



Quality Improvement Study

Forced air contamination risk in the OR[☆]

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ABSTRACT

Introduction: Forced-air warming (FAW) is a commonly used method of patient warming to reduce perioperative hypothermia and minimize associated surgical complications.

Objectives: The primary objective of this study was to demonstrate even when properly managed, FAW units may contribute to greater environmental bacterial load and infection risk.

Methods: A study conducted in 2018 revealed that FAW contamination occurs more than expected in the surgical environment. The study demonstrated that 42.5 percent of the 320 samples collected were higher than the minimum accepted pathogen levels.

Results: The present study provided a retrospective-research correlation between samples collected in the 2018 analysis, along with evidence of any associated Surgical Site Infections (SSIs).

Conclusion: In a retrospective study of these cases, 3.4 percent of OB/GYN, 5.6 percent of colon cases, 1.4 percent of GI cases, and 5.3 percent of amputation cases developed an SSI. The results indicate that when FAW is in use, the risk for SSI is present.

1. Background

According to recently published information, the Centers for Disease Control (CDC) has estimated that in 2014, a total of 14.2 million operative procedures were performed in the inpatient setting in United States hospitals [1]. The CDC healthcare-associated infection (HAI) prevalence survey established that there were an estimated 110,800 surgical site infections (SSIs) associated with inpatient surgeries in 2015 [2]. Based on the 2019 HAI data results published in the National Healthcare Safety Network's (NHSN's) HAI Progress Report, about a 7 percent decrease in the standardized infection ratio (SIR) related to all NHSN operative procedure categories combined was reported between 2015 and 2019 [3].

Although advances have been made in infection-prevention efforts, including sterilization methods, barriers, surgical techniques, antimicrobial prophylaxis, and improved operating room ventilation, SSIs remain a substantial cause of morbidity, prolonged hospitalization, and death. SSI is associated with a mortality rate of 3 percent, and 75 percent of SSI associated deaths are directly attributable to the SSI [4]. SSI is the most costly HAI type with an estimated annual cost of \$3.3 billion, and is associated with nearly 1 million additional inpatient days annually [5, 6].

Forced-air warming (FAW) devices— among the most commonly

used warming devices in operating theaters—introduce bacteria into the surgical environment, increase possible contamination risk, and raise the possibility of attributable SSI. Although some reviews on the subject are inconclusive, a number of studies have focused on surface-component contamination and tissue-air risk connection. This clinical investigation was designed to identify any correlation between FAW bacteria and consequential SSI risk.

2. Methodology

A retrospective chart review was conducted on all medical records of patients who had been associated with surgical cases during the 2018 study. The cases procedures were reviewed in accordance with the established NHSN definition of the operative procedure. All procedures included a review of cases for the identification of superficial incisional, deep incisional, and organ/space SSI events.

2.1. Case review methodology

SSI monitoring requires active, patient-based, and prospective surveillance. Concurrent and post-discharge surveillance methods were used to detect SSI in the cases represented in the 2018 study. This included inpatient operative procedures as well as post-discharge

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surveillance for outpatient operative procedures.

Record-review methodology methods included review of medical records, admission, readmission, emergency department, operating room logs, and patient charts for signs and symptoms of SSI. Acceptable documentation included patient-reported signs or symptoms within the SSI surveillance period, as documented in the medical records by a healthcare provider. Further criteria were validated utilizing laboratory studies, imaging, other diagnostic test reports, and ICD-10-CM Infection Diagnosis Codes.

For those patients who did not have a documented case of infection during hospitalization (if inpatient), the surgeon was contacted by telephone to ask if the patient’s follow-up post-surgical office visit had proven any evidence of postoperative infection.

For an SSI, the date of event was the date when the first element used to meet the SSI infection criterion occurred for the first time during the SSI surveillance period. The date of the event must fall within the SSI surveillance period to meet SSI criteria. The type of SSI (superficial incisional, deep incisional, or organ/space) reported and the date of the event assigned must reflect the deepest tissue level where SSI criteria are met during the surveillance period. Synonyms: infection date.

All elements required to meet an SSI criterion usually occur within a 7–10 day timeframe with no more than 2–3 days between elements. The elements must be relational to each other, meaning that all elements are associated with the SSI, and this can only happen if elements occur in a relatively tight timeframe. Each case differs based on the individual elements that occur and the type of SSI.

Organisms excluded from meeting SSI criteria include well-known community-associated organisms (organisms belonging to the genera *Blastomyces*, *Histoplasma*, *Coccidioides*, *Paracoccidioides*, *Cryptococcus*, and *Pneumocystis*) and/or organisms associated with latent infections (e.g., herpes, shingles, syphilis, or tuberculosis).

Methods for attributing SSI to an NHSN operative procedure when there is evidence of infection at the time of the primary surgery include the items discussed herein. The definition of POA does not apply to the SSI protocol. If evidence of infection was present at the time of the procedure and the patient met the SSI criteria within the SSI surveillance period following the procedure, an SSI was attributed to the procedure. Infection present at the time of surgery (PATOS): PATOS is a YES/NO field on the SSI event form. PATOS denotes evidence of infection visualized (seen) during the surgical procedure to which the SSI is attributed. Evidence of infection must be noted intraoperatively and documented within the narrative portion of the operative note or report of surgery. The patient does not have to meet the NHSN definition of an SSI at the time of the procedure, but there must be documentation that there is evidence of infection present at the time of surgery.

3. Results

Based on findings documented in the 2018 study, the primary prevalent pathogens isolated were *Staphylococcus epidermidis*, a gram-positive, coagulase-negative cocci, an “opportunistic” pathogen. Other pathogens that followed in frequency included 10.0 percent *Staphylococcus aureus* and 9.0 percent *Staphylococcus pyogenes*, followed by 5.0 percent of *Micrococcus spp.*, and 3.0 percent each of *Corynebacterium spp.* and *Propionibacterium spp.* (Fig. 1) (see Fig. 3) (see Fig. 2).

A retrospective review of the said FAW-positive samples, as correlated with an intense review of medical records, indicated that four (4) of the 320 specimens collected in the 2018 FAW study demonstrated a correlation in SSI. Three (3) of the four (4) cases involved superficial *Staphylococcus epidermidis* infection, along with one (1) case of *Corynebacterium spp.* superficial SSI. This provides an overall rate of FAW-attributable infection rate of 1.3%. In a retrospective study of these cases, 3.4 percent of OB/GYN, 5.6 percent of colon cases, 1.4 percent of GI cases, and 5.3 percent of amputation cases developed an SSI. Where FAW is in use, SSI risk is present (see Table 1).

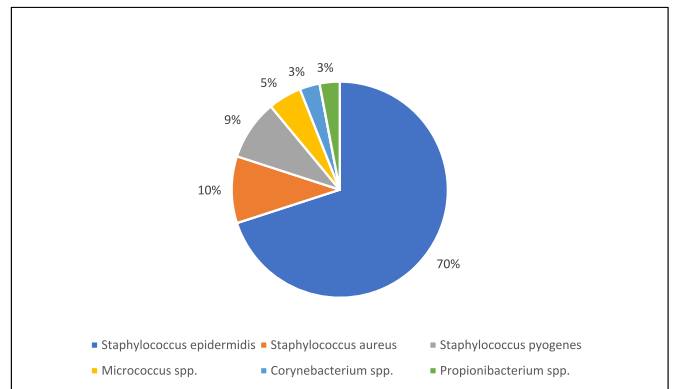


Fig. 1. Prevalent pathogens (percent, %).

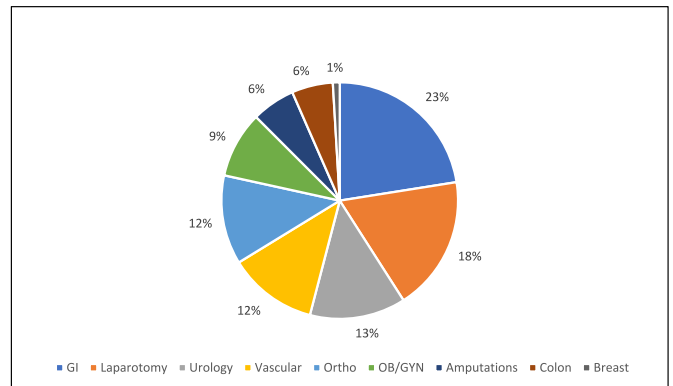


Fig. 2. Samples by case (percent, %).

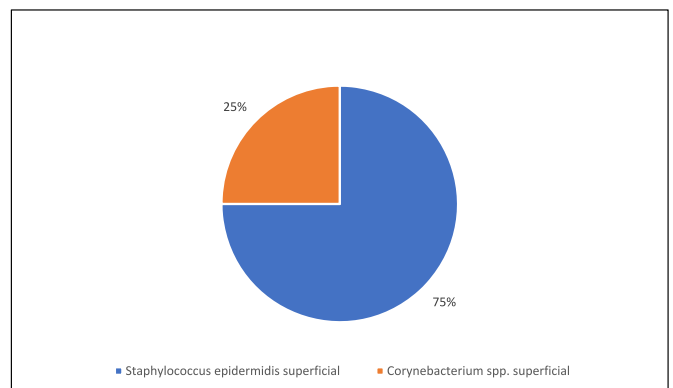


Fig. 3. Pathogens by case (percent, %).

Table 1

Cases, samples, and SSI by surgery.

Surgery Type	Sample Number	SSI Number (Type)	SSI Surgery-Type Detail
GI	72	1 (Coryne)	Small Bowel Surgery
Laparotomy	59		
Urology	42		
Vascular	39		
Ortho	39		
OB/GYN	29	1 (Staph)	Abdominal Hysterectomy
Amputation	19	1 (Staph)	Foot Amputation
Colon	18	1 (Staph)	Colon Surgery
Breast	3		

4. Conclusion

FAW device-component contamination is a real risk in the OR. Cross-contamination of the environment is a risk factor. As hypothesized in the 2018 FAW study, a reduction in surface and airborne colony-forming units may positively reduce infection risk. Based on the correlation between pathogen and SSI risk, it has been determined that infection risk may be eliminated through the use of alternate patient-warming technologies/techniques.

Ethical approval

Although this study was a retrospective chart review, the study was approved by the Ethics Committee of AHMC Healthcare.

Ethics statement

The study was approved by the Ethics Committee of AHMC Healthcare.

Sources of funding

Nothing to declare.

Author contribution

Victor R. Lange, author.

Registration of research studies

- 1.Name of the registry:
- 2.Unique Identifying number or registration ID:
- 3.Hyperlink to your specific registration (must be publicly accessible and will be checked):

Guarantor

Victor R. Lange.

Consent

Nothing to declare – No consent required.

Data access statement

All relevant data are within the paper and its Supporting Information files.

Declaration of competing interest

The author declares no competing interests.

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