Review

Impact of implementation of the Surgical Care Improvement Project and future strategies for improving quality in surgery

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Abstract

BACKGROUND: We present a comprehensive systematic review of the effect of Surgical Care Improvement Project (SCIP) measures on surgical site infections (SSIs) as related to SCIP compliance.

DATA SOURCES: A systematic review of the peer-reviewed literature was performed on PubMed, Medline, and Cochrane database group using their own search engines. Keywords used were Surgical Care Improvement Project (SCIP), adherence, compliance, surgical site infection (SSI), infection bundle, antibiotics, perioperative antibiotics, and combinations thereof. Furthermore, reference lists of selected articles were cross-searched for additional literature. Papers published from January 1, 1998 to January 1, 2014 were included.

RESULTS: A comprehensive analysis of these data demonstrated an 18% decrease in the odds of developing SSI and a cumulative 4% decrease in SSI. The largest increases in compliance for individual SCIP measures were reported between 2004 and 2006. However, compliance with multiple measures simultaneously had the sharpest increase between 2006 and 2009 without a definitive asymptote ascertained from the current data.

CONCLUSIONS: These results represent some positive progress toward the SCIP task force’s 2006 goal of a 25% decrease in SSI by 2010. Suggestions for improved future papers in this area were also added. © 2014 Elsevier Inc. All rights reserved.

Prevention and management of postoperative infection at the surgical site have been a frequent topic for publications and discussions since the inception of the morbidity and mortality conference by Codman. Surgical site infection (SSI) is a serious and often preventable complication that increases patient morbidity, mortality rates, and creates a significant fiscal burden to the health-care system. SSI is said to account for over 40% of nosocomial infections in surgical patients and has an estimated annual incidence of 500,000 to 750,000 in the...
Patients with SSI are more likely to spend time in the intensive care unit, have a prolonged length of stay, are at greater risk for readmission, may have a lower rate of cancer survival, and have increased requirements for home health care and supplies. These consequences of SSI translate to an estimated $2 billion in excess healthcare expenditures annually.

The causation and prevention of SSI are complex and multi-factorial. Several patient risk factors that correlated with SSI include obesity, advanced age, diabetes mellitus/poor glucose control, malnutrition, tobacco use, chronic systemic disease, drug and alcohol abuse, steroid use, preoperative nursing home stay, and colonization with virulent/resistant organisms. SSI is also affected by many treatment-related factors including surgical technique, type of operation, adherence to aseptic/sterile technique, contamination with enteric contents, length of operation, hair removal method, foreign bodies/implants, antibiotic administration, patient temperature control, blood transfusions, and postoperative glycemic control. The Surgical Care Improvement Project (SCIP) was created nearly a decade ago to reduce surgical infection, venous thromboembolism, and cardiac events by defining process measures that are consistent with evidence-based practice recommendations. SCIP initiatives that focus on perioperative infection prevention include prophylactic antibiotic within 1 hour before surgical incision, correct antibiotic selection for probable microbial contaminants, discontinuation of antibiotics within 24 hours after surgery, well-controlled blood glucose in cardiac surgery patients, using depilatory methods or clippers for surgical site hair removal, discontinuation of urinary catheters by the second postoperative day, and perioperative normothermia.

During and after World War II, the introduction of sulfanilamide and penicillin offered hope for the possibility of infection-free surgery. During the 1950s and 1960s, the foundational studies of perioperative antibiotics were conducted. From this work came high-quality laboratory and clinical evidence that timely and appropriate preoperative antibiotic administration decreased rates of SSI. Furthermore, continued administration of preventative antibiotics beyond 24 hours postoperatively was demonstrated to not improve outcomes.

In 1970, the Centers for Disease Control and Prevention (CDC) established the National Nosocomial Infections Surveillance (NNIS) system to monitor the rates and trends in nosocomial infections. NNIS has since transitioned into the National Healthcare Safety Network. Multiple decades of monitoring by NNIS indicated variability in SSI rates among hospitals, which reflected both a continued lack of uniformity and compliance for these and other preventive practices. Initial baseline studies demonstrated that antibiotics were administered within 1 hour of incision in 56% of patients, appropriate antibiotic selection was achieved in 93% of patients, and discontinuation of antibiotics occurred within 24 hours of surgery for only 41% of patients.

Because of imperfect application of these established preventative measures, the Centers for Medicare and Medicaid Services (CMS) partnered with the Centers for Disease Control and Prevention and more than 30 professional organizations to create the National Surgical Infection Prevention Project (SIP) in 2002. SIP was designed with the goal of standardizing surgical quality improvement measures that could be implemented on a national level. SIP primarily focused on measures regarding perioperative antibiotics. In July 2006, SIP transitioned into SCIP, with expanded infection measures and additional recommendations for venous thromboembolism and prevention of adverse cardiac events, such as atrial fibrillation and myocardial infarction. This national standard of surgical best practices had a goal of reducing such surgical complications by 25% by the year 2010. Since inception, a number of scientific reports regarding SCIP have been published with variable interpretations. We present a comprehensive systematic review of the effect of SCIP measures on SSIs.

** Patients and Methods

A systematic review of the peer-reviewed literature was performed on PubMed, Medline, and Cochrane data base group (Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Health Economic Evaluations Database, and Database of Health Technology Assessments) using their own search engines. Keywords used were Surgical Care Improvement Project (SCIP), adherence, compliance, surgical site infection (SSI), infection bundle, antibiotics, perioperative antibiotics, and combinations thereof. Furthermore, reference lists of selected articles were cross-searched for additional literature. Articles published from January 1, 1998 to January 1, 2014 were included. All languages of original publication were considered. In cases of overlapping patient cohorts between reports from the same authors, the studies with the largest power were included.

The literature search began broadly with SCIP. Adherence and compliance were added to the search criteria to focus on the search results. Titles and abstracts were reviewed and screened for papers involving antibiotics, perioperative antibiotics, SSI, and SCIP-infection (INF). Papers with SSI as a reported endpoint were included. We ultimately settled on papers that reported odds ratios of SSI along with compliance to SCIP and papers that reported a change in percentage of SSI with a corresponding change in adherence. Forest plots were created for each group of papers with an overall calculated effect noted at the bottom of each plot. This meta–analysis-type methodology is well known to be associated with limitations and disadvantages secondary to data heterogeneity with dissimilar elements being compared, particularly over time. During our analysis, we recalculated, extracted, and extrapolated reported data from individual papers to create figures and...
Results

An initial search result for SCIP yielded 555 articles and was narrowed to 75 publications after including “adherence” and “compliance” to the search. Titles and abstracts were reviewed and screened for antibiotics, perioperative antibiotics, SSI, and SCIP-INF, which decreased the number of papers to 47. Of the 47 papers with this focus, only 17 papers had SSI as an endpoint. Few papers provided complete data needed to align SCIP compliance with SSI outcomes. The majority of published literature on SCIP was in the form of editorial commentary that lacked objective measures of either compliance or adherence to SCIP and/or have SSI as a primary outcome. Twelve of the original 555 articles met inclusion criteria for this study. These 12 articles, however, represented over a half million (n = 515,579) patients. Four of these studies were cohort studies derived from large electronic databases (n = 488,618) that compared SCIP adherence with odds ratio of SSI. The other 8 were from single institutions (n = 26,961) and reported SSI percentage with implementation of SCIP measures. The publications represented a wide array of specialties. Multispecialty or colorectal operations comprised 4 papers each; the remainder focused on orthopedic, cardiac, or trauma operations.

Five of the papers reported SCIP’s correlation with SSI via an odds ratio. These results were aggregated into a forest plot (Fig. 1A). The Stulberg et al (n = 405,720) and Hawn et al (n = 26,027) papers were multispecialty retrospective cohort studies that mined data from Premier Inc’s Perspective Database and the Veterans Affairs Surgical Quality Improvement Program, respectively. These papers concluded that individual SCIP measures did not lower the overall probability of SSI. However, comprehensive adherence to the SCIP infection measures showed a statistically significant decrease in SSI.10,14 Wang et al (n = 17,714) conducted an observational study of patients who underwent hip replacements from a New York State Department of Health database. Their study demonstrated an increase in compliance for SCIP-INF with a decrease in SSI that approached statistical significance.15 Hendren et al (n = 4,331) presented a retrospective cohort study of patients undergoing colectomy from the Michigan Surgical Quality Collaborative. Several individual SCIP measures including antibiotic selection, normothermia, and glucose control were shown to be associated with a lower risk of SSI.8 Smith et al (n = 306) provided a retrospective review of patients who underwent emergency trauma laparotomy at 2 Level 1 trauma centers. Even though SCIP measures have not yet been recommended for use in trauma cases, these data demonstrated that the antibiotic prophylaxis guidelines effectively reduced the risk of SSI in this patient population.17 The weighted aggregate odds ratio for these 5 papers was .82 or a calculated 18% decrease in odds of developing SSI. While short of the 25% goal, this represents a substantial reduction in SSI with comprehensive compliance with SCIP measures.

The remaining 7 papers had data with SSI as an endpoint over a time period in which compliance with SCIP protocols was quantified (Fig. 1B). Rasouli et al24 (n = 23,907) is the largest study in this group. This retrospective review of total joint replacements (at an institute with lower than average SSI rates) showed a further decrease in SSI over the study period. Larochelle et al (n = 606) presented a prospective study of gastrointestinal surgery in which SSI was monitored simultaneously with SCIP compliance. Compliance with SCIP measures was consistently greater than 90%, and no beneficial effect on SSI was observed during the study period.16 Garcia et al13 (n = 703) described a multispecialty retrospective cohort review that correlated increases in SCIP compliance and decreases in SSI rates. SCIP compliance in conjunction with a comprehensive unit-based safety program (CUSP) was studied prospectively in relation to SSI in the Wick et al (n = 602) paper. CUSP measures included standardized skin preparation, preoperative chlorhexidine showers, selective administration of mechanical bowel prep, warming of patients in preanesthesia area, and adoption of enhanced sterile techniques for skin and fascial closure. SCIP plus CUSP demonstrated a decrease in percentage of SSI across multiple specialties.3 Berenguer et al (n = 113)
and Pastor et al \((n = 491)\) present studies of SCIP and SSI in colorectal patients in a retrospective and prospective manner, respectively. Berenguer et al demonstrated an increase in SCIP compliance with a corresponding significant decrease in SSI. Pastor et al also demonstrated an increase in SCIP compliance, but with a much smaller SSI decline.\(^5,12\) In the lone cardiac surgery paper, Sun et al \((n = 133)\) showed significant increases in SCIP compliance; however, the initial and final SSI rates were zero.\(^25\) The calculated cumulative decrease in SSI for these 7 papers was 4\%, which is much lower than the original SCIP goal of a 25\% reduction in SSI.

Compliance rates with SCIP process measures were also analyzed in this study. All data from papers reporting compliance percentage and year \((n = 17)\) were combined and plotted (Fig. 2). This data plot demonstrated that compliance had the sharpest increase for the “individual” SCIP measures between the years 2004 and 2006. Compliance with the SCIP infection “bundle” increased the greatest between 2006 and 2009. After 2006, compliance for SCIP INF-1 and SCIP INF-2 asymptotically approached 96\% (CI: ±1\%). Compliance for SCIP INF-3 approached 94\% (CI: ±2\%). Data for the multiple simultaneous SCIP measures had not yet approached an asymptote.

**Comments**

A comprehensive analysis of these data demonstrated an 18\% decrease in the odds of developing SSI and a cumulative 4\% decrease in SSI. The largest increases in compliance for individual SCIP measures were reported between 2004 and 2006. However, compliance with multiple measures simultaneously had the sharpest increase between 2006 and 2009 without a definitive asymptote ascertained from the current data. These results represent positive progress toward the SCIP task force’s 2006 goal of a 25\% decrease in SSI by 2010.

The gap between the reported decreases in SSI and the goal is not a reflection on the quality, efficacy, or legitimacy of the known best practices that make up SCIP, but in our opinion shortcomings in the current body of literature reported about SCIP. The current literature is largely opinion based and editorial in nature and has scant objective measures that are incomplete and unevenly reported at best. The studies that do present objective data are not easily comparable. Some present SSI as percentages, while others use odds ratios, relative risk ratios, and/or other statistical metrics to express effects on SSI. Also, many papers had vague representations about compliance percentage or did not include any numeric data on compliance at all.

The quality of the studies and data is disappointing. They are mostly retrospective reviews or cohort studies. None of these studies specific to SCIP measures is a prospective randomized trial. The lack of control groups allows for environmental factors to produce unrecognized and unaccounted effects on the rate of SSI. The majority of the data is collected from large administrative databases. These administrative databases produced studies with a large power. However, they do not accurately link individual patients to SCIP compliant perioperative care and SSI. The other smaller institutional studies are of a whole better quality data, but their study power is much lower, which often prevents proof of a statistically significant effect.

Within the body of data, the reported percentages of SSI may be vastly under-reported or inaccurately represented. Factors that contribute to this under-reporting are intrinsic to both the data and the medical environment in which we currently practice. The large administrative databases were

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**Figure 2** Plots of individual and composite percent compliance with SCIP measures over time.
Within the literature, a reported SCIP compliance rates correlated with variable decreases in SSI. This variability is a reflection on the poor standardization of the current SCIP data and the multi-factorial nature of SSI. The literature unevenly represents a wide variation in hospital performers, which makes it difficult to compare efficacy of SCIP from different studies. In initially poorly performing hospitals, SCIP implementation has a much larger impact on SSI. Wang et al demonstrated that highly compliant (95% to 100%) hospitals did not demonstrate a significantly lower infection rate than less compliant hospitals (50% to 95%). However, both groups of hospitals were among high performers, with an SSI less than 2%. Gawande et al sampled a heterogeneous group of worldwide hospitals. Some of these institutions were from low- and middle-income countries, had irregular administration of prophylactic surgical antibiotics, and had reported initial SSI ranging from 6.2% to 20.5%. This study illustrated that poorly performing hospitals could see a marked decrease in SSI (54%) with the orderly administration of prophylactic antibiotics.

Perhaps the most dramatic outcome of our study is how very seldom “before and after” results are provided for the reader. In fact, failure to report these results should be considered a major flaw in most medical journal reviews.

SCIP is an established system of best practices that should continue to be implemented, measured, and reported. However, some unintended consequences have arisen from the system’s implementation. Regulatory reimbursement has taken SCIP which is a system of evidence-based best practices enacted for the purpose of reducing complications and increasing patient safety, and misused its compliance as a marker of hospital quality. The Medicare Modernization Act (2003) began by proposing a reduction in reimbursement from CMS for hospitals that did not voluntarily report performance measures. The Deficit Reduction Act (2006) expanded the list of reported measures, and mandated reporting at a risk of a reduction in reimbursement. In 2011, the voluntary reporting of SCIP compliance became “mandatory” for a hospital’s Joint Commission accreditation, and SCIP became a pay-for-performance measure from CMS. Compliance with SCIP process measures is now used as a marker of quality performance of hospitals by CMS. A hospital’s national ranking will allegedly influence reimbursement levels. These threats of reduced reimbursement and accreditation penalties have been slow to materialize and are seldom directly applicable for the ultimate leader of surgical quality—the surgeon. An incentivized reimbursement system paid directly to the surgeon, instead of reimbursement cuts to the hospital, may provide a more effective method for motivating compliance.

Conclusions

This comprehensive evaluation of the current data regarding SCIP implementation and impact reveals positive progress toward the 2006 SCIP taskforce’s goal of a 25% reduction in
SSI. The SCIP process measures are evidence-based practices, yet compliance appears imperfectly related to institutional or surgeon performance. Reflection on failed strategies may permit a wiser approach to the future opportunities and challenges. Our data indicate needs for the following:

- Controlled trials with improved risk stratification, larger power, and longer duration;
- Compliance with SCIP (infection bundle) measures must be correlated with rates of SSI over specific time intervals;
- Interval analysis and frequent dissemination of data/best practices among surgical professional organizations;
- An improved understanding that SSI prevention requires systematic attention to more than just antibiotics;
- Pay-for-performance incentives paid to surgeons rather than penalties for compliance issued to the institution.

References