ORIGINAL CONTRIBUTION

Defining Surgical Site Infection in Colorectal Surgery: An Objective Analysis Using Serial Photographic Documentation

Traci L. Hedrick, M.D.[1] • Amy M. Harrigan, B.S., C.C.R.C.[1] • Robert G. Sawyer, M.D.[1,2]
Florence E. Turrentine, Ph.D., R.N.[1] • George J. Stukenborg, Ph.D., M.A.[1,2]
Bindu A. Umapathi, M.D.[1] • Charles M. Friel, M.D.[1]

1 Department of Surgery, University of Virginia, Charlottesville, Virginia
2 Department of Health Evaluation Sciences, University of Virginia, Charlottesville, Virginia

BACKGROUND: Surgical site infection is common following colorectal surgery, yet the incidence varies widely. CDC criteria include "diagnosis by attending physician," which can be subjective. Alternatively, the ASEPSIS score is an objective scoring system based on the presence of clinical findings.

OBJECTIVE: The aim of this study is to compare the interrater reliability of the ASEPSIS score vs CDC definitions in identifying surgical site infection.

DESIGN: This 24-month prospective study used serial photography of the wound. Three attending surgeons independently reviewed blinded photographic/clinical data.

SETTINGS: This study was conducted at an academic institution.

PATIENTS: Patients undergoing elective colorectal surgery were selected.

INTERVENTIONS: Surgeons assigned an ASEPSIS score and identified surgical site infection by using CDC definitions. The interrater reliability of ASEPSIS and the CDC criteria were compared by using the κ statistic. These data were also compared with the institutional National Surgical Quality Improvement Program database.

RESULTS: One hundred seventy-one patients were included. Four surgical site infections (2.4%) were identified by the National Surgical Quality Improvement Program. Data from the surgeons demonstrated significantly higher yet discrepant rates of infection by the CDC criteria, at 6.2%, 7.4%, and 14.1% with a κ of 0.55 indicating modest interrater agreement. Alternatively, the ASEPSIS assessments demonstrated excellent interrater agreement between surgeons with 96% agreement (2.4%, 2.4%, and 3.6%) and a κ of 0.83.

LIMITATIONS: This was a single-institution study.

CONCLUSIONS: This study demonstrates the relatively poor reliability of CDC definitions for surgical site infections in comparison with an objective scoring system. These findings could explain the wide variability in the literature and raise concern for the comparison of institutional surgical site infection rates as a quality indicator. Alternatively, an objective scoring system, like the ASEPSIS score, may yield more reliable measures for comparison.

KEYWORDS: Surgical site infection; ASEPSIS; Quality; Scoring system.

According to the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP), which uses the CDC definitions for the diagnosis of surgical site infections (SSIs), the national rate of SSI following elective colorectal surgery is 9%.[1] However, the incidence of SSI is almost uniformly greater than 15%

Funding/Support: This work was funded by the American Society of Colon and Rectal Surgeons (ASCRS) Research Foundation, Career Development Award.

Financial Disclosures: None reported.

Podium presentation at the meeting of the American Society of Colon and Rectal Surgeons, Boston MA, May 30 to June 3, 2015. It will be presented at the meeting of the European Society of Coloproctology, Dublin, Ireland, September 23 to 25, 2015.

Correspondence: Traci Hedrick, M.D., Assistant Professor of Surgery, University of Virginia Health System, PO BOX 800709, Charlottesville, VA 22908. E-mail: th8q@virginia.edu

Dis Colon Rectum 2015; 58: 1070–1077
DOI: 10.1097/DCR.0000000000000466

throughout the literature when prospective collection methods are used[2–4] and varies widely from 5% to 40%.[5,6] Understandably, there will be variability based on case mix and patient demographics. However, this discrepancy raises questions surrounding the difficulty in accurately defining SSI.

One of the key criteria in the CDC definition is "diagnosis by attending physician," leaving the attending surgeon as the final arbiter. Previously, we demonstrated poor reliability between attending surgeons in defining SSI using CDC criteria based on blinded chart review of the electronic medical record (EMR).[7] However, it was unclear whether the discrepancy related to differences in interpretation of documentation or true differences in clinical interpretation.

Alternatively, the ASEPSIS score is an objective wound-scoring system, previously described in cardiac surgery, based on the presence of specific clinical findings.[8] The ASEPSIS score has the advantage of being objective and is designed to relate the wound appearance to clinical consequences. In addition, it provides a quantitative analysis that can be used to grade the severity of the wound disturbance.

The aim of this prospective study is to evaluate the interrater reliability of the CDC definitions and the ASEPSIS score in identifying SSIs. We hypothesize that there will be poor interrater reliability between surgeons in defining SSI based on CDC definitions and that the ASEPSIS score will provide a more reliable and quantifiable mechanism for defining SSI in patients undergoing colorectal surgery.

MATERIALS AND METHODS

Study Design

A 24-month (November 29, 2012 to November 30, 2014) prospective observational study was undertaken at the University of Virginia under informed consent with permission to obtain and publish deidentified information including photographs of the wound (IRB # 16097). Adult patients (≥18 years) undergoing elective colorectal procedures by 1 of 2 colorectal surgeons were consented and prospectively followed by a clinical research coordinator. Emergent procedures, patients younger than 18, prisoners, pregnant women, and patients unable to provide consent were excluded.

Patients were identified in the outpatient clinic and approached for informed consent after the decision was made to proceed with surgery. The clinical research coordinator followed the patients and maintained a prospective database including digital photographic images of each patient's wound. The patient's wound was photographed every other day beginning after postoperative day 2 during his/her inpatient stay, and at any follow-up visits up to 30-days or until wound healing. Clinical data, such as whether or not the wound had been opened, the presence of drainage, and treatment with antibiotics, were collected independently from what was documented in the EMR at each wound assessment.

Three surgeons reviewed the prospectively gathered data (complete with photographs) individually and independently. All identifying information was removed so the reviewers were completely blinded. Reviewers classified each wound with the use of CDC definitions for SSI. Reviewers also assigned an ASEPSIS score to each wound assessment to generate a cumulative 30-day ASEPSIS score.

Secondary clinical variables were collected including patient and procedure demographic variables, length of stay, 30-day readmission, and 30-day morbidity/mortality from the prospectively collected database and the institutional ACS NSQIP database. NSQIP data are abstracted on all procedures included in the colectomy and proctectomy modules in the Targeted Procedure Program.

CDC Definition of SSI

ACS NSQIP uses the CDC's National Nosocomial Infections Surveillance (NNIS) system,[9] which classifies SSIs into incision or organ/space. Incisional SSIs are further divided into those involving only skin and subcutaneous tissues (superficial SSI) and deeper softer tissues (deep SSI) (Table 1). According to the CDC, "NNIS definitions of SSIs have been applied consistently by surveillance and surgical personnel in many settings and currently are a de facto national standard." CDC definitions were reviewed with the surgeons before the review, and each case file was associated with a copy of the CDC definitions to aid during the review process. We did not include organ/space SSIs given their inherent difference from incisional SSIs.

ASEPSIS Score

The ASEPSIS score is calculated by assigning a score based on the presence of erythema, serous exudate, purulent exudate, and deep tissue separation according to the percentage of the wound affected by each process (Table 2). Additional points are awarded for antibiotic treatment, incision and drainage, isolation of bacteria from the wound, and an inpatient stay. The addition of home health for the purposes of wound care was added to the score as a modification to reflect current practice. A score greater than 20 defines a SSI. Scores are grouped into 4 categories (satisfactory (0–10), disturbance of healing (11–20), minor SSI (21–30), moderate SSI (31–40), severe SSI (>40)).

Analysis

The primary outcome of interest was the interrater reliability of the CDC definition of a superficial or deep SSI between the 3 surgeons and the institutional NSQIP database. A secondary outcome of the study was the interrater reliability of the ASEPSIS score in identifying SSI. Wound evaluations were compared between the 3 surgeons and NSQIP. Patient, procedure, and wound variables were evaluated in cases of disagreement to determine predictive factors of disagreement. In addition, because the

TABLE 1. CDC definition of deep and superficial surgical site infection

Superficial incisional SSI is an infection that occurs within 30 days after the operation and the infection involves only skin or subcutaneous tissue of the incision and at least one of the following:

- Purulent drainage, with or without laboratory confirmation, from the superficial incision.
- Organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision.
- At least one of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness, or heat AND superficial incision is deliberately opened by the surgeon, unless incision is culture negative.
- *Diagnosis of superficial incisional SSI by the surgeon or attending physician.*

Do not report the following conditions as SSI:

- Stitch abscess (minimal inflammation and discharge confined to the points of suture penetration).
- Infected burn wound.
- Incisional SSI that extends into the fascial and muscle layers (see deep incisional SSI).

Deep infection occurs within 30 days and the infection appears to be related to the operation and infection involved deep soft tissues (eg, fascial and muscle layers) of the incision and at least one of the following:

- Purulent drainage from the deep incision but not from the organ/space component of the surgical site.
- A deep incision spontaneously dehisces or is deliberately opened by a surgeon when the patient has at least one of the following signs or symptoms: fever (>38°C), localized pain, or tenderness, unless site is culture negative.
- An abscess or other evidence of infection involving the deep incision is found on direct examination, during reoperation, or by histopathologic or radiologic examination.
- *Diagnosis of a deep incision SSI by a surgeon or attending physician.*

Note:

- Infection that involves both superficial and deep incision sites is reported as deep incisional SSI.
- An organ/space SSI that drains through the incision is reported as a deep incisional SSI.

SSI = surgical site infection.

number of assessments was not uniform for each patient based on differences in the length of stay and frequency of follow-up visits, we evaluated this as a potential contributor to discordance. The χ^2 statistic and student *t* test were used to compare categorical and continuous variables.

The interrater reliability of the CDC definition of SSI was compared between the 3 surgeon reviewers and ACS NSQIP by using the weighted generalized κ statistic.[10] The surgeons also calculated a cumulative 30-day ASEPSIS score for each patient based on the clinical and photographic data collected at each wound assessment. The interrater reliability of the ASEPSIS score was also compared by using the weighted generalized κ statistic.

The κ statistic is a commonly used measure of the reliability of paired measures with nominal or ordinal scales. The Fleiss generalized weighted κ extends the statistic to multirater comparisons (3 or more raters) with scores for nominal or ordinal categories. Weights are included to adjust for differences in the scale of disagreement between ordinal scale values. The weighted generalized κ statistic measures how much

TABLE 2. ASEPSIS scoring system

	Proportion of wound affected (%)				
Wound characteristic	*<20*	*20–39*	*40–59*	*60–79*	*>80*
Serous exudate	1 pts	2 pts	3 pts	4 pts	5 pts
Erythema	1 pts	2 pts	3 pts	4 pts	5 pts
Purulent exudate	2 pts	4 pts	6 pts	8 pts	10 pts
Separation of deep tissues	2 pts	4 pts	6 pts	8 pts	10 pts
Additional points for:					
Antibiotics	10 pts				
Incision and drainage	5 pts				
Debridement of the wound	10 pts				
Isolation of bacteria	10 pts				
Inpatient stay >14 days	5 pts				
Need for home health[a]	5 pts				
Total points	*Category of infection*				
0–10	Satisfactory healing				
11–20	Disturbance of healing				
21–30	Minor wound infection				
31–40	Moderate wound infection				
>40	Severe wound infection				

Pts = points; SSI = surgical site infection.

[a]The addition of home health specific for wound care was added to the score as a modification to reflect current standards in practice that are commonly used for patients with SSI.

the level of agreement among raters exceeds the amount of agreement expected by chance alone. In general, κ statistic values of >0.7 indicate excellent interrater agreement.

A power analysis with continuity correction was performed based on the authors' previous study, which demonstrated an NSQIP institutional SSI rate of 8% and an average surgeon SSI rate of 25% among the same 3 surgeon reviewers. The power analysis indicated that a total sample of 170 would be needed to detect a difference from 25% to 8% in the incidence of SSI with 80% power with α at 0.05.

RESULTS

One hundred ninety-two patients were consented during the study period. Twenty-one patients were excluded from analysis, leaving 171 patients in the final analysis: 1 patient was lost to follow-up, 1 patient died in the immediate postoperative period, 2 patients withdrew consent before surgery, 6 patients were consented but did not undergo surgery, and 11 patients were not captured by NSQIP. The complete demographic data for the final study population are presented in Table 3.

TABLE 3. Demographic data of patients undergoing elective colorectal surgery

Age, y	59.5 ± 6.7
Sex, % male	82 (48.0)
Diagnosis	
Malignancy	100 (58.5)
IBD	34 (19.9)
Diverticular disease	35 (20.5)
Other	
BMI	29.0 ± 7.5
Diabetes mellitus	21 (12.3)
Steroids	21 (12.3)
Smoker	28 (16.4)
Chronic renal insufficiency	11 (6.4)
Bowel preparation (PEG + oral antibiotics)	150 (87.7)
ASA classification	
1	1 (0.6)
2	79 (46.2)
3	86 (50.3)
4	5 (2.9)
Wound classification	
Clean-contaminated	148 (86.5)
Contaminated	18 (10.5)
Dirty	5 (2.9)
Procedure (CPT code)	
Hartman reversal (44626)	13 (7.6)
Partial colectomy (44140)	22 (12.9)
Low anterior resection (44145, 44146)	45 (26.3)
Laparoscopic low anterior resection	30 (17.6)
Total proctocolectomy (44158, 44155)	4 (2.4)
Laparoscopic partial colectomy (44204)	33(19.4)
Abdominoperineal resection (45110, 45126)	8 (4.7)
Rectal surgery	92 (53.8)
Laparoscopy	73 (42.7)
Ostomy	68 (39.8)
Operative time	224.0 ± 99.3

Values shown are n (%), unless otherwise stated.
CPT = Current Procedural Terminology; PEG = polyethylene glycol.

CDC Definition

NSQIP identified 3 patients with a superficial SSI (1.8%) and 1 patient with a deep SSI (0.6%) in the study group. Data from the 3 surgeons demonstrated significantly higher ($p < 0.001$) rates of SSI by CDC criteria in comparison with the institutional NSQIP database. In addition, the rates of SSI were significantly different between each of the 3 surgeon reviewers at 6.2% (3.7% superficial, 2.5% deep), 7.4% (7.4% superficial), and 14.1% (9.2% superficial, 4.9% deep) ($p < 0.001$). There was 91.2% agreement between the 3 surgeon reviewers and NSQIP with a κ of 0.55 indicating relatively poor interrater agreement.

Table 4 represents a detailed outline of cases with an SSI identified by at least 1 reviewer. The data presented in the table were collected from the prospectively maintained database independent of what was documented in the EMR. The next to last column in the table describes what was actually documented in the EMR. All 3 surgeons agreed there was a SSI in 3 NSQIP-identified superficial SSIs; however, 2 of these SSIs were classified as deep by at least 1 of the surgeons. None of the surgeons identified a SSI in the patient identified as having a deep SSI by NSQIP (case D). This patient developed diffuse erythema around each laparoscopic site prompting evaluation by the treating surgeon. A CT scan revealed fat stranding in the subcutaneous tissue but no fluid collection. The surgeon documented the findings were not consistent with an SSI. The patient's primary care physician subsequently placed the patient on antibiotics, and a deep SSI was identified by NSQIP. The patient's wounds at the time of evaluation are depicted in Figure 1.

Six patients not identified by NSQIP as having a SSI were identified by all 3 of the surgeons independently as having a SSI (Table 4, cases E–J). In each case, the wound had been deliberately opened. The wound of patient J is seen in Figure 2. On postoperative day 9, this patient was ordered to receive antibiotics for "cellulitis versus wound infection," which was charted in the EMR, and staples were removed from the wound. The following day the physician note states "no purulent drainage, erythema has improved slightly since staples were removed." The patient remained in the hospital for several more days where documentation only states "wound open and packed." The photograph in Figure 2 was taken the day before discharge. Ten additional superficial SSIs were identified by surgeon 3, but not by the other 2 surgeons. Each of these patients had either erythema or was placed on antibiotics by their primary care physician. Surgeon 3 captured 1 additional deep SSI that was not identified by the other 2 surgeons or NSQIP. This patient presented with bleeding from the midline wound.

Table 4. Case details for patients with an incisional SSI identified by at least 1 reviewer

Case	*NSQIP*	*Surg. 1*	*Surg. 2*	*Surg. 3*	*Purulent drainage*	*Erythema*	*I & D*	*Antibiotics*	*Documentation in medical record*	*Average ASEPSIS*
A	Super	Super	Super	Super	Yes	Yes	Yes	None	"Port site with erythema requiring incision and drainage, purulent drainage"	6
B	Super	Super	Super	Deep	Yes	Yes	Yes	Surgeon	"Small area at midline wound, foul smelling drainage, opened"	16
C	Super	Deep	Super	Deep	Yes	Yes	Yes	Surgeon	"Small area opened in midline wound"	36
D	Deep	None	None	None	None	Yes	No	PCP	"Diffuse erythema around all port site wounds, not consistent with SSI"	3
E	None	Super	Super	Super	Yes	Yes	Yes	None	"Small area opened, foul smelling drainage"	22
F	None	Super	Super	Deep	Yes	Yes	Yes	None	" Redness and drainage, incision opened, purulent drainage"	10
G	None	Super	Super	Deep	Yes	Yes	Yes	Surgeon	Anastomotic leak, wound closed via delayed primary closure, subsequently "wound opened and packed for drainage and erythema" (classified as organ space SSI in NSQIP)	11
H	None	Deep	Super	Super	Yes	Yes	Yes	None	"Drainage from midline wound, wound infection vs dehiscence"	12
I	None	Deep	Super	Deep	Yes	Yes	Yes	Surgeon	"Incision opened, hematoma evacuated", culture with *Enterococcus faecalis*	38
J	None	Deep	Super	Deep	Yes	Yes	Yes	Surgeon	"Cellulitis vs wound infection; staples removed, no purulent drainage, erythema improved slightly"(Fig. 2)	36
K	None	None	None	Super	None	Yes	Yes	None	"Wound healing well"	1
L	None	None	None	Super	None	Yes	None	None	Wound not commented on	4
M	None	None	None	Super	None	Yes	None	None	"Wounds healed"	2
N	None	None	None	Super	None	Yes	None	None	Erythema	6
O	None	None	None	Super	None	Yes	None	PCP	"PCP placed on antibiotics, wound looks fine"	7
P	None	None	None	Super	None	Yes	None	None	"Erythema and mild drainage"	3
Q	None	None	None	Super	None	Yes	None	PCP	"PCP placed on antibiotics"	11
R	None	None	None	Super	None	Yes	None	None	"Wound with mild drainage"	13
S	None	None	None	Super	None	Yes	None	None	"No issue with wound"	13
T	None	None	None	Super	None	Yes	None	None	"Mild redness"	13
U	None	None	None	Deep	None	None	Yes	None	"Wound opened and a hematoma drained"	14

NSQIP = National Surgical Quality Improvement Program; `Surg. = surgeon; Super = superficial; PCP = primary care physician; SSI = surgical site infection..

According to the progress notes, the wound was "opened at the bedside and hematoma evacuated from the wound."

In total, there was only 1 case in which all 3 surgeons and NSQIP fully agreed with regard to the CDC definition and only 2 additional situations where all 3 surgeons fully agreed with 1 another. Documentation was generally thought to account for the lower rate of SSI identified in NSQIP.

Table 5 demonstrates comparisons of patient, procedure, and wound factors in patients with SSI disagreement. In addition to the difference in wound factors, BMI was the only patient factor associated with disagreement. Patients with disagreement have statistically higher BMIs than those without disagreement. The number of assessments did not predict disagreement.

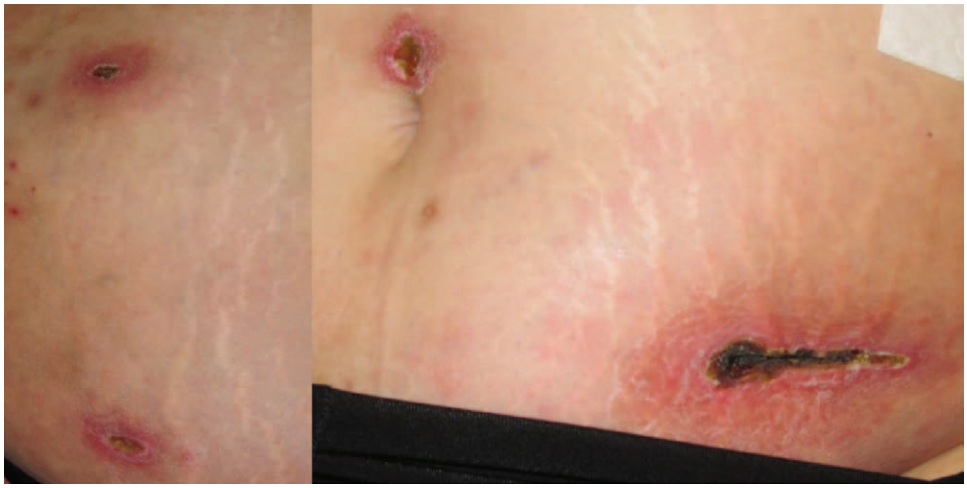

FIGURE 1. Photograph demonstrating an example of disagreement between NSQIP and the surgeon reviewers in the presence of an incisional SSI. None of the surgeons identified an SSI in this patient, who was identified as having a deep SSI by NSQIP. NSQIP = National Surgical Quality Improvement Program; SSI = surgical site infection.

ASEPSIS Criteria

The breakdown of ASEPSIS scores for each reviewer is seen in Figure 3. There was 95.7% agreement with ASEPSIS between the 3 surgeons with a κ of 0.83 indicating excellent interrater agreement. Four patients had scores greater than 20 (indicative of a SSI by ASEPSIS criteria) from all 3 surgeons. The average ASEPSIS score for these 4 patients was 33.0. Each of these patients was determined to have an SSI by the use of CDC criteria by the surgeon reviewers but only one by NSQIP. Of note, the average ASEPSIS score for the 4 patients identified as having an SSI by NSQIP was 15. Two additional patients received a score greater than 20 by 1 surgeon: 1 patient was thought to have an SSI by CDC criteria by 2 surgeons, and the other was thought to have an SSI by CDC criteria by 1 surgeon alone. The average ASEPSIS score of the 3 surgeons for each patient is depicted in the last column of Table 4.

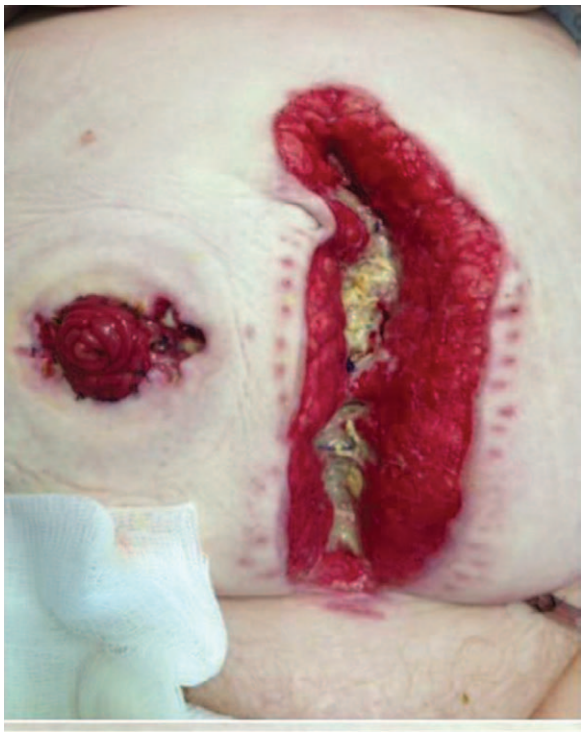

FIGURE 2. Photograph demonstrating an example of disagreement between NSQIP and the surgeon reviewers in the presence of an incisional SSI. This patient was identified as having an incisional SSI by all 3 of the surgeons independently but not by NSQIP. NSQIP = National Surgical Quality Improvement Program; SSI = surgical site infection.

DISCUSSION

The current study demonstrates relatively poor interrater reliability among 3 attending surgeons in identifying SSI according to CDC criteria, particularly in patients with obesity. Compared with our previous study, which relied on documentation in the EMR, the addition of photographic data in the current study indicates that these surgeons, despite looking at the same wound, could not reliably agree on the presence of an SSI.

Clinical Implications

The potential discrepancy in accurately defining SSI has significant implications. These findings could explain the wide variability reported in the literature with regard to SSI following colorectal surgery. However, it also highlights the limitations inherent to using institutional SSI rates as a reliable marker of quality. Increasingly, deep and organ space SSIs to a greater extent than superficial SSIs following colorectal surgery are tied to quality. Centers for Medicare & Medicaid Services requires hospitals to report deep and organ space SSIs after colon surgery through the National Healthcare Safety Network. In addition, the rate of SSI following colectomy for each institution is now available on the Hospital Compare Web site. Ju et al[6] investigated the discrepancies in

Table 5. Patient, procedure, and wound variables in patients with reviewer disagreement for the presence of an incisional SSI

	Agreement (n = 151)	*Disagreement (n = 20)*	*p*
Patient characteristics			
Sex, male, %	47.6	50.0	N/S
Diagnosis, malignancy, %	57.6	60.0	N/S
BMI	28.15 ± 7.08	33.99 ± 8.12	0.0008
Diabetes mellitus, %	11.9	15.0	N/S
Steroids, %	11.9	15.0	N/S
Smoker, %	15.9	20.0	N/S
Race, white, %	89.4	90.0	N/S
Procedure characteristics, %			
Bowel preparation	88.1	85.0	N/S
Wound classification, clean-contaminated	86.1	90.0	N/S
Rectal surgery	56.3	40.0	N/S
Laparoscopy	41.7	50.0	N/S
Ostomy	41.7	30.0	N/S
Surgeon	40.4	52.0	N/S
Wound characteristics, %			
Serous drainage	13.9	30.0	<0.0001
Erythema	15.9	55.0	<0.0001
Purulent drainage	0.0	30.0	<0.0001
Separation deep tissue	0.0	30.0	<0.0001
Incision and drainage of wound	0.7	35.0	<0.0001
Home health	0.0	25.0	<0.0001

N/S = not significant; SSI = surgical site infection.

SSI rates between National Healthcare Safety Network and ACS NSQIP in 16 participating hospitals and demonstrated discordant rates of SSI between the 2 surveillance methodologies. Improved methods for defining SSI should be sought after and implemented if these data are made publicly available and tied to performance measures.

ACS NSQIP is among the most reliable surgical outcomes database. Shiloach et al[11] and Davis et al[12] demonstrated greater than 95% and 98% interrater agreement between auditors and clinical reviewers who are trained in data collection. However, this was based on reviews of what was documented in the EMR. Unlike a urinary tract infection or deep vein thrombosis, where the definition is based on objective data, SSI is based entirely on the physical examination findings documented in the EMR. Therefore, SSI is particularly vulnerable to omissions in documentation. This was clearly demonstrated in our study, because the majority of omissions by NSQIP were due to the lack of clear documentation leading to a very low rate of SSI in the NSQIP database. As a result, institutions that provide detailed documentation of the wounds may actually have higher rates of SSI than other centers where the documentation is less robust. This type of bias cannot be quantified or controlled for between institutions and may, in fact, provide a disincentive for accurate documentation.

Alternatively, an objective scoring system, such as the ASEPSIS score, which allows for objective stratification of the wound may prove more useful in overcoming the subjective interpretation of the physical examination findings inherent in defining SSI. A study undertaken in Turkey of patients undergoing elective or emergency colorectal surgery performed surveillance of the surgical wound with the ASEPSIS method. The authors found that 47.7% of all wounds developed some delay in healing. However, 17.6% met criteria for an SSI by using an ASEPSIS score greater than 20 points indicative of infection. (Abstract presented at

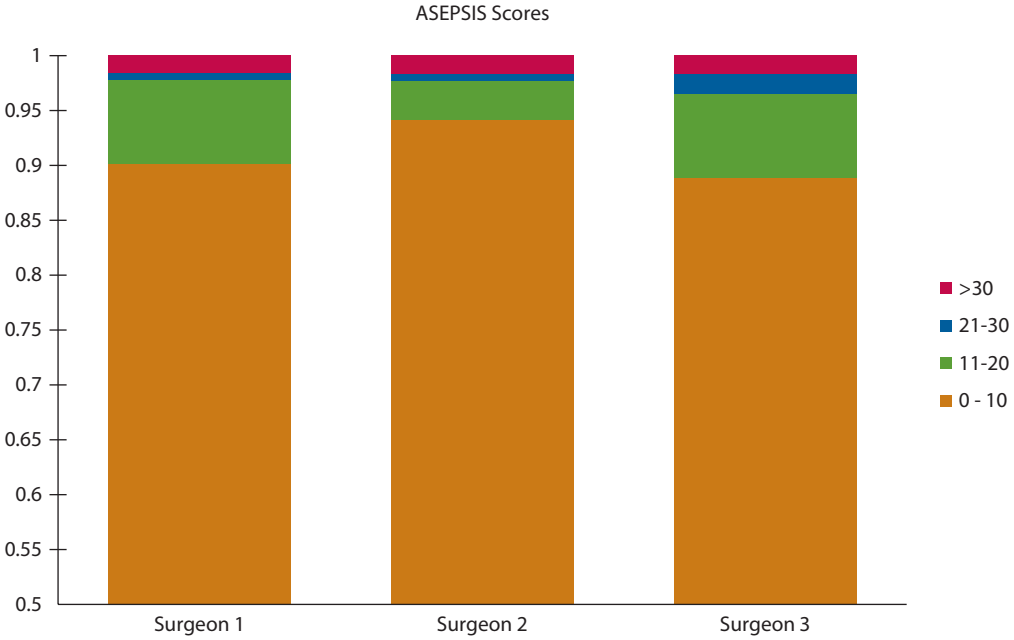

FIGURE 3. This figure demonstrates the breakdown of ASEPSIS scores for each surgeon reviewer. Surgeon 1 (90.2% no wound issues, 7.6% minor wound issue, 0.6% minor wound infection, 1.8% major wound infection); Surgeon 2 (94.2% no issue, 3.5% minor wound issue, 0.6% minor wound infection, 1.8% major wound infection); Surgeon 3 (88.9% no issue, 7.6% minor wound issue, 1.8% minor wound infection, 1.8% major wound infection).

18th World Congress of the International Associated of Surgeons and Gastroenterologists, October 2008.) Therefore, it is possible that an objective scoring system, much like the ASEPSIS score, may improve documentation by providing a template that could be incorporated into the EMR.

Strengths and Limitations

The primary strength of the current study is that, to the authors' knowledge, this is the only known prospective blinded evaluation addressing the identification of SSI using photographic data in patients undergoing colorectal surgery. However, we are limited in that this was a single-institution study involving 3 surgeons, and further validation is needed. In addition, the ASEPSIS score itself, although seemingly less vulnerable to subjective interpretation, is not an ideal clinical tool. It includes variables that may be superfluous such as the presence of serous exudate and the use of antibiotics, which in our study were prescribed liberally. It only takes into account the percentage of the affected wound rather than the length of the incision, which is important in laparoscopy. A SSI involving a 1-cm port site that must be opened incurs much less morbidity than a 20-cm midline laparotomy wound.

A further limitation that became apparent during the study is that the ASEPSIS score is cumbersome to collect and may not be clinically viable unless modified for simplicity. Ultimately, the morbidity incurred by the development of an SSI is in the care and the long-term implications of an open wound. Unfortunately, an unintended consequence of the focus on SSI has been that wounds considered "high risk" are now deliberately left open by many surgeons to "prevent" SSI, leaving the patient with the very outcome we are trying to prevent. Based on the authors' opinion, the most clinically applicable data in the ASEPSIS scoring system pertains to the objective evaluation of whether the wound was opened and the length of the wound affected. A modified scoring system based on these 2 key criteria has the potential to improve the accuracy of uniformly capturing SSI and is an avenue for further study.

Finally, it should be noted that the rates of SSI in the current study are significantly lower than in our preliminary study from which the power calculation was derived. A significant quality initiative, based on the implementation of a standardized enhanced recovery protocol, was initiated during the study period. This was associated with a significant reduction in overall complications including SSI.[13] It is unlikely that the reduction in the incidence of SSI affected the results of the current study, because it should have no bearing on the methodology for defining SSI.

CONCLUSION

This study highlights the difficulty in accurately capturing SSI within a single institution and represents a first step toward the development of an objective measure of SSI. Given the discrepancy in defining SSI based on subjective interpretation of physical examination findings, poor documentation in the EMR, as well as the unintended consequence of prophylactically leaving more wounds open, it may be more logical to simply measure whether a wound is open and, if so, the length of this open wound as a quality metric. This could be tracked using photodocumentation of the wound in the EMR and subject to independent objective review. Although there is no doubt that transparency in quality outcomes is important and can significantly improve patient care, it must be founded on sound data, which, as this study suggests, is difficult to define in the current system.

REFERENCES

1. Hedrick TL, Sawyer RG, Friel CM, Stukenborg GJ. A method for estimating the risk of surgical site infection in patients with abdominal colorectal procedures. *Dis Colon Rectum*. 2013;56:627–637.
2. Anthony T, Murray BW, Sum-Ping JT, et al. Evaluating an evidence-based bundle for preventing surgical site infection: a randomized trial. *Arch Surg*. 2011;146:263–269.
3. Krieger BR, Davis DM, Sanchez JE, et al. The use of silver nylon in preventing surgical site infections following colon and rectal surgery. *Dis Colon Rectum*. 2011;54:1014–1019.
4. Itani KM, Wilson SE, Awad SS, Jensen EH, Finn TS, Abramson MA. Ertapenem versus cefotetan prophylaxis in elective colorectal surgery. *N Engl J Med*. 2006;355:2640–2651.
5. Krieger BR, Davis DM, Sanchez JE, et al. The use of silver nylon in preventing surgical site infections following colon and rectal surgery. *Dis Colon Rectum*. 2011;54:1014–1019.
6. Ju MH, Ko CY, Hall BL, Bosk CL, Bilimoria KY, Wick EC. A comparison of 2 surgical site infection monitoring systems. *JAMA Surg*. 2015;150:51–57.
7. Hedrick TL, Sawyer RG, Hennessy SA, Turrentine FE, Friel CM. Can we define surgical site infection accurately in colorectal surgery? *Surg Infect (Larchmt)*. 2014;15:372–376.
8. Wilson AP, Treasure T, Sturridge MF, Grüneberg RN. A scoring method (ASEPSIS) for postoperative wound infections for use in clinical trials of antibiotic prophylaxis. *Lancet*. 1986;1:311–313.
9. Delgado-Rodríguez M, Sillero-Arenas M, Medina-Cuadros M, Martínez-Gallego G. Nosocomial infections in surgical patients: comparison of two measures of intrinsic patient risk. *Infect Control Hosp Epidemiol*. 1997;18:19–23.
10. JL F. Measuring nominal scale agreement among many raters. *Psychol Bull*. 1971;76:378–382.
11. Shiloach M, Frencher SK Jr, Steeger JE, et al. Toward robust information: data quality and inter-rater reliability in the American College of Surgeons National Surgical Quality Improvement Program. *J Am Coll Surg*. 2010;210:6–16.
12. Davis CL, Pierce JR, Henderson W, et al. Assessment of the reliability of data collected for the Department of Veterans Affairs national surgical quality improvement program. *J Am Coll Surg*. 2007;204:550–560.
13. Thiele RH, Rea KM, Turrentine FE, et al. Standardization of care: impact of an enhanced recovery protocol on length of stay, complications, and direct costs after colorectal surgery. *J Am Coll Surg*. 2015;220:430–443.