly oxygenated causing delayed wound healing and necrosis of local tissue. Poor tissue vascularization may also prevent adequate tissue concentrations of prophylactic antibiotics.

• Technical Difficulties during surgery on patients with a high BMI may be related to SSI risk:
  – Increased wound surface area with consistent tension pulling on the healing wound increasing the risk of wound dehiscence.
  – A large amount of adipose tissue near the incision can result in longer operation times.

(Meijs et al., 2019; Winfield, Reese, Bochicchio, Mazuski, & Bochicchio, 2016)
Impact of Obesity

• Findings from the largest retrospective study to evaluate weight loss in relation to 30-day postoperative outcomes (n = 394,016) utilized data from the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP)

  – Unsafe weight loss prior to bariatric surgery increases the risk of superficial SSIs and is most likely due to a compromised nutrition status.

  – Each additional percent body weight loss was associated with a 2.3% increase in superficial SSIs. There was no correlation between preoperative weight loss and organ/space or deep tissue SSIs.

<table>
<thead>
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<th>Variable</th>
<th>OR</th>
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<th>p value</th>
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<tr>
<td></td>
<td></td>
<td>Lower</td>
<td>Upper</td>
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<td>SSI</td>
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<td></td>
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<tr>
<td>Superficial</td>
<td>1.023</td>
<td>1.009</td>
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<tr>
<td>Deep</td>
<td>1.033</td>
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<tr>
<td>Organ/space</td>
<td>0.979</td>
<td>0.960</td>
<td>0.999</td>
</tr>
</tbody>
</table>

(Tewksbury et al., 2019)
Low Albumin Lab Values

- Low serum albumin levels associated with dehydration, inflammation, infection and poor nutritional status.
  - Impaired immune response: decreased proliferation of lymphocytes, macrophages, and fibroblast proliferation.
  - Decrease in collagen synthesis and granulation formation, impairing wound healing

- Serum albumin as a preoperative marker associated with 6 mo. mortality in patients aged >65 undergoing major surgery

- A meta-analysis conducted by Yuwen et. al (2017) demonstrated that patients undergoing orthopedic surgery who have a preoperative albumin level <3.5 g/dL had a 2.5x increased risk of developing an SSI postoperatively.

(Banz, Jakob, & Inderbitzin, 2011; Quain & Khardori, 2015; Son, Roh, Choi, Nam, & Kim, 2018; Yuwen et al., 2017)
Non-Modifiable Risk Factors

• Age: Older patients at higher risk for SSIs
  – Cardiac muscle in older patients limits the heart’s contractile ability decreasing stroke volume and cardiac output. Minimizing cardiac output limits the delivery of nutrients and neutrophils to the incision site
  – Reduced ability to overcome hypoxia due to reduced lung surface area
  – Malnutrition and involuntary weight loss are common hindering the immune response

• Recent Radiotherapy
  – Causes inflammation and limits microcirculation of blood to tissues

• History of skin/soft tissue infection
  – Independent preoperative risk factor and strongly predictive for SSI
  – Open wound or skin infection serves as a host for bacteria which can progress to a secondary infection
  – Skin infections should be treated prior to a scheduled procedure

(Banz, Jakob, & Inderbitzin, 2011; Moreno Eiola-Olaso, Davenport, Hundley, Daily, & Gedaly, 2012; Thorgersen et al., 2017)
Strategies for SSI Prevention

• The use of care bundles is widely supported in the SSI prevention literature:
  – Tanner et al. (2015) examined 13 studies and found that the most common bundle elements included antibiotic administration, (clipper) hair removal, glycemic control, and normothermia. Meta-analysis found the SSI rate in the bundle group to be 7% as compared to the standard group at 15.1%. 49
  – In a prospective quality improvement study, Lippitt et al. (2017) found the bundle approach to be successful in reducing surgical site infections for women undergoing cytoreductive surgery for ovarian cancer. A total of 219 women were enrolled in the study. Prebundle SSI rate was 20% and postbundle the rate was reduced to 3%. 30

• However, there is a lack of consensus on the components of an effective bundle to prevent SSIs 4,6,30,49

(Anderson et al., 2014; Ban et al., 2017; Lippitt et al., 2017; Tanner et al., 2015)
Common SSI Bundle Elements Include:

1. Antibiotic Dosing, Timing, and Selection 4,6,10,4,49
2. Normothermia 4,6,10,4,49
3. Glycemic Control 4,6,10,4,49
4. Oxygenation 4,6,10,4
5. Fluid Management 4
6. Hair Removal 4,6,4,49
7. Reducing OR Traffic 4
8. Skin Prep 4,6,10

(Anderson et al., 2014; Ban et al., 2017; Berrios-Torres et al., 2017; Dellinger et al., 2005; Tanner et al., 2015)
BUNDLE ELEMENT #1: ANTIMICROBIAL PROPHYLAXIS
Overview of Antibiotics

• Administration of surgical antimicrobial prophylaxis reduces the risk of SSI after various procedures 1,4,6,8,10,11,19,37,46

• Timing should aim to establish bactericidal concentrations in the serum and tissue at time of incision 10
  – Most guidelines suggest administration within 60 minutes before surgical incision (120 minute for vancomycin or fluoroquinolones) 4,6,11
  – Some studies recommend administration of cephalosporins within 30 minutes before surgical incision 1,9

• Redosing should be based on duration of surgery, renal function, and choice of antibiotic

• Selection of the appropriate antimicrobial agents should be based on procedure to target the most common pathogens that cause SSI for indicated procedure 4,6,11

(Berrios-Torres et al., 2017; Hasselgren, Ivarsson, Risberg, & Seeman, 1984; Platt et al., 1990; Steinberg et al., 2009)
• Administer preoperative antimicrobial agents according to clinical practice guidelines (Category 1B- strong recommendation-accepted practice)

• Timing should aim to establish bactericidal concentrations in the serum and tissue at time of incision (Category 1B- strong recommendation- accepted practice)

• Cesarean sections: administer prophylaxis before surgical incision (Category 1A- strong recommendation; high quality evidence)

• In clean and clean-contaminated procedures: do not administer additional antimicrobial prophylaxis after surgical incision is closed, even if drain is placed. (Category 1A- strong recommendation; high-quality evidence)

• Do not apply antimicrobial agents (solutions, ointments, powders) to the surgical incision to prevent SSI. (Category 1B- strong recommendation; low-quality evidence)

• Similar to guidelines from ACS, ASHP, WHO, SHEA

(Berrios-Torres et al., 2017)
BUNDLE ELEMENT #2: NORMOTHERMIA
Hypothermia and Anesthesia

• Hypothermia commonly occurs during and after surgery due to impairment of thermoregulation caused by anesthesia medications and exposure to the cold environment of the operating room 41-43.

• Redistribution of body heat from the core to the periphery decreases the core temperature 1-1.5 degrees Celsius during the first hour of anesthesia.

• After hour one of surgery, core temperature decreases at a slower rate.

• Pre-warming allows the peripheries to warm and decrease the overall impact to core temperature changes when redistribution occurs.

(Sessler, 1997, 2000, 2016)
Normothermia Literature

• In a study performed by Kurz et al. (1996), 200 colorectal surgery patients were randomized to two groups:
  – Intraoperative warming group received warm fluids and forced air warming to maintain 36.5 degrees
  – Standard (hypothermia) group received standard warming to maintain temperature of 34.5 degrees
  – Wound infections were higher in the standard warming group as compared to the active warming group: 19% vs. 6% (P=.009)

• Melling et al. (2001) conducted a similar study in 421 patients undergoing breast, vascular, or hernia surgery
  – Routine care (no warming) group had more wound infections as compared to the two other groups in which pre-warming was administered (local and systemic): 14 to 5% (P=.007)

(Kurz, Sessler, & Lenhardt, 1996; Melling, Ali, Scott, & Leaper, 2001)
Recommendations for Maintaining Normothermia

• Society for Healthcare Epidemiology of America (SHEA) Guidelines 2014 4
  – Maintain normothermia (temperature of 35.5 degrees Celsius or greater) during periop period

• CDC Guidelines for the Prevention of SSIs 2017 10
  – Maintain perioperative normothermia- target temperature undefined (Category 1A- strong recommendation)

• WHO Recommendations 6
  – Warming devices are recommended for use in the operating room to maintain core temperature greater than or equal to 36.0 degrees Celsius

• American College of Surgeons and Surgical Infection Society: SSI Guidelines 2016 56
  – Maintain intraoperative normothermia – target temperature undefined
  – Preoperative warming is recommended for all cases and intraoperative warming methods should be employed for all but short, clean cases
  – For longer cases, both preoperative warming and ongoing temperature monitoring and warming measures are recommended.

(Anderson et al., 2014; Ban et al., 2017; Berrios-Torres et al., 2017; "WHO Guidelines Approved by the Guidelines Review Committee," 2018)
ASPIRE Measure: TEMP 01

Measure Summary: The percentage of cases in which an active warming device was applied between Case Start and Case End or the patient maintained a temperature above 36.0 degrees Celsius without active warming.

Active Warming includes:
- Convective warming: forced air
- Conductive warming: circulating water mattress, resistive heating electrical blankets
- Endovascular warming, using a heat exchanging catheter (very rarely used)
- Radiant heaters

Inclusions: Cases with general or neuraxial anesthetic technique.

Success:
- Cases with documentation of an active warming device applied OR
- Cases with at least one temperature greater than or equal to 36.0° C within the 30 minutes before case end.
- For patients undergoing cesarean section, fluid warmer is accepted as an active warming device.

Responsible Provider: Provider present at induction end.

TEMP 01 Performance

Compliance by Institution

Anonymized Institutions

% Compliance

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

MPOG
ASPIRE Measure: TEMP 02

**Measure Summary:** The percentage of cases where the anesthesia provider documented at least one core temperature intraoperatively for any patient receiving a general anesthetic.

**Core or Near Core Temperature Monitoring Includes:**
- Esophageal Temperature
- Nasopharyngeal Temperature
- Tympanic Membrane Temperature
- Bladder Temperature
- Rectal Temperature
- Axillary Temperature (arm must be at patient side)
- Oral Temperature

**Inclusions:** All surgical patients receiving general anesthesia

**Success:** Cases with at least one core temperature documented between Anesthesia Start and Patient out of Room.

**Responsible Provider:** Provider present at induction end

[https://mpog.org/files/quality/measures/TEMP-02_spec.pdf](https://mpog.org/files/quality/measures/TEMP-02_spec.pdf)
TEMP 02 Performance

Compliance by Institution

Anonymized Institutions

% Compliance

% Compliance
ASPIRE Measure: TEMP 03

**Measure Summary:** The percentage of patients who undergo procedures under general or neuraxial anesthesia greater than or equal to 60 minutes or longer for whom at least one body temperature greater than or equal to 36 degrees Celsius (or 96.8 degrees Fahrenheit) was recorded within 30 minutes immediately before or 15 minutes after anesthesia end time.

**Inclusions:** All patients, regardless of age, who undergo surgical or therapeutic procedures under general or neuraxial anesthesia of 60 minutes duration or longer.

**Success:** At least one body temperature measurement equal to or greater than 36 degrees Celsius (or 96.8 degrees Fahrenheit) achieved within the 30 minutes immediately before or the 15 minutes immediately after anesthesia end time.

**Responsible Provider:** Provider present for longest duration of the case per staff role.

Summary of Recommendations: Normothermia

1. Apply active warming to maintain core body temperature of 36.0 degrees Celsius $^{3,6,26,27}$

2. Surgical patients often experience hypothermia within the first hour after induction of general anesthesia due to the anesthetic induced vasodilation. $^{43}$

3. Maintaining a core temperature below 36 degrees Celsius increases the rate of surgical site infections $^{27}$

(Allegranzi et al., 2016; Ban et al., 2017; Kurz, 2008; Kurz, Sessler, & Lenhardt, 1996; Sessler, 2016)
BUNDLE ELEMENT #3:
GLYCEMIC CONTROL
Hyperglycemia and Surgical Site Infections

- Hruska et al. (2005) studied 761 cardiac surgery patients and found that diabetics were at increased risk of infection and glucose control (120-160 mg/dL) reduced the risk of wound infection in diabetics.  

- Kwon et al. (2013) evaluated the relationship between perioperative hyperglycemia (>180 mg/dL) and subsequent insulin administration on mortality, reoperation, and infections for patients undergoing colorectal and bariatric surgery.  
  - Of the 11,633 patients, 29.1% of patients were hyperglycemic on DOS, POD1, and/or POD2  
  - 13.5% of non-diabetic patients had hyperglycemia; 58% of diabetic patients had hyperglycemia  
  - Patients with hyperglycemia had a 2-fold higher risk of infection

(Hruska, Smith, Hendy, Fritz, & McAdams, 2005; Kwon et al., 2013)
Bundle Element #3: Glycemic Control

• Society for Healthcare Epidemiology of America (SHEA) Guidelines 2014 ⁴
  – Control blood glucose levels during the immediate postoperative period: ≤180 mg/dL

• CDC Guidelines for the Prevention of SSIs 2017 ⁶
  – Maintain blood glucose levels less than 200 mg/dL during the perioperative period for patients with and without diabetes (Category 1A-strong recommendation; high to moderate quality evidence)

• American College of Surgeons and Surgical Infection Society: SSI Guidelines 2016 ¹⁰
  – Target perioperative blood glucose should be between 110-150 mg/dL in all patients regardless of diabetic status, except in cardiac surgery where target should be <180 mg/dL

(Anderson et al., 2014; Ban et al., 2017; Berrios-Torres et al., 2017)
Bundle Element #3: Glycemic Control

- World Health Organization Recommendations 56
  - Strict protocols should be implemented to control blood glucose levels in both diabetic and non-diabetic patients undergoing surgical procedures
  - Blood glucose target and perioperative timing of glucose control could not be defined

- Society for Ambulatory Anesthesia (SAMBA) Consensus Guidelines-2010 24
  - Postpone elective surgery in patients with significant complications of hyperglycemia (severe dehydration, ketoacidosis, hyperosmolar nonketotic states)
  - In patients with well-controlled diabetes, maintain intraop blood glucose levels <180mg/dL
  - In patients with poorly controlled diabetes, maintain intraop blood glucose levels around their preop baseline values rather than normalizing them

(Joshi et al., 2010; "WHO Guidelines Approved by the Guidelines Review Committee," 2018)
Preoperative Hyperglycemia Management

• For non-diabetics undergoing surgical procedures, consider checking blood glucose upon arrival to assess for hyperglycemia in the non-diabetic patient. \(^\text{28}\)

(Duggan, Carlson, & Umierrez, 2017; Kwon et al., 2013)
ASPIRE Measure: GLU 01

**Measure Summary:** Percentage of intraoperative glucose labs with perioperative glucose >200 with administration of insulin or glucose recheck within 90 minutes of original glucose measurement for the time period between Anesthesia Start and Anesthesia End.

**Inclusions:** All patients with glucose level greater than 200 mg/dL between Anesthesia Start and Anesthesia End; Patients with and without diagnosis of diabetes.

**Success:** Administration of insulin within 90 minutes (either IV or sub Q routes) or Recheck of glucose level within 90 minutes

**Responsible Provider:** The provider signed in at the first glucose recheck or first administration of insulin. If neither occurred, then the responsible provider is the one signed in 90 minutes after the high glucose measurement.

BUNDLE ELEMENT #4: FLUID MANAGEMENT
Bundle Element #4: Fluid Management

- Kabon et. al. (2005) demonstrated infection rates did not differ between patients who were assigned a low or high fluid balance protocol. Fluid replacement between 3.1 mL to 5.7 mL did not have a major impact on SSI risk.
- “Trials without standardized volume replacement protocols reported an increase in SSIs.
- Fluid management is most effective in minimizing SSI rates when paired with optimization of tissue oxygenation.
Summary of Recommendations: Fluid Management

• There is conflicting evidence on whether restrictive or liberal fluid management protocols put patients at risk for developing an SSI postoperatively.

• Healthcare institutions should adopt and implement a standardized fluid management protocol for surgical patients

• Maximizing cardiac output through fluid administration can improve the migration of neutrophils and other inflammatory cells to the incision site, however, use caution not to place the patient in a hypervolemic state.

• “Maintain appropriate fluid balance by providing them with the right amount of the right fluid at the right time”

(Varadhan & Lobo, 2010)
BUNDLE ELEMENT #5: OXYGENATION
Bundle Element #5: Oxygenation

• CDC Guidelines for the Prevention of SSIs 2017 \(^{10}\)
  – For patients with normal pulmonary function undergoing general anesthesia with ETT, administer increased FiO2 during surgery and after extubation in the immediate postop period.
  – No clear evidence to support administration of increased FiO2 via ETT during the intraoperative phase only.
  – No clear evidence to support administration of FiO2 via face mask or nasal cannula during the perioperative period.

• American College of Surgeons and Surgical Infection Society: SSI Guidelines \(^6\)
  – Administration of supplemental oxygen (80% FiO2) is recommended during surgery and in the immediate postop period for procedures performed under general anesthesia.

(Ban et al., 2017; Berrios-Torres et al., 2017)
Bundle Element #5: Oxygenation

- World Health Organization Recommendations 2016
  - Adult patients undergoing general anesthesia with an ETT for surgical procedures should receive an 80% FiO2 intraoperatively and 2-6 hours postoperatively, if possible

(Anderson et al., 2014; "WHO Guidelines Approved by the Guidelines Review Committee," 2018)
Oxygenation – maybe not so effective…

“In a recent analysis investigating the scientific integrity of the work published by Schietroma et al., evidence was found for potential data fabrication in 38 trials reporting on a variety of perioperative interventions, including supplemental oxygen to reduce surgical site infections.

While some of these studies have been retracted, others have now come under scrutiny and require further investigation. Major concerns were raised about the impact of these compromised data on the World Health Organization recommendations on surgical site infections, which included two trials published by Schietroma et al.

The World Health Organization recommended the use of 80% inspired oxygen fraction. In contrast, two recently published meta-analyses found no argument in favor of high oxygen concentrations when trials by Schietroma et al. were excluded.”

BUNDLE ELEMENT #6: HAIR REMOVAL
Summary of Recommendations: Hair Removal

1. Do not remove hair at the operative site unless the presence of hair will interfere with the operation. Do not use razors. They can cause micro abrasions leading to increased SSI

2. If hair removal is necessary, remove hair outside of the operating room and use clippers or a depilatory agent.

(Anderson et al., 2014; Ban et al., 2017; Mangram, Horan, Pearson, Silver, & Jarvis, 1999)
BUNDLE ELEMENT #7: OPERATING ROOM TRAFFIC
Bundle Element #7: OR Traffic Overview

- Personnel are main contributors to particles in the operating room air.\(^1\)

- In a study conducted by Teter et al. (2017): \(^2\)
  - 13.4 door openings per hour during cases
  - Total of 660 air measurements were obtained
  - Overall air particulate counts increased 13% when the door was open. Larger particles that correlated to bacterial size were elevated significantly during door opening (P<.001).

(Qadan, Akca, Mahid, Hornung, & Polk, 2009; Teter et al., 2017)
OR Traffic Overview

- Research linking a specific culture of airborne bacteria to SSIs is lacking. Current studies have shown airborne bacteria is related to an increase in OR traffic but not necessarily to SSIs.

- After controlling for duration of surgery, there was a strong correlation between the total CFU/m$^3$ of bacteria and OR traffic flow - Alizo, Onayemi, Sciarretta, & Davis, 2019 and Andersson, Bergh, Karlsson, Eriksson, & Nilsson, 2012

<table>
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<th>Variables</th>
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<th>Mean (SD)</th>
<th>95% CI for mean</th>
<th>Median (range)</th>
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<td>CFU/m$^3$</td>
<td>91 (1)$^*$</td>
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<tr>
<td>Total CFU/m$^3$ per operation</td>
<td>24$^1$</td>
<td>60.4 (55.9)</td>
<td>36.8-84</td>
<td>33.5 (7-187)</td>
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<td>Number of people</td>
<td>111 (9)$^1$</td>
<td>5.4 (1)</td>
<td>5.2-5.6</td>
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<tr>
<td>Traffic flow rate</td>
<td>119 (1)$^1$</td>
<td>4.3 (2.9)</td>
<td>3.8-4.8</td>
<td>4 (0-14)</td>
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<tr>
<td>Traffic flow rate per operation</td>
<td>30$^1$</td>
<td>17.4 (13.5)</td>
<td>12.4-22.4</td>
<td>14 (0-67)</td>
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<td>Duration of surgery, minutes</td>
<td>29 (1)$^3$</td>
<td>83.5 (39.7)</td>
<td>68.4-98.5</td>
<td>60 (20-200)</td>
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</tbody>
</table>

$^*$Number of air samples.
$^1$Number of operations.
$^2$Measured in 20-minute intervals.
$^3$From incision time to end of closure in minutes.
BUNDLE ELEMENT #8: SKIN PREP
Summary of Recommendations: Surgical Prep

1. Alcohol based prep should be used unless contraindicated
   - Avoid for procedures where prep may pool and not dry (fire risk!)
   - Contraindicated for use in mucosa, cornea, or ear

2. CHG scrub is superior to iodine based prep when alcohol preparations are contraindicated.

3. Implementing a standardized surgical prep protocol that includes the use of CHG wipes preoperatively significantly reduces the incidence of infection.

4. Sterile iodine should be used when prepping open surgical wounds
Overall Summary of Recommendations

- Surgical Site Infections are a complex problem requiring a multi-modal approach.
- Anesthesia providers play an integral role in reducing the risk of SSIs.
- Measure and provide feedback to providers regarding rates of compliance with process measures and SSI outcome data?
- Specific recommendations are outlined on the next few slides and are categorized by phase of care;
- For access to the SSI toolkit, please visit our website: https://mpog.org/quality/toolkits/
Preoperative Recommendations: Prior to Surgery

- Provide patient education regarding smoking cessation & consider nutrition and exercise counseling, specifically in patients with BMI>30
- Check albumin, HgbA1c as part of lab panel
  - If HgbA1C is greater than or equal to 6.5, consider surgical risk and create glycemic control plan
- MRSA screening, as indicated
- Check baseline glucose in all patients who are diabetic or at risk of stress hyperglycemia
Intraoperative Recommendations

• Begin antibiotic administration within 1 hour before incision (within 2 hours for vancomycin and fluoroquinolones). Account for weight.

• Redose based on antibiotic selection, duration of surgery, and kidney function

• Apply active warming to maintain core body temperature of 36.0 degrees Celsius for all patient undergoing general anesthesia

• Body temperature should be monitored in most patients undergoing general anesthesia exceeding 30 minutes in duration and in all patients whose surgery lasts longer than one hour.
Intraoperative Recommendations

- Aim for blood glucose levels <180 to 200 mg/dL throughout the perioperative period for patients with and without diabetes
- Adopt and implement a standardized fluid management protocol for surgical patients
Remember, Junior, say no to drugs.
References


References


References


References


