“SCIP”ping antibiotic prophylaxis guidelines in trauma: The consequences of noncompliance

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OBJECTIVE: The Surgical Care Improvement Project (SCIP) established surgical antibiotic prophylaxis guidelines as part of a national patient safety initiative aimed at reducing surgical complications such as surgical site infection (SSI). Although these antibiotic prophylaxis guidelines have become well established in surgical patients, they remain largely unstudied in patients with injury from trauma undergoing operative procedures. We sought to determine the role of these antibiotic prophylaxis guidelines in preventing SSI in patients undergoing trauma laparotomy.

METHODS: A retrospective review of all patients who underwent emergency trauma laparotomy at two Level I trauma centers (2007–2008) revealed 306 patients who survived more than 4 days after injury. Demographics and clinical risk SSI factors were analyzed, and patients were compared on the basis of adherence to the following SCIP guidelines: (1) prophylactic antibiotic given, (2) antibiotic received within 1 hour before incision, (3) correct antibiotic selection, and (4) discontinuation of antibiotic within 24 hours after surgery. The primary study end point was the development of SSI.

RESULTS: The study sample varied by age (mean [SD], 32 [16] years) and injury mechanism (gunshot wound 44%, stab wound 27%, blunt trauma 39%). When patients with perioperative antibiotic management complying with the four SCIP antibiotic guidelines (n = 151) were compared with those who did not comply (n = 155), no difference between age, shock, small bowel or colon resection, damage control procedures, and skin closure was detected (p > 0.05). After controlling for injury severity score, hypotension, blood transfusion, enteric injury, operative duration, and other potential confounding variables in a multivariate analysis, complete adherence to these four SCIP antibiotic guidelines independently decreased the risk of SSI (odds ratio, 0.43; 95% confidence interval, 0.20–0.94; p = 0.035). Patients adhering to these guidelines less often developed SSI (17% vs. 33%; p = 0.001) and had shorter overall hospital duration of antibiotics (4 [6] vs. 9 [11] days, p < 0.001) and hospital length of stay (14 [13] vs. 19 [23] days, p = 0.016), although no difference in mortality was detected (p > 0.05).

CONCLUSIONS: Our results suggest that SCIP antibiotic prophylaxis guidelines effectively reduce the risk of SSI in patients undergoing trauma laparotomy. Despite the emergent nature of operative procedures for trauma, efforts to adhere to these antibiotic guidelines should be maintained. (J Trauma Acute Care Surg. 2012;73: 452–456. Copyright © 2012 by Lippincott Williams & Wilkins)

LEVEL OF EVIDENCE: Therapeutic study, level II.

KEYWORDS: Antibiotic prophylaxis; surgical site infection; SCIP guidelines; trauma laparotomy.

Prophylactic antibiotic use has become commonplace in both surgical literature and practice due in part to a mandate from the Centers for Medicare and Medicaid Services in the form of the Surgical Care Improvement Project (SCIP). This evidence-based initiative targeted a 25% reduction in elective surgical complications such as surgical site infection (SSI) by 2010. A cornerstone of the SCIP guidelines focused on SSI prevention is not only the provision of prophylactic antibiotics but also the administration of the appropriate prophylactic antibiotic within 1 hour before elective surgical incisions and cessation of the antibiotic within 24 hours of surgery.

The efficacy of the SCIP measures remains unclear. There is evidence that the implementation of SCIP-based antibiotic guidelines is associated with lower rates of SSI in areas such as general, laparoscopic, and colorectal surgeries. Other authors have questioned the true validity of these findings using large outcomes-based data sets.

The individual SCIP measures have evolved from the best-known data in elective surgical and semielective general surgical procedures but remain unstudied in the population with injury from trauma. As such, the role of this widespread performance improvement initiative in the care of patients with injury from trauma is unknown. Our primary study objective was to demonstrate that SCIP antibiotic prophylaxis guideline compliance would reduce SSI after trauma laparotomy.

METHODS

Cooper University Hospital in Camden, New Jersey, and Temple University Hospital in Philadelphia, Pennsylvania, are busy urban Level I trauma centers. Institutional review board approval was granted at both hospitals, and a retrospective study was performed on all patients who underwent emergent laparotomy (within 2 hours of emergency department arrival) as a result of injury from trauma during 2007 and 2008 at these two centers. Patients between the ages of 18 and 100 years old were included, whereas patients who died before the fourth day...
of hospital admission were excluded. Our study hypothesis was that adherence to SCIP antibiotic prophylaxis guidelines would decrease the risk of SSI in patients undergoing trauma laparotomy. The primary end point of the study was any SSI (superficial, deep, or organ/space) documented in the medical record by an attending physician as indicated by physical examination, reopening of laparotomy incision, isolation of an organism from the wound, or infection of the deep or organ space as evident by computed tomography or subsequent operation.

Studied demographic and clinical variables included age, mechanism of injury, and body mass index. Comorbidities such as diabetes and tobacco use were noted, as were preoperative and intraoperative physiologic variables including hypotension (systolic blood pressure < 90 mm Hg), tachycardia, and transfusion requirements (crystalloid and blood products). Injury severity score (ISS) was used to grade severity.

The primary study variable was compliance with SCIP antibiotic guidelines. Patients were considered “SCIP-compliant” if all four of the following criteria were fulfilled: (1) prophylactic antibiotic given before laparotomy, (2) antibiotic initiation within 60 minutes before laparotomy incision, (3) correct antibiotic administration (as detailed below), and (4) discontinuation of antibiotic therapy within 24 hours of the completion of index surgery. Antibiotics were considered “correct” based on the injuries found at laparotomy and 2007 SCIP recommendations. Specifically, injuries limited to solid organ or soft tissue (i.e., liver, spleen, abdominal wall) necessitated preoperative administration of cefazolin, clindamycin, or vancomycin, whereas hollow viscus injuries required the administration of cefoxitin, ampicillin/sulbactam, or metronidazole combined with ciprofloxacin or cefazolin. Choice of antibiotics was based on institution-specific guidelines. Cooper University Hospital guidelines used cefoxitin as prophylaxis for patients undergoing laparotomy after a penetrating injury, whereas Temple University Hospital used cefazolin and metronidazole. Both institutions used cefazolin as first-line prophylaxis in patients with injury from blunt trauma without suspected hollow viscous injury.

Data were reported as percentages and means (SDs). Categorical variables were compared using the χ² test, and continuous variables were analyzed with Student’s t test. Variables found to be statistically different on univariate analysis were entered into a multiple variable logistic regression. Patient age was forced into the final model because of the known association of advanced age and SSI. In addition, hospital site was used in the final regression to adjust for unrecognized practice variation that might have occurred between hospitals. The final model adjusted for age, hospital, ISS, preoperative hypotension, intraoperative blood transfusions, total operative time, enteric injuries, and damage control surgery. All regressions were performed using SPSS version 19.0 (SPSS, Inc, Chicago, IL). All comparisons were two-sided, and tests were considered significant if p < 0.05.

RESULTS

Three hundred six patients underwent laparotomy for injuries from trauma and survived at least 4 days at both study institutions. Mean (SD) age was 32.3 (15.9) years, and 82.7% were men (Table 1). Mean (SD) ISS was 14.8 (11.2), and injuries from penetrating causes were more common than those from blunt (gunshot 43.5%, stab 26.8%, and blunt 29.4%).

### TABLE 1. Characteristics of Included Patients

<table>
<thead>
<tr>
<th></th>
<th>All Patients (N = 306)</th>
<th>SCIP-Compliant (n = 151)</th>
<th>Non-SCIP-Compliant (n = 155)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>32.2 (15.9)</td>
<td>32.7 (17.4)</td>
<td>31.9 (14.4)</td>
<td>0.150</td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>253 (82.7)</td>
<td>122 (81.3)</td>
<td>131 (84.5)</td>
<td>0.543</td>
</tr>
<tr>
<td>Race,* n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>154 (51.7)</td>
<td>71 (47.0)</td>
<td>83 (53.5)</td>
<td>0.767</td>
</tr>
<tr>
<td>Hispanic</td>
<td>59 (19.8)</td>
<td>28 (18.5)</td>
<td>31 (20.0)</td>
<td>0.959</td>
</tr>
<tr>
<td>White</td>
<td>85 (28.5)</td>
<td>47 (31.1)</td>
<td>38 (24.5)</td>
<td>0.654</td>
</tr>
<tr>
<td>ISS, mean (SD)</td>
<td>14.8 (11.1)</td>
<td>13.3 (10.0)</td>
<td>16.1 (12.0)</td>
<td>0.035</td>
</tr>
<tr>
<td>BMI, mean (SD), kg/m²</td>
<td>27.5 (6.8)</td>
<td>27.0 (5.8)</td>
<td>27.7 (7.2)</td>
<td>0.543</td>
</tr>
<tr>
<td>Tobacco use,‡ n (%)</td>
<td>118 (38.6)</td>
<td>58 (40.3)</td>
<td>60 (39.2)</td>
<td>0.906</td>
</tr>
<tr>
<td>Diabetes,‡ n (%)</td>
<td>15 (4.9)</td>
<td>6 (4.2)</td>
<td>9 (5.8)</td>
<td>0.602</td>
</tr>
<tr>
<td>Penetrating, n (%)</td>
<td>215 (70)</td>
<td>103 (68.7)</td>
<td>112 (72.3)</td>
<td>0.531</td>
</tr>
<tr>
<td>Preoperative hypotension, n (%)</td>
<td>65 (21.3)</td>
<td>33 (22.0)</td>
<td>32 (20.6)</td>
<td>0.595</td>
</tr>
<tr>
<td>Preoperative IVF transfusion, n (%)</td>
<td>1,292 (1,076)</td>
<td>1,357 (1,031)</td>
<td>1,228.1 (1,119.8)</td>
<td>0.298</td>
</tr>
<tr>
<td>Preoperative blood transfusion, mean (SD)</td>
<td>0.24 (0.99)</td>
<td>0.24 (0.73)</td>
<td>0.25 (0.67)</td>
<td>0.965</td>
</tr>
<tr>
<td>Operative hypotension, n (%)</td>
<td>82 (26.8)</td>
<td>38 (25.2)</td>
<td>44 (28.4)</td>
<td>0.525</td>
</tr>
<tr>
<td>Enteric injury, n (%)</td>
<td>134 (44.4)</td>
<td>53 (35.1)</td>
<td>81 (52.3)</td>
<td>0.027</td>
</tr>
<tr>
<td>Damage control surgery, n (%)</td>
<td>51 (16.7)</td>
<td>25 (16.6)</td>
<td>26 (16.8)</td>
<td>0.959</td>
</tr>
<tr>
<td>ICU length of stay, mean (SD), d</td>
<td>5.5 (10.1)</td>
<td>4.2 (7.7)</td>
<td>6.8 (11.9)</td>
<td>0.028</td>
</tr>
<tr>
<td>Hospital length of stay, mean (SD), d</td>
<td>16.2 (19.0)</td>
<td>13.6 (12.9)</td>
<td>18.8 (23.2)</td>
<td>0.016</td>
</tr>
<tr>
<td>Mortality, n (%)</td>
<td>14 (4.6)</td>
<td>5 (3.3)</td>
<td>9 (5.8)</td>
<td>0.413</td>
</tr>
</tbody>
</table>

* Race data missing on eight patients.
‡ Tobacco data missing on nine patients.
† Diabetes data missing on seven patients.
Among the 306 included patients, 151 (49.3%) were treated with prophylactic antibiotic regimens that were in complete accordance with SCIP recommendations. Of the 155 non-SCIP-compliant patients, 55.1% were given either no prophylaxis or incorrect antibiotics before laparotomy, 45.8% of patients received antibiotics outside the recommended initiation period, and 53.8% were given prophylactic antibiotics for more than 24 hours after surgery. Fifty-eight patients (37.4%) were treated with prophylactic antibiotic regimens that violated at least two of the four SCIP guidelines.

When SCIP-compliant and non-SCIP-compliant patients were compared (Table 1), there were no statistical differences in body mass index (27.0% vs. 27.7%), diabetes (4.2% vs. 5.8%), or tobacco use (40.3% vs. 39.2%). Likewise, no statistical differences with respect to preoperative hypotension (22.0% vs. 20.6%), crystalloid volume resuscitation (1,357.7 [1,031.1] mL vs. 1,228.1 [1,119.8] mL), packed red blood cell resuscitation (0.24 [0.73] units vs. 0.25 [0.67] units), intraoperative hypotension (25.2% vs. 28.4%), or use of damage control surgeries (16.6% vs. 16.8%) between SCIP-compliant and non-SCIP-compliant patients.

Among the 306 patients, 134 (43.8%) had enteric injuries (consisting of injuries in the stomach [10.1%], duodenum [2.3%], small bowel [25.2%], or colon [24.8%]). The SCIP-compliant patients less commonly had enteric injuries discovered at laparotomy than their non-SCIP-compliant counterparts (35.1% vs. 52.3%, p = 0.027). More often, prophylactic antibiotics were administered for more than 24 hours, causing SCIP noncompliance, in those with enteric injuries than those without enteric injuries (38.6% vs. 19.4%, p = 0.001). When non-SCIP-compliant patients with enteric injuries were analyzed alone (n = 81), 60.6% of them failed SCIP criteria with antibiotic prophylaxis continued for more than 24 hours.

Adherence to the four measured SCIP antibiotic guidelines influenced the development of postoperative SSI. Although 16.6% of SCIP-compliant patients developed SSI, 32.9% of non-SCIP-compliant patients developed SSI after laparotomy (p < 0.001; Fig. 1). Furthermore, non-SCIP-compliant patients had longer lengths of stay in the intensive care unit (ICU; 6.8 [11.9] vs. 4.2 [7.7], p = 0.028) and in the hospital (18.8 [23.2] vs. 13.6 [12.9], p = 0.016) relative to patients who were treated according to SCIP recommendations, although no mortality difference was appreciated (p = 0.413).

Multiple variable logistic regression was used to determine independent predictors of SSI after trauma laparotomy. Although age, hospital, ISS, preoperative hypotension, and blood transfusion were not predictive (all p > 0.05), operative duration (per minute of elapsed operative time; OR, 1.004; 95% confidence interval [CI], 1.002–1.007; p < 0.001; Fig. 2), damage control operations (OR, 7.516; 95% CI, 2.546–22.186), and enteric injuries (OR, 3.414; 95% CI, 1.640–7.105), each independently increased the risk of SSI. After controlling for age, hospital, ISS, preoperative hypotension, blood transfusions, operative duration, enteric injuries, and damage control surgery, only SCIP antibiotic prophylaxis compliance was found to independently reduce the risk of postlaparotomy SSI (OR, 0.448; 95% CI, 0.197–0.942; p = 0.035).

**DISCUSSION**

Establishing guidelines for prophylactic antibiotic use in trauma remains challenging. This is due, in part, to the heterogeneity of injuries caused by trauma, both in mechanism and patient risk factors. Our data suggest that a prophylactic antibiotic strategy from the general surgery literature is...
associated with lower rates of SSIs among patients with injuries from trauma. This is important because standardized trauma care and performance improvement remain important goals in growing our trauma systems.8,9

Satisfaction of the individual antibiotic measures within this research study is below the national, and many individual programs, compliance rates.4,10,11 This should be expected because these specific measures have not yet been proposed in the care of patients with injuries from trauma. This leaves much to be learned from the 155 patients who were treated outside the SCIP guidelines.

Since the work of Fullen and colleagues in the 1970s, the administration of preoperative antibiotics has played an important role in preventing SSIs. In addition, this dose is most effective when administered within one hour before the skin incision.12,13 In our sample, 10% of the non–SCIP-compliant patients received prophylactic antibiotics greater than 1 hour before surgical exploration. Although we were unable to detail why this occurred, it is reasonable to surmise that diagnostic testing and possibly some interventions extended the time from initial presentation to operative intervention. It is possible that withholding the administration of antibiotics until a better understanding of the patient’s course, rather than reflexively administering prophylaxis in the trauma bay, could lead to more timely administration of medications and a reduction in postoperative wound infections.

There is ample evidence demonstrating no difference between single and multiagent antimicrobial regimens.14,15 Some authors have suggested that coverage be extended to cover both aerobes and anaerobes.16 Therefore, the appropriate antibiotic choice remains important. In our study, 55.1% of non–SCIP-compliant patients received inadequate coverage based on the injuries found at the time of operation. The most common error was administration of cefazolin to patients found to have hollow visceral (specifically colon) injuries.

We also show that patients with injuries from trauma continue to receive prophylactic antibiotics beyond the recommended 24 hours. Eighty-four patients (53.9%) in the non–SCIP-compliant group were treated with prophylactic antibiotics beyond 24 hours. At present, there are no Level I recommendations regarding the use of prophylactic antibiotics in patients with penetrating abdominal trauma.17 However, there is good evidence to support the early cessation of antibiotics as described in the EAST Practice Management Guidelines.18 In our sample, enteric injuries were associated with prolongation of prophylactic antibiotics beyond 24 hours (38.6% vs. 19.4%, p = 0.001). This practice is not supported by the surgical literature and it is an important focus of antibiotic stewardship for clinicians who choose to initiate prophylactic therapies.19–21

Standardized trauma care and performance improvement remain important goals in growing our trauma systems.8,9 Effective antibiotic guidelines that transcend trauma systems would mark a significant step towards more universal trauma care programs. Our data represent patients from two independent health care systems. Adherence to the SCIP measures remained a significant factor (p = 0.035) associated with lower wound infection rates, even after adjusting for hospital system.

These data also reinforce the notion that simple treatment guidelines can have dramatic effects on global aspects of care. We show that parsimonious prophylactic antibiotic use is associated with significantly shorter ICU and hospital lengths of stay among patients with injuries from trauma undergoing laparotomy. This was true despite equal rates of comorbidities such as obesity, diabetes, and tobacco use. Although we were unable to capture hospital costs, it seems reasonable to assume that fewer days of antibiotic therapy combined with the need for less intensive therapies and a shorter hospital length of stay could translate into a significant reduction in hospital expenditures.

We were limited by the flaws of any retrospective study. Although there were no defined protocols for documentation of SSIs at the time the records were being generated, we reviewed the records in detail to fully capture these events. Also, it is possible that SSI rates were influenced by both the greater ISS and enteric injuries rates of the non-SCIP group. However, we have controlled for the ISS and enteric injury statistical differences in our multivariable logistic regression model and found that adherence to SCIP prophylaxis guidelines independently decreased the rate of SSI in our patients who underwent trauma laparotomy.

In conclusion, we have shown that a significant proportion of patients undergoing trauma laparotomy are treated with prophylactic antibiotic regimens that are in compliance with SCIP recommendations for elective surgery. Although the benefit of the SCIP antibiotic prophylaxis guidelines has not been realized in elective surgical patients, our injured patients are a particularly high-risk group in which adherence to these four simple SCIP guidelines alone has markedly decreased the risk of SSI. The addition of randomized prospective data is needed to validate the SCIP recommendations in the care of patients with injuries from trauma. Our data suggest that these national quality measures could serve as useful markers for performance improvement in trauma.

DISCLOSURE

The authors declare no conflict of interest.

REFERENCES


**EDITORIAL CRITIQUE**

The article shows that “Surgical Care Improvement Project (SCIP)”-ing antibiotic prophylaxis guidelines increased the risk of surgical site infections in patients with trauma who are undergoing laparotomy versus those patients who are undergoing laparotomy and who received appropriate coverage, as outlined by the SCIP Guidelines.

The authors focused on four of the SCIP antibiotic prophylaxis guidelines and controlled for the other factors that have been shown to contribute to surgical site infections, such as enteric or colon injury, hypotension, shock, and so on; they also left out some very important factors that must be addressed.

There are six SCIP measures for preventing surgical site infection, and only four were used in the analysis. Measures not addressed, such as skin preparation before surgery and normothermia were not in the data studied.

These were all emergent or urgent operations, and they all received laparotomy within 2 hours of arrival. Was there a difference in the transfer times, and did they come from other institutions, and is that the reason why some of those patients did not receive antibiotics or received antibiotics outside of the appropriate time frame used in the SCIP guidelines?

In addition, the article does not address the issue of antibiotic use in the enteric injuries, specifically, when did “prophylactic” antibiotics change to empiric treatment? These data are essential because once the antibiotic usage was extended past the 24-hour window and was being used as empiric treatment rather than surgical prophylaxis, it would no longer be considered an SCIP violation.

In closing, we have to be very careful when we extrapolate guidelines from elective operations and use it in patients with trauma and urgent operation patients for obvious reasons.

The more appropriate message of this article should be “antibiotic prophylaxis bundles decrease surgical site infections/and or complications” rather than nonadherence to SCIP guidelines increases complications in patients with trauma.

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