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An Evaluation of Surgical Site Infections by Wound Classification System Using the ACS-NSQIP

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Background. **Surgical wound classification has been the foundation for infectious risk assessment, perioperative protocol development, and surgical decision-making. The wound classification system categorizes all surgeries into: clean, clean/contaminated, contaminated, and dirty, with estimated postoperative rates of surgical site infection (SSI) being 1%–5%, 3%–11%, 10%–17%, and over 27%, respectively. The present study evaluates the associated rates of the SSI by wound classification using a large risk adjusted surgical patient database.**

Methods. **A cross-sectional study was performed using the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) dataset between 2005 and 2008. All surgical cases that specified a wound class were included in our analysis. Patient demographics, hospital length of stay, preoperative risk factors, co-morbidities, and complication rates were compared across the different wound class categories. Surgical site infection rates for superficial, deep incisional, and organ/space infections were analyzed among the four wound classifications using multivariate logistic regression.**

Results. **A total of 634,426 cases were analyzed. From this sample, 49.7% were classified as clean, 35.0% clean/contaminated, 8.56% contaminated, and 6.7% dirty. When stratifying by wound classification, the clean, clean/contaminated, contaminated, and dirty wound classifications had superficial SSI rates of 1.76%, 3.94%, 4.75%, and 5.16%, respectively. The rates of deep incisional infections were 0.54%, 0.86%, 1.31%, and 2.1%. The rates for organ/space infection were 0.28%, 1.87%, 2.55%, and 4.54%.**

Conclusion. **Using ACS-NSQIP data, the present study demonstrates substantially lower rates of surgical site infections in the contaminated and dirty wound classifications than previously reported in the literature.**

Key Words: **wound classification; surgical site infection; National Surgical Quality Improvement Program; surgical outcomes.**

INTRODUCTION

Surgical wound classification, introduced by the National Academy of Sciences in 1964, has been the foundation for infectious risk assessment, perioperative protocol development, and surgical decision-making. The classification system classifies all surgeries into four categories: clean, clean/contaminated, contaminated, and dirty based on the bacterial load of the surgical wound [1, 2]. In 1970, the National Nosocomial Infectious Surveillance Survey was conducted to identify factors that played a role in postoperative wound infections [3], which led to the 1985 Center for Disease Control's (CDC) guidelines for preventions of postoperative wound infection [4]. The guidelines provided updated estimated postoperative rates of surgical site infections to 1%–5% for clean, 3%–11% for clean/contaminated, 10%–17% for contaminated, and over 27% for dirty [5, 6].

The wound classification system is an important predictor of postoperative outcomes. Recent studies have focused on elements such as preoperative risk factors and co-morbidities, operative time, prophylactic antibiotic use, and the American Society of Anesthesiology

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(ASA) physical status score, along with wound classification to predict postoperative surgical outcomes [5]. Currently, national efforts such as the Medicare guidelines on antibiotic prophylaxis that specify when the antibiotic infusion should begin and end have contributed to decreased rates of SSIs [7, 8]. Appropriate use of antibiotic prophylaxis in surgical patients was one of 11 practices rated by the Agency for Healthcare Research and Quality (AHRQ) to be strongly supported by evidence-based studies [9]. Initiatives by the AHRQ and programs like the American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP) have elevated quality of care to the forefront of national healthcare concerns and have spurred the need to evaluate current systems to consider the changes in healthcare. The ACS-NSQIP database provides a tool to assess surgical outcomes drawing from the records of hundreds of hospitals. The present study evaluates the rates of postoperative surgical site infection (SSI) by wound classification using the ACS-NSQIP, a large risk-adjusted surgical patient database.

METHODS

A retrospective analysis was performed using the ACS-NSQIP dataset between 2005 and 2008. All surgical cases that specified a wound class were included in our analysis. Patients who died on the same day of operation were excluded. Patients were stratified by wound classification (clean, clean/contaminated, contaminated, and dirty) as defined by ACS-NSQIP (Table 1). Patient demographics, hospital length of stay, preoperative risk factors, co-morbidities, and complication rates were compared across the different wound class categories. Surgical site infection was the primary outcome of the study. Surgical site infection rates for superficial, deep incisional, and organ/space infections were analyzed among the four wound classifications using χ^2 test.

An SSI, as defined by ACS-NSQIP, is an infection that occurs within 30 d after the operation and requires at least one of the following: purulent drainage from the superficial incision; organisms isolated from an aseptically obtained culture of fluid or tissue from the incision; at least one of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness, or heat, or fever (>8°C) in the case of deep incisional or organ/space SSIs. The depth and location of the wound designates the type of SSI. Superficial SSIs are infections involving only skin or subcutaneous tissue of the incision, deep incisional SSIs are infections involving the deep soft tissues (e.g., fascial and muscle layers) of the incision, and organ/space SSI are infections involving any part of the anatomy (e.g., organs or spaces), other than the incision, which was opened or manipulated during an operation [10]. Our study focused on superficial, deep incisional, and organ/space SSI as the wound classification system is based on the bacterial load of the wound. The SSI categories used by ACS-NSQIP correspond with those defined by the CDC in 1992 in their revision of surgical wound infections [11].

Multivariate logistic regression analysis was conducted, adjusting for gender, age category, ethnicity, preoperative risk factors, and co-morbidities (body mass index $\geq$ 35, smoking, type II diabetes mellitus, history of chronic obstructive pulmonary disease, end stage renal disease, steroid usage, transfusion within 72 h of operation, hypoalbuminenia, chemotherapy or radiation treatment, intraoperative transfusion, ASA score, and emergency operation). Statistical analysis was done using Stata ver. 11.0 (College Station, TX).

RESULTS

A total of 634,426 cases were analyzed. From this sample, 49.7% of wounds were classified as clean, 35.0% as clean/contaminated, 8.6% as contaminated, and 6.7% as dirty. Most patients were female (57.4%) and over the age of 60 (40.8%) y. The mean age for all patients was 54.7 y. Regarding ethnicity, White patients were the most common (71.7%), followed by Black (9.8%), and Hispanic (6.0%). The most common co-morbidity examined was obesity (defined as a body mass index $\geq$ 35, 27.8%), followed by type II diabetes mellitus (14.5%). The most common preoperative risk factor was smoking (27.8%), followed by hypoalbuminemia (6.2%). The overall mortality rate was 1.6%; the mean length of stay was 4.3 d; and 12.8% of the cases were emergent (Table 2).

The most common procedures for the clean wound class were: repair of a reducible inguinal hernia (8.7%); thromboendarterectomy (5.9%); and repair of initial incisional or ventral hernia (4.3%). Laparoscopic cholecystectomy (18.4%), laparoscopic gastric restrictive procedure (7.7%), and laparoscopic cholecystectomy with cholangiography (6.9%) were the most common procedures for the clean/contaminated wound class. Laparoscopic appendectomy (21.2%), laparoscopic cholecystectomy (14.2%), and open appendectomy (5.8%) were the most common procedures for the contaminated wound class. Laparoscopic appendectomy (11.4%), open appendectomy with abscess or generalized peritonitis (5.3%), partial colectomy with

TABLE 1

Surgical Wound Classifications as Defined by ACS-NSQIP*

Clean	These are uninfected operative wounds in which no inflammation is encountered and the respiratory, alimentary, genital, or uninfected urinary tracts are not entered.
Clean/contaminated	These are operative wounds in which the respiratory, alimentary, genital, or urinary tract is entered under controlled conditions and without unusual contamination.
Contaminated	These include open, fresh, accidental wounds, operations with major breaks in sterile technique or gross spillage from the gastrointestinal tract, and incisions in which acute, non-purulent inflammation is encountered.
Dirty	These include old traumatic wounds with retained devitalized tissue and those that involve existing clinical infection or perforated viscera.

*User Guide for the 2008 Participant Use Data File American College of Surgeons National Surgical Quality Improvement Program.