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ORIGINAL RESEARCH & CONTRIBUTIONS

A Colorectal "Care Bundle" to Reduce Surgical Site Infections in Colorectal Surgeries: A Single-Center Experience

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Abstract

Background: Kaiser Sunnyside Medical Center has participated in the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) since January 2006. Data on general and colorectal surgical site infections (SSIs) demonstrated a need for improvement in SSI rates.

Objective: To evaluate application of a "care bundle" for patients undergoing colorectal operations, with the goal of reducing overall SSI rates.

Methods: We prospectively implemented multiple interventions, with retrospective analysis of data using the NSQIP database. The overall, superficial, deep, and organ/space SSI rates were compared before and after implementation of this colorectal care bundle.

Results: Between January 2006 and December 2009, there were 430 colorectal cases in our NSQIP report with 91 infections, an overall rate of 21.16%. Between January 2010, when the colorectal care bundle was implemented, and June 2011, there were 195 cases and 13 infections, a 6.67% overall rate. The absolute decrease of 14.49% is significant ($p < 0.0001$). The rate of superficial SSI decreased from 15.12% to 3.59% ($p < 0.0001$). The rates for deep and organ/space SSI also showed a decrease; however, this was not statistically significant. The NSQIP observed-to-expected ratio for colorectal SSI decreased from a range of 1.27 to 1.83 before implementation to 0.54 after implementation (fiscal year 2010).

Conclusions: Our institution was a NSQIP high outlier in general surgery SSIs and had a high proportion of these cases represented in colorectal cases. By instituting a care bundle composed of core and adjunct strategies, we significantly decreased our rate of colorectal SSIs.

Introduction

In the US, an individual who undergoes a major operation carries a 2% risk of surgical site infection (SSI). This rate is substantially higher if the patient undergoes colorectal surgery, with reported rates of 5% to 30%.[1,2] In a recent claims study by Wick et al[3] with more than 10,000 colorectal surgery patients, the 30-day readmission rate was 11.4%, the 90-day readmission rate was 23.3%, and the 30-day SSI rate was 18.8%. The mean readmission length of stay was 8 days, and the median cost for an SSI readmission was $12,835. These reports support the concept that interventions that reduce SSIs are likely to reduce length of stay and costs. SSIs represent an important target for surgical quality.

Interest in improving surgical outcomes led to the National Veterans Administration Surgical Risk Study in the late 1980s,[4] and from that, the National Surgical Quality Improvement Program (NSQIP) was developed in the mid-1990s.[5] The American College of Surgeons NSQIP collects data on 135 variables from more than 300 different institutions around the country. NSQIP is the first nationally validated, risk-adjusted, outcomes-based program to measure and improve quality of surgical care. It provides participating hospitals risk-adjusted outcomes on a biannual basis and expresses them as an "observed-to-expected" (O/E) ratio. An O/E ratio below 1 indicates that the hospital is performing better than expected, and an O/E ratio greater than 1 indicates that a hospital is performing worse than expected. These reports are blinded, allowing participating centers to compare their risk profiles and outcomes with those of peer medical centers and with national averages. As a result, NSQIP has become a catalyst for the development of quality-improvement programs designed to advance surgical care. Several studies have demonstrated that institutions can improve outcomes by directing quality initiatives in areas where they seem to be outliers.[6]

Schilling et al[7] examined 36 different procedure groups in the NSQIP and their relative contribution to morbidity and mortality, and they found that 10 procedure groups accounted for 62% of all complications. Colectomy, which composed 9.9% of all procedures, accounted for the greatest share of these adverse events. At the Kaiser Sunnyside Medical Center (KSMC) in Clackamas, OR, colorectal procedures composed 13.4% of all general surgery operations but made up 33% of all the SSIs. We hypothesized that colorectal operations should be targeted to decrease SSIs in general surgery. The purpose of this study is to evaluate the application of a bundle of care designed to reduce SSIs in patients undergoing colorectal operations. The NSQIP database was used to evaluate the efficacy of the colorectal care bundle.

Methods

Study Design

The study design was prospective implementation of multiple interventions (Colorectal SSI Bundle) with retrospective analysis of data. KSMC has been participating in NSQIP since January 2006. Patients who underwent laparoscopic and open colorectal operations, whose data were submitted to NSQIP from January 2006 through June 2011, were included

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Table 1. Current Procedural Terminology codes[1]	
Procedure	**Code**
Colectomy	44140, 444141, 44143-44147, 41450, 44151, 44160, 44204-44208, 44210-44213
Proctectomy	44155-44158, 44211, 44212, 45110, 45111, 45113, 45114, 45116, 45119-45121, 45123, 45126, 45395, 45397

[1] Abraham M, Ahlman JT, Boudreau AJ, Connelly JL, Evans DD. Current procedural terminology 2011, Standard Edition. Chicago, IL: American Medical Association; 2010.

in the study. Patients were identified using Current Procedural Terminology codes (Table 1).[8] Data were accrued into the NSQIP database by trained dedicated nurses, who prospectively collected information from the preoperative, intraoperative, and 30-day postoperative periods.

Development of the Colorectal "Care Bundle"

At KSMC, a 300-bed hospital in a large metropolitan city, approximately 250 to 300 major elective and emergency colorectal procedures are performed annually. In a review of our site-specific NSQIP data, general surgery SSI rates were statistically higher (high outlier) than at other NSQIP participating institutions. Between 2006 and 2009, we received 5 semiannual reports indicating that SSIs were an area of needs improvement. Inspired by our NSQIP risk-adjusted reports, in 2009 a program to eliminate SSIs at KSMC was developed, called "Pathway to Zero Surgical Site Infections." There was a sense of urgency to drive down SSI rates. Colorectal surgery was identified as a subset of operations with the potential for high impact given their high rate of SSIs. On the basis of published literature, consensus views on feasibility, and recommendations from individual surgeons, the colorectal "care bundle" was proposed (Table 2). Education of general surgery attending physicians and house staff regarding elements of the care bundle was done before its implementation and has become a part of orientation for all new staff. The colorectal care bundle was implemented in January 2010. Compliance with the steps of the bundle was not prospectively tracked in all areas.

Data Collection and Analysis

The SSI rates were compared before and after implementation of the colorectal care bundle. Established NSQIP definitions for superficial, deep, and organ/space infections were used.[9] The SSI rates were calculated every month, a run chart was developed (Figure 1), and quarterly reports were established. The SSI Quality Group's monthly meetings allowed for tracking data and provided for opportunities to increase awareness for recommended SSI prevention strategies to all appropriate care providers.

Each case of an SSI was identified and reviewed every month with regard to elements of the bundle. If any part of the bundle was omitted, the SSI was declared preventable and a standardized report regarding the specific case was provided to the surgeon. This allowed for identification of defects, and as they were identified, actions were taken, which included individual feedback and broad education to groups of providers. Some interventions were addressed more globally. One example was production of standardized tables for prophylactic antibiotics that were posted in the operating rooms and included appropriate redosing intervals and weight-based dosing guidelines. In addition, to decrease variation, the electronic medical record was leveraged

Table 2. Colorectal surgery "care bundle"
Preoperative
1. Give patient the SSI patient education sheet
2. Encourage smoking cessation 30 days before surgery
3. Use preoperative antiseptic skin cleansing: with chlorhexidine wipes (night before and morning of surgery)
4. Mechanically prepare the colon the day before surgery
5. Administer nonabsorbable oral antimicrobial agents (neomycin and metronidazole) the night before surgery
6. Screen diabetic and nondiabetic patients using HbA_{1C} levels
Holding
1. Check blood glucose levels; if >140 mg/dL, start insulin infusion
2. Remove hair with clippers in holding area (SCIP 6)
3. Apply forced warm air gown to maintain normothermia
Intraoperative
1. Prescribe appropriate antibiotic (SCIP 1)
2. Dose prophylactic antimicrobial agent based on weight
3. Administer prophylactic antimicrobial agents IV on time (SCIP 1)
4. Redose prophylactic antibiotic based on duration of operation
5. Use standardized antiseptic agent for skin preparation: chlorhexidine gluconate (Chloraprep)
6. Use at least 80% fraction of inspired oxygen
7. Ensure double gloving for all scrubbed surgical team members
8. Maintain perioperative normothermia (SCIP 9)
9. Aggressively control glucose in all patients; start insulin infusions for any blood glucose level >140 mg/dL
10. Perform pulse lavage of subcutaneous tissues for all open operations using 2 L of saline
Postoperative
1. Maintain control of serum blood glucose levels in all patients; glycemic control team consulted
2. Protect primary-closure incisions with silver-impregnated (Acticoat) or polyhexamethylene biguanide (AMD) dressing for 5 days
3. Use high fraction of inspired oxygen (nonrebreather mask) for 4 hours
4. Discontinue prophylactic antimicrobial agent within 24 hours of surgery (SCIP 3)

HbA_{1C} = hemoglobin A_{1C}; IV = intravenously; SCIP = Surgical Care Improvement Project SSI reduction measure; SSI = surgical site infection.

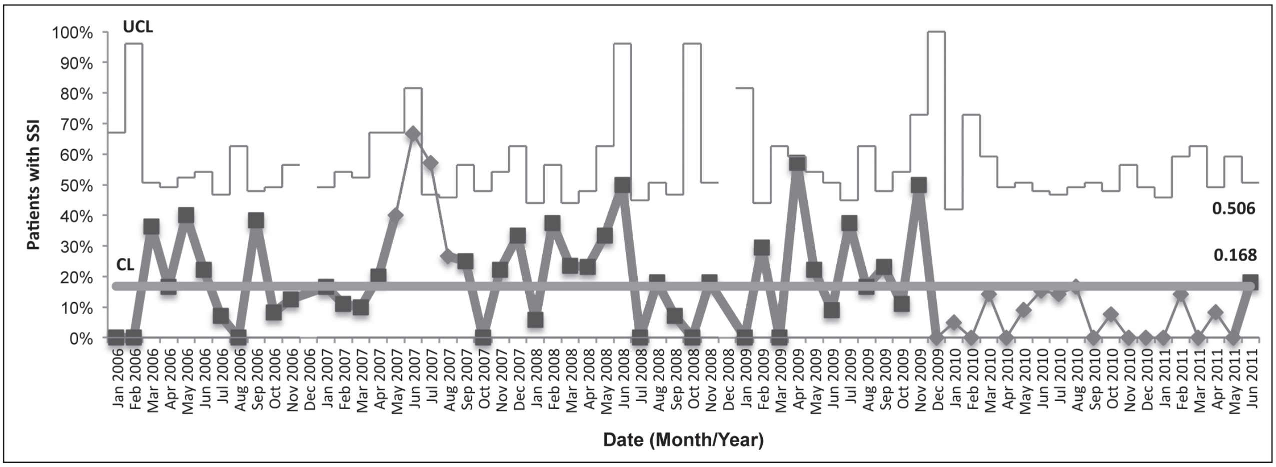

Figure 1. P Chart for Colorectal Surgery SSI Rates at KSMC, January 2006 to July 2011.

CL = control limit (grey straight line at bottom); KSMC = Kaiser Sunnyside Medical Center; SSI = surgical site infection; UCL = upper control limit (thin lines at top).

to standardize the preoperative orders, which include elements such as oral antibiotics and mechanical bowel preparation. Also, SSI "dashboards" were created and posted in the surgeon and operating room lounges for data transparency.

Every month the total number of documented SSIs was divided by the total number of patients at risk in that period and was expressed as the overall case rate. Rates for superficial, deep, and organ/space SSIs were calculated in a similar fashion. Case rates were compared by the difference of proportions test for two independent samples, before and after implementation of the colorectal care bundle (test for null hypothesis: H0: P1 − P2; 95% confidence interval limits set at $\alpha = 0.05$). QI SPC Macros (1996-2011) version 2016.01 (KnowWare International; Denver, CO) was used for statistical analysis.

Results

Between 2006 and 2009, NSQIP captured 430 of the targeted Current Procedural Terminology codes, and overall there were 91 infections, a rate of 21.16%. In comparison, there were only 13 of 195 overall infections in the postintervention study period (January 2010 to June 2011), a rate of 6.67% (Table 3). This absolute decrease of 14.49% was highly significant ($p < 0.0001$). The rate of superficial SSIs decreased from 15.12% to 3.59% after the intervention, and this change was also highly significant ($p < 0.0001$). The rate of deep incision infections decreased from 1.2% to 0.5% after the intervention but was not statistically significant ($p = 0.066$). The rate of organ/space SSI decreased from 4.9% to 2.6% after the intervention, which was not statistically significant ($p = 0.131$). General surgery Class II cases had a significant decrease in overall SSI rates from 11.75% before the intervention to 5.31% after the intervention ($p < 0.0001$; Table 4).

For fiscal years 2006 to 2009, KSMC was a statistically high outlier institution in general surgery SSIs in NSQIP risk-adjusted reports (Table 4); our O/E ratios ranged from 1.40 to 1.68. The overall rate of colorectal SSIs at KSMC was 21.16% compared with 14.44% at other NSQIP participating hospitals, a difference that was statistically significant ($p < 0.001$), and O/E ratios ranged from 1.27 to 1.83 during this 4-year period. The rate of superficial SSIs was 15.11% for KSMC compared with 8.44% for other NSQIP institutions, and the difference was statistically significant ($p < 0.0001$). The rate of deep and organ/space SSIs was not statistically different between KSMC and other NSQIP hospitals.

After the intervention (2010 to 2011), there was a significant improvement in the O/E ratio in colorectal surgery SSIs at KSMC. In 2010, the O/E ratio was 0.54 and was the lowest since the Medical Center joined NSQIP. Compared with 2009, KSMC was no longer a high outlier institution. The rate of overall colorectal SSIs at KSMC was 6.67% vs 12.58% for other NSQIP hospitals, and this difference was statistically significant ($p < 0.001$). The rate for superficial SSIs at KSMC was 3.59% vs 7.19% for other NSQIP hospitals, a significant difference ($p < 0.007$). The rates for deep and organ/space SSIs between KSMC and other NSQIP hospitals were not significantly different ($p < 0.084$ and $p < 0.210$, respectively). Figure 2 shows the graphed rates of colorectal SSIs for both KSMC and NSQIP. In 2010, we also noted a corresponding drop in the O/E ratio for SSIs in general surgery to 0.70, placing KSMC in the low outlier category 1 year after implementation of the colorectal care bundle (Table 4).

Table 3. Colorectal surgery SSI rates at KSMC

	Preintervention (2006-09)	Postintervention (2010-11)	p value
No. of patients at risk	430	195	
SSI rate, no. (%)			
Overall	91 (21.16)	13 (6.67)	< 0.0001
Superficial	65 (15.12)	7 (3.59)	< 0.0001
Deep	5 (1.2)	1 (0.5)	0.066
Organ/space	21 (4.9)	5 (2.6)	0.131

KSMC = Kaiser Sunnyside Medical Center; SSI = surgical site infection.

Discussion

The most frequent complication after colorectal procedures is SSI,[10] and few studies have been able to isolate results in such a way as to standardize care around the issue. One of the most challenging aspects of quality improvement has been the identification of best practice. The literature demonstrating direct cause and effect on relationships for a specific intervention is scarce, and there are few Category IA recommendations from the US Centers for Disease Control and Prevention (CDC). Recently, there has been some evidence that implementation of bundles of care elements can reduce the number of SSIs.[11-13]

The Surgical Care Improvement Project (SCIP), developed by the Centers for Medicare and Medicaid Services and implemented in 2006, was designed as an evidence-based initiative to be applied broadly across selected surgical services, with a stated goal of reducing morbidity and mortality rates 25% by the year 2010.[14] The SSI reduction measures from SCIP include: 1) removal of hair with clippers, 2) use of appropriate antibiotics, 3) prophylactic antibiotics given intravenously in appropriate time, 4) discontinuation of antibiotics within 24 hours, and 5) maintenance of perioperative normothermia. These are so-called core strategies, based on high levels of scientific evidence with high levels of feasibility.

However, the overall success of SCIP has been decidedly mixed. Hedrick et al[15] reported a 10% reduction in colorectal infection rate (26% to 16%) following implementation of the SCIP protocols. In a study involving a larger sample of patients undergoing colorectal resection, the investigators observed a significant increase in compliance with SCIP process measures over 2 consecutive 14-month study periods ($p < 0.001$).[16] However, this greater compliance did not result in a significant reduction of SSIs in patients undergoing colorectal procedures ($p < 0.92$).[16] In a retrospective study using the Premier Inc Perspective Database (Charlotte, NC), SCIP compliance data for 405,720 patients from 398 hospitals were analyzed using a hierarchical logistic model. No relationship was found between adherence to SCIP process measures and occurrence of SSIs. Indeed, the authors documented an increase in SSIs despite substantial improvement in SCIP compliance over a 2-year period.[13] Furthermore, the authors suggested that even if compliance had been 100%, the stated SCIP goal of 25% reduction in SSI was unachievable.

At KSMC, despite following SCIP infection measures, NSQIP data continued to demonstrate high SSI rates. Like other researchers, we decided that the SCIP process has considerable shortcomings as a stand-alone intervention strategy.[13,17] However, SCIP is the largest surgical patient safety and surgical infection reduction initiative in US history[18] and should be viewed as more of a baseline to which other adjunctive strategies are added to create a total risk-reduction package. Supplemental strategies that have some scientific evidence with variable levels of feasibility are the adjunctive measures we added to complete the colorectal care bundle (listed below).

Table 4. KSMC NSQIP risk-adjusted SSI rates by calendar year: colorectal and general surgery

	2006	2007	2008	2009	2010	2011
Colorectal surgery						
Overall (%)	19.61	24.77	16.24	24.51	6.57	6.90
O/E	1.27	1.48	1.31	1.83[a]	0.54	N/A
CI	N/A	0.98-2.09	0.81-1.95	1.20-2.69	0.24-1.02	N/A
General surgery						
Overall (%)	8.13	7.51	5.93	6.82	2.89	2.72
Class II (%)	11.17	11.53	9.82	14.33	5.49	4.97
O/E	1.56[a]	1.49[a]	1.40[a]	1.68[a]	0.70[b]	N/A
CI	1.26-2.07	1.19-1.84	1.08-1.78	1.33-2.09	0.49-0.98	N/A

[a] High outlier, needs improvement.
[b] Low outlier, exemplary.
CI = 95% confidence interval; KSMC = Kaiser Sunnyside Medical Center; N/A = not available; NSQIP = National Surgical Quality Improvement Program; O/E = observed-to-expected ratio; SSI = surgical site infection.

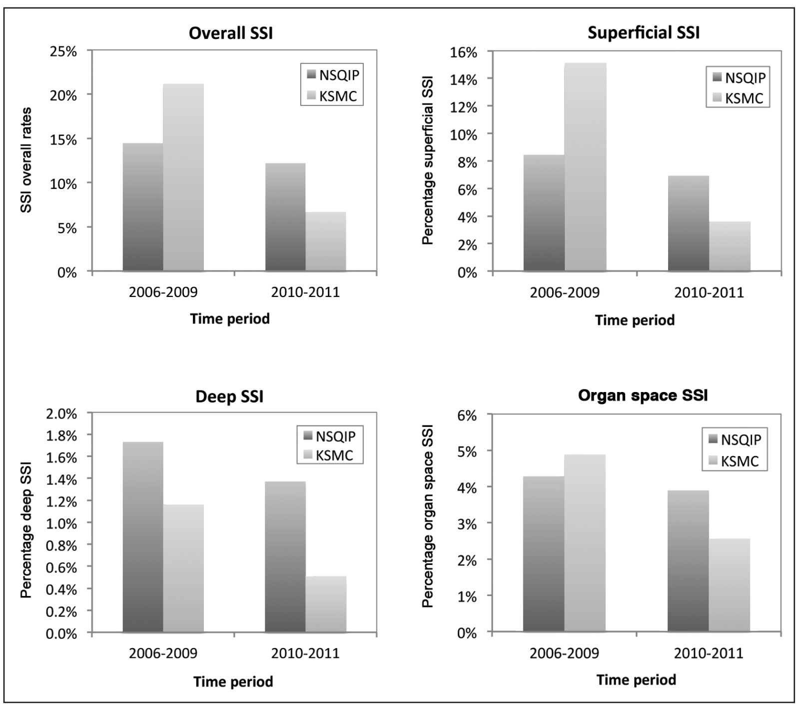

Figure 2. Rates of Colorectal SSI Between KSMC and NSQIP.
KSMC = Kaiser Sunnyside Medical Center; NSQIP = National Surgical Quality Improvement Program; SSI = surgical site infection.

These were deemed to be critical factors to achieve success in lowering the SSI rates.

The SCIP infection measures were the base of the colorectal care bundle. Nurses and surgeons were trained in the importance of these processes. We sought to ensure consistent delivery of the interventions. Razors were removed from the operating room. Our anesthesia group "owned" (was responsible for) the normothermia measure and developed appropriate processes. Body warming devices were used in all cases. The electronic medical record was modified so that only approved and appropriate antibiotics could be chosen for prophylaxis and were given in the appropriate time frame before surgery. We expanded this SCIP measure so that it is best described as antibiotic management. Appropriate weight-based dosing and redosing based on duration of the case and the half-life of the antibiotic was addressed.[19] Standard protocols were developed for the anesthesia team reflecting these factors as well.

We decided to make double gloving a requirement for all scrubbed personnel.

The SCIP does not evaluate all the important surgical quality issues; however, it does begin to give surgeons infrastructure on quality improvement.[20] In completing the bundle, we added adjunctive measures and believe they played a critical role in reducing the risk for SSIs. Although these measures have some evidence to support their use, we recognize that some remain controversial and they have varying levels of feasibility. Adjunctive strategies included the following:

1. mechanical bowel preparation with oral antibiotics (neomycin and metronidazole)
2. aggressive glycemic control
3. chlorhexidine wipes, used the night before and the morning of surgery
4. high fraction of inspired oxygen (>80%) during and after surgery (15-L nonrebreather mask for 4 hours)
5. double gloving for all scrubbed staff
6. pulse lavage of subcutaneous tissues before skin closure with 2 L of normal saline
7. standardized antimicrobial dressing.

The role of mechanical bowel preparation has been questioned recently in three meta-analyses of the randomized controlled trials (RCTs) evaluating omission of mechanical bowel preparation.[21-23] Yet two other meta-analyses have found that oral antibiotics in combination with systemic antibiotics lead to the lowest SSI rates.[24,25] Whether the oral antibiotics are as effective when a mechanical bowel preparation is omitted is a question that remains unanswered. Thus, we decided to proceed with use of a mechanical bowel preparation in addition to oral antibiotics as part of our bundle. Mechanical cleansing is completed the morning before surgery, and oral antibiotics are administered the night before.

There is ample evidence showing that perioperative hyperglycemia in noncardiac surgery has been associated with postoperative infections, increased length of stay, hospital complications, and mortality.[26-28] Other studies have demonstrated that reductions in postoperative complications can be achieved with postoperative normoglycemia.[29,30] In December 2006, KSMC developed a multidisciplinary glycemic work group that led to the formation and implementation of the "glycemic control team" in 2009. This team is made up of pharmacists and internists trained in postoperative glucose control. Since then, all patients undergoing inpatient surgery at KSMC have had a blood glucose level checked in the holding area and 1 hour into an operation. For any patient with a level greater than 140 mg/dL, insulin infusion is started. The glycemic control team then assumes management of the infusions, ensures proper transitions off the intravenous "drips," and maintains a glucose level between 80 and 180 mg/dL using standard protocols.[31]

Despite the limited evidence for other adjunctive measures in our bundle, we approached the bundle as an opportunity for thinking outside the box to find ways to reduce the risk of an SSI. For example, although preoperative chlorhexidine has been recommended for SSI prevention,[32,33] a meta-analysis of the RCTs investigating the use of preoperative chlorhexidine cleansing in preventing SSIs failed to show a benefit.[34] However, one study published in 2008 showed that individuals who used a 2% chlorhexidine gluconate polyester cloth to cleanse with had skin surface concentrations that approached 350X the minimal inhibitory concentration for staphylococcal skin isolates.[35] Because of potential benefits with few side effects, the CDC and the Association of Perioperative Registered Nurses have endorsed the concept of preadmission skin cleansing.[31,32,36] We use a dual skin cleansing done the night before surgery and then in the preoperative holding area.

Similarly, some studies have shown a benefit from high fraction of inspired oxygen during and after surgery in reducing SSIs. A meta-analysis in 2009 examined 5 RCTs evaluating the utility of perioperative hyperoxia to reduce the risk of SSIs and showed a statistically significant reduction from 12% to 9%, without an increase in pulmonary complications.[37] The PROXI trial (PeRioperative OXygen Fraction—Effect on SSI and Pulmonary Complications After Abdominal Surgery), published after the 2009 meta-analysis, was an RCT that failed to show the positive influence of hyperoxia on SSIs; however, it also showed no increased risk of complications from it either.[38] Again, hyperoxia is a low-cost intervention with little risk, and implementation makes sense. We routinely use 80% intraoperative oxygen and a nonrebreather mask at 15 L for 4 hours postoperatively.

We decided to make double gloving a requirement for all scrubbed personnel. In a large observational cohort study in Switzerland, the authors showed that without surgical antimicrobial prophylaxis, glove perforation increases the risk of SSI.[39] To our knowledge, that was the first study to explore the correlation between SSI and glove leakage in a large series of surgical procedures.[39] Other studies have demonstrated the increased risk of glove perforation as well as the increase in bacterial density with duration of an operation.[40] Thus, double gloving may be beneficial in lowering the risk of an SSI and is a low-cost measure.

Before skin closure, the standard practice has been to rinse the wound with a pour of irrigation. This produces less than 1 psi of pressure and is of little clinical value. Lavage at greater than 10 psi can potentially protect wounds from gross contamination.[41] In one retrospective review of laparotomies lasting greater than 4 hours, there was a significantly lower SSI rate when the subcutaneous tissues were lavaged with 2 L of normal saline.[42] This measure is inexpensive, is easy to do, and may further reduce the risk of SSI, and thus we employ this measure in all open colorectal cases before skin closure.

We also decided to standardize our wound dressings. Currently, the CDC Guidelines for Prevention of Surgical Site Infection recommend the use of sterile dressing to protect closed incisions for 24 to 48 hours postoperatively.[32,33] However, there is no evidence to support this recommendation, and none exists with regard to dressing types. Topical silver is an effective bactericidal agent against a broad range of microorganisms that does not appear to induce bacterial resistance. Some single-center reports have demonstrated a lower risk of SSI with silver-impregnated dressings (Acticoat; Smith&Nephew; London, UK).[43,44] Antimicrobial gauze coated with polyhexamethylene biguanide (AMD) has recently been introduced as another alternative with effective antimicrobial activity. We implemented use of a standard silver-impregnated (Acticoat) dressing or AMD gauze and leave it in place for 5 days postoperatively.

Despite our efforts to adhere to SCIP infection measures, KSMC continued to have high SSI rates compared with other NSQIP institutions. Thus, we hypothesized that incorporating multiple strategies into a single treatment bundle that involves not only these core strategies but also supplemental measures would have a synergistic effect on reduction of SSIs in colorectal operations. Since implementation, we have seen a significant reduction in the total number of infections in colon and rectal operations. Furthermore, we have seen significant reductions in overall general surgery infections and in Class II wounds, the class into which most colorectal operations fall. The O/E ratio for colorectal and general surgery SSIs fell as well after implementation.

In establishing a bundle of care, we were able to decrease variability for patients receiving a colorectal operation. One of the key features of this project was sharing our data openly. NSQIP provides risk-adjusted data that allowed us to examine how our Medical Center performs with respect to our peers. This information was distributed among all involved stakeholders at KSMC (administrators, surgeons, nursing staff, infection control, SSI Quality Committee). Although our data between 2006 and 2009 was not favorable, it provided a catalyst for all involved parties to improve SSIs, none more than the surgeons who "own" these outcomes. Despite not monitoring all elements of the bundle, the components that were monitored (SCIP) were posted in the surgical lounges and physicians' lounge for all to see. We reviewed process measures and outcomes data on a monthly basis, and perceived gaps were addressed. The outcomes were reviewed on a regular basis at departmental meetings, which allowed for further opportunity to educate and share knowledge and to identify more barriers that had to be addressed.

Several limitations in this study exist. The current study is not powerful enough and was not designed to isolate specific strategies to eliminate SSIs. We felt an urgency to improve our SSI rates; thus, our goal was to eliminate SSI as quickly and efficiently as possible. Ultimately, this was a "just do it" project. Compliance with all elements of the colorectal care bundle was incomplete, and therefore the association of interventions with SSI prevention could not be assessed. Although some experts argue that aggregated metrics would be a better representation of the quality of care provided to each patient and would allow for better outcome comparisons, we hypothesized that patients who instead receive multiple risk reduction interventions will have a lower risk of SSI. All or none metrics would capture this effectively and allow for better comparison of the actual complication rates; however, this is much more difficult to perform in our current system. Surgical risk mitigation is multifactorial, and our observed reduction in SSI rates may have been affected by an improved culture in the operating room, more attention by leadership, or improved skill and knowledge of the surgical team.

As a result of these factors, our reduction in SSIs may yet prove to be a statistical aberration; however, the sustained reduction through 18 months and the decrease in the risk-adjusted NSQIP O/E ratio is very promising. It remains to be seen if this 18-month reduction in SSI rate is sustainable long term or can be reduced even more. Further investigation will be required to assess the degree and sustainability of risk reduction delivered using this colorectal care bundle.

Conclusion

Participation in NSQIP can identify areas of increased hospital morbidity compared with peer hospitals on a national basis. Through NSQIP participation, KSMC identified SSIs as an area of critical need for improvement. We implemented a bundle of care elements incorporating both core and supplemental strategies and demonstrated a significant decrease in overall colorectal SSIs. Despite being only a single-center case study, the effectiveness of our bundle lends strength to the argument that a bundle of care can act in a synergistic manner to reduce SSIs. As hospitals, physicians, and nurses embrace the quality movement and adopt preventive strategies, large reductions in complications will likely be seen. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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Bacteriology

Every operation in surgery is an experiment in bacteriology.

— Berkeley George Andrew Moynihan, 1st Baron Moynihan, KCB, KCMG, 1865-1936, British abdominal surgeon