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Surgical wound classification for pediatric appendicitis remains poorly documented despite targeted interventions

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ABSTRACT

Background/Purpose: Surgical wound class (SWC) is used to risk-stratify surgical site infections (SSI) for quality reporting. We previously demonstrated only 8% agreement between hospital-based SWC and diagnosis-based SWC for acute appendicitis. We hypothesized that education and process-based interventions would improve hospital-based SWC reporting and the validity of SSI risk stratification.
Methods: Patients (<18 years old) who underwent appendectomies for acute appendicitis between January 2011 and December 2013 were included. Interventions entailed educational workshops regarding SWC for perioperative personnel and inclusion of SWC as a checkpoint in the surgical safety checklist. Thirty-day postoperative SSIs were recorded. Chi-square, Fisher's exact test, and kappa statistic were utilized.
Results: 995 cases were reviewed (pre-intervention = 478, post-intervention = 517). Weighted interrater agreement between hospital-based and diagnosis-based SWC improved from 50% to 81% ($p < 0.01$), and weighted kappa increased from 0.16 (95% CI 0.004–0.03) to 0.29 (95% CI 0.25–0.34). Hospital-based dirty wounds were significantly associated with SSI in the post-intervention period only ($p < 0.01$).
Conclusions: Agreement between hospital-based SWC and diagnosis-based SWC significantly improved after simple interventions, and SSI risk stratification became consistent with the expected increase in disease severity. Despite these improvements, there were still substantial gaps in SWC knowledge and process.

Risk-stratified quality measures such as surgical site infections (SSI) are commonly utilized for hospital comparisons and healthcare reimbursements [1,2]. We previously demonstrated that a 92% discordance existed between hospital-based surgical wound classification (SWC) and surgeon diagnosis-based SWC for appendicitis [3], which would significantly impact SSI as a risk-stratification variable [4]. Similar inconsistencies between hospital-based SWC, diagnosis-based SWC, and American College of Surgeons National Surgical Quality Improvement Program (NSQIP) surgical clinical reviewers-based SWC have been demonstrated [5].

In response, we developed an educational program for operative personnel as well as incorporated postoperative confirmation of SWC between the circulating nurse and surgeon into the debriefing phase of the surgical safety checklist. These interventions were developed based on consensus among surgeons, anesthesiologists, and nursing leaders in the perioperative environment to address the widespread gaps in SWC knowledge as well as to improve the process and timing of SWC documentation, which remains controversial in the existing guidelines. We hypothesized that these interventions would significantly improve hospital-based and diagnosis-based SWC agreement and the validity of hospital-based SWC as a SSI risk-stratification variable.

1. Methods

A before-and-after study of all children less than 18 years who underwent an appendectomy for acute appendicitis at Children's Memorial Hermann Hospital (CMHH) between January 2011 and December 2013 was conducted. Institutional review board approval (HSC-MS-14-0388) was obtained from the University of Texas Health Science Center at Houston and CMHH. CMHH is a tertiary children's hospital within the Memorial Hermann Hospital–Texas Medical Center. This study included 8 board-certified or eligible pediatric surgeons.

1.1. Subjects

Children (<18 years) who underwent an appendectomy for acute appendicitis at CMHH between January 2011 and May 2012 comprised the pre-intervention group. The study interventions described in

Abbreviations: SWC, surgical wound class; SSI, surgical site infection; NSQIP, National Surgical Quality Improvement Program; CMHH, Children's Memorial Hermann Hospital; AORN, Association of Perioperative Registered Nurses; EMR, electronic medical record; IAA, intra-abdominal abscess.

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Section 1.3 were implemented in June 2012. Patients who underwent appendectomies from July 2012 to December 2013 comprised the post-intervention group.

1.2. Surgical wound classification

The pre-intervention SWC process was mapped and evaluated through interviews with circulating nurses and surgeons. The hospital-based SWC is recorded in the electronic medical record (EMR) by the circulating nurse as part of the intraoperative nursing record note. The timing for entering this data point was not standardized during the pre-intervention period and was therefore performed at any time during the operation or before closing the intraoperative nursing note. There was no default SWC in the EMR based on the operation being performed, so one of four SWC options was selected for every case. In addition, there was no standardized process that ensured the surgeon and circulating nurse would review the case in regards to SWC.

The SWC includes four stratifications based on the degree of wound contamination and the Association of Perioperative Registered Nurses (AORN) SWC guidelines: clean, clean contaminated, contaminated, and dirty [6].

The diagnosis-based SWC was documented based on the findings described in the operative note and the postoperative diagnosis. The postoperative diagnosis in our institution is classified as simple, gangrenous, perforated, or perforated with intra-abdominal abscess (IAA) and is based on the surgeons' intraoperative findings. In accordance with our previous study, the postoperative diagnoses of simple and gangrenous appendicitis were considered as contaminated while postoperative diagnoses of perforated appendicitis or perforated with IAA were assigned a diagnosis-based SWC of dirty. Cases in which purulence was discovered within the abdomen but a gross hole in the appendix not clearly visualized by the surgeon were considered dirty cases. This was performed in agreement with both the AORN and NSQIP SWC guidelines [6,7].

1.3. Interventions

Based on our previous findings of SWC discordance within our institution as well as results from the process mapping [3], we implemented two interventions in June 2012. Both interventions leveraged ongoing emphasis to improve checklist adherence, teamwork, and the perioperative safety culture [8]. The first intervention entailed modification of the debriefing phase of the pediatric surgical safety checklist to include an SWC checkpoint. The purpose of this checkpoint was to facilitate discussion at the end of the operation between the attending surgeon or surgical fellow and the circulating nurse to determine the correct SWC based on the intraoperative findings.

The second intervention was an education-based workshop for all direct care givers in the pediatric operating rooms including attending surgeons and surgical fellows, attending anesthesiologists, and perioperative nurses. Findings from our previous evaluation of SWC were provided as well as review of SWC guidelines. In addition, a separate targeted educational session was provided to the circulating nurses led by the pediatric surgeons to discuss process standardization, principles of SWC, and the importance of accurate SWC documentation for SSI risk stratification purposes. SWC for acute appendicitis was specifically utilized as an example.

A multidisciplinary, 30-day postoperative surveillance program monitored SSIs through reviews of the EMR as well as through a standardized 14- and 30-day clinical follow-up regimen for all appendicitis patients. Superficial and deep incisional SSIs as well as organ/space IAA were defined based on CDC criteria [9]. Specifically, IAAs were defined as an image-confirmed (ultrasound or computed tomography) fluid collection deemed to be an abscess by a pediatric radiologist at CMHH. When possible, SSI diagnoses were further corroborated by wound or IAA fluid cultures.

1.4. Statistical analysis

Chi-square and Fisher's exact test were used for categorical variables. SWC is an ordinal variable that designates clean cases as the least contaminated and dirty cases as the most contaminated [6]. Therefore, a weighted kappa statistic was calculated which takes into account different degrees of disagreement. Kappa values <0.20 are considered poor whereas values from 0.20 to 0.40 are fair and values >0.80 are very good. A p-value < 0.05 was considered statistically significant. Statistical testing was performed with STATA 13 (College Station, TX).

2. Results

2.1. Patient demographics and outcomes

A total of 995 children underwent appendectomies for acute appendicitis (pre-intervention = 478, post-intervention = 517). Gender, age, body mass index, and disease severity were similar between the two groups. Additionally, 30-day postoperative SSI rates were similar between the two groups when stratified by simple (nongangrenous, nonperforated) or complicated (gangrenous or perforated) appendicitis (Table 1).

2.2. Surgical wound classification

Relative to the diagnosis-based SWC, 427 (89%) cases were underclassified in the hospital-based SWC during the pre-intervention period which significantly decreased to 231 (45%, p < 0.01) cases during the post-intervention period. The percentage of cases inappropriately classified as clean and clean contaminated significantly decreased during the post-intervention period (Fig. 1).

After the study interventions, overall concordance between the hospital-based and diagnosis-based SWC improved from 9% to 52% (p < 0.01). Weighted interrater agreement improved from 50% to 81% and weighted kappa increased from 0.16 (95% CI 0.004–0.03) to 0.29 (95% CI 0.25–0.34). The proportion of clean or clean-contaminated hospital-based SWC for acute appendicitis decreased from 83% to 38% (p < 0.01). Additionally, the proportion of cases with 2 or 3 class discordance between the diagnosis-based and hospital-based SWC decreased from 48% to 8% (p < 0.01) whereas the proportion of cases with 1 class discordance remained unchanged (p = 0.37, Fig. 2).

2.3. Risk stratification

Using the diagnosis-based SWC, dirty wounds were associated with increased IAA and total SSIs during the pre- and post-intervention periods (both p < 0.01). In contrast, during the pre-intervention period, SSI incidence was highest among the hospital-documented clean (14%) and clean-contaminated cases (13%) and resulted in there being

Table 1
Patient demographics and outcomes.

	Control (n = 478)	Intervention (n = 517)	p-value
Gender, male (%)	308 (64)	327 (63)	0.70
Mean age, years ± SD	10 ± 3.8	11 ± 3.7	0.05
Mean BMI, kg/m^2 ± SD	12 ± 5.5	21 ± 6.2	0.41
Laparoscopy, n (%)	444 (93)	499 (97)	0.01
Complicated appendicitis[a], n (%)	193 (40)	197 (38)	0.46[b]
Surgical site infections, n (%)	60 (13)	43 (9)	0.81
Superficial, n (%)	15 (3)	9 (2)	
Deep/organ space, n (%)	45 (10)	34 (7)	

[a] Gangrenous, perforated, or perforated with intraabdominal abscess.
[b] Chi-squared, adjusted for disease severity (simple vs. complicated).