Surveillance of Surgical Site Infection: Development of an Effective System

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Abstract

Background and Aim: Surgical site infection (SSI) remains an important concern in Japan. The Japanese Society for Infection and Prevention Control disclosed that the incidence of SSIs has been lowered only by a fraction over the past 10 years. The importance of taking steps to reduce the occurrence of SSIs is recognized by many hospitals, but to date, no truly effective countermeasures have been reported. We executed a plan to better understand the specific surveillance needs at St. Marianna University School of Medicine Hospital and then develop and institute procedures that would reduce the incidence of SSIs.

Methods and Results: In 2005, we began development of an enhanced SSI surveillance system. With our basic CDC-based surveillance system in place, we assembled a team of doctors and nurses to oversee surveillance. We practiced strict record keeping and data analysis, gleaned information from staff, and enlisted the cooperation of other departments. New procedures were established accordingly and implemented in three phases. Between 2005 and 2013, we witnessed informative fluctuations in the incidence of SSIs. Key components of our new system were standardized postoperative wound cleansing, use of buried absorbable sutures to close surgical wounds, consistent provision of 6 antibacterial agents, each one active against a common organ-specific pathogen, and establishment of a prophylactic protocol. New methods of information sharing were also instituted. We lowered the incidence of SSIs from 8% in 2006 to approximately 6.9% in 2012. We continue to monitor the number of SSIs occurring and are encouraged by a steady decline.

Conclusion: Establishment of the SSI team at our hospital has proven to be a useful multidisciplinary approach to nosocomial infection awareness and control. Gradual introduction of the system to the various departments and step-by-step implementation have decreased the occurrence of SSIs and the nosocomial spread of infectious agents.

Key words

Surgical site infection, Surveillance, Gastroenterological surgery

Introduction

Surgical site infection (SSI) remains an important concern in Japan¹. The Japanese Society for Infection and Prevention Control collected data from many hospitals and disclosed that the incidence of SSIs has been lowered only by a fraction over the past 10 years². The importance of taking steps to reduce the occurrence of SSIs is recognized by many hospitals, but to date, no truly effective countermeasures have been reported³. Although diligent surveillance has been reported nationwide, a discrepancy still exists between surveillance efforts and realization of the goal, which is to prevent SSIs⁴.
In an effort to reduce the threat of SSI outbreaks at our hospital, our Division of Gastroenterological and General Surgery established an SSI team, a team of doctors and nurses responsible for surveillance of SSIs. This was done in July 2005, and our goal was to put specific evidence-based control measures into practice, accumulate data based on those measures from which we could extrapolate further steps needed, and then repeat the process as many times as necessary to build a surveillance system that lowers the SSI rate in our hospital substantially. We obtained approval of the St. Marianna University School of Medicine Ethics Committee (approval number: 1402) to review patients records so that the incidence of SSIs and the details of these infections could be calculated and evaluated within the hospital and then published in this report.

Patients and Methods

The study population comprised 6418 patients who were treated by elective or emergency surgery in our department between July 1, 2005 and March 31, 2012.

Assembling an SSI team suited to the patient population of our department

The first step we took was to assemble an SSI team that could meet the needs of our particular patient population. The Division of Gastroenterological and General Surgery has 114 beds in 5 wards (including combined wards), to which patients are admitted and treated. We created a team consisting of 11 staff, including 3 surgeons (including the author), 6 ward or operating room nurses, and 2 nurses from the Infection Prevention Department.

General SSI prevention guidelines followed

The CDC-based guidelines followed by our department since before the start of the study were maintained throughout the 7-year study period. Prevention, which begins in the preoperative period and continues through the postoperative period, is a stepwise system that includes the following:

Preoperative prevention. Preventative measures taken preoperatively include the following: Cessation of smoking is advised. This precaution is recommended at the time of outpatient consultation. The patient’s nutritional status is evaluated, with the Onodera Prognostic Nutrition Index and pre-albumin concentration used as indicators. Patients with a history of diabetes mellitus are evaluated in the Department of Metabolism and Endocrinology. Patients with esophageal cancer are examined by a dentist.

Intraoperative prevention. Antibiotics that have been given preoperatively are administered intraoperatively. Absorbable sutures are used because they decrease the risk of infection.

Postoperative prevention. Antibiotics are administered postoperatively per the hospital protocol.

Surveillance

Surveillance practiced before the study period comprised the following: In the case of an infection observed preoperatively, intraoperatively, or postoperatively, the occurrence was recorded on our surgical site infection worksheet. If an infection occurred during the 30-day postoperative period, the patient’s body temperature was checked, the wound was inspected (for exudate, hemorrhage, calor, rubor, dehiscence), and the method of wound treatment was evaluated. These factors were examined and recorded daily on the nurses’ worksheet until the wound had healed completely or until the patient was discharged. Surveillance was continued in the outpatient department. Patients with a suspected or confirmed SSI were identified from the worksheet, and those with a confirmed SSI were examined. These general surveillance procedures are still practiced. The new surveillance system was intended to add to rather than replace these procedures.

Phase-by-phase development of a new surveillance system

Once the SSI team was in place and functioning, we began to tally the number of SSIs that appeared each month, and we reported these numbers in department meetings and also at the Japan Society of Surgical Infection conference in 2006. We also gleaned perspectives from the doctors and nurses, and we used the data and information we obtained to continuously evaluate and reshape our surveillance system.

Our new surveillance system was instituted in three phases spanning three successive time periods. These phases constitute our developing methodology on the one hand and our study outcomes on the other hand because the new practices that we instituted and the changing incidence of SSIs we report below are the direct results of new measures put into place, phase-by-phase (Table 1).
Table 1. Implementation of Our SSI Surveillance System in Three Phases Spanning Three Successive Time Periods.

**Phase 1 (2005–2006)**
- November 2005: Individual packaging of items related to wound dressing
- April 2006: Creation of ward teams for each organ
- July 2006: Change in the sequence of preoperative sterilization measures taken in the operating room
- August 2006: Change to subcutaneous washing when the wound is opened
- August 2006: Publication of bacteria isolated from cultures, per ward
- September 2006: Notification of use of anti-MRSA drugs

**Phase 2 (2007–2009)**
- April 2007: Reporting the use of antibiotics and number of MRSA and P. aeruginosa infections, per hospital ward
- August 2007: Simplification of the surveillance sheet
- November 2007: Enforcement of the indicated uses of antibiotics
- February 2008: Extension of the indicated use of antibiotics (throughout the hospital)

**Phase 3 (2010–2012)**
- October 2010: Simplified chart of antibiotic resistance and sensitivity based on the culture results in our hospital
- April 2010: Use of buried absorbable subcutaneous sutures to close laparotomy wounds during elective surgery
- October 2011: Use of a hand-shaped sign at the bedside of infected patients
- October 2011: Reporting the status of infection in the hospital wards
- January 2012: Simplification of the surveillance sheet

**Results**

Mean age of our study patients was 63.0 (11–100) years, and the sex ratio (M/F) was 4028/2390. Scheduled surgery was performed in 4932 patients and emergency surgery in 1486 patients. The 6418 operative procedures performed in our department during the study period were of the following types: appendectomy, n=659; liver/pancreas, n=744; cholecystectomy, n=1080; colon, n=1081; esophagus, n=77; gastric, n=820; herniorrhaphy, n=77; other gastrointestinal tract, n=175; rectum, n=361; small bowel, n=249; laparotomy, n=73; and splenectomy, n=33.

The overall incidence of surgery-related infections during the July 1, 2005 through March 31, 2012 study period was 9.7% (622/6418). Four hundred and eleven (66.1%) were superficial incisional infections, 21 (3.4%) were deep incisional infections, and 190 (30.5%) were organ/space infections. The incidences of SSI are shown per type of surgery in Fig. 1.

The surgery-related infection rates are plotted at 3-month intervals and shown in Fig. 2 in correspondence to the three-phase implementation of the new surveillance system. The first-year incidence of SSI after establishment of our SSI team was approximately 8%. We witnessed a gradual decrease after August 2006, when we switched to skin cleansing at the planned incision site and wound washing as part of the standardized preoperative and postoperative management. By December 2006, a lower SSI incidence of approximately 4.9% was noted, but by August 2007, the incidence increased to 16.5%. Of particular note was infection in the colon and rectum. When the cause of the sudden increase was investigated, no obvious precipitating factor was found.

We found, however, that one of the main factors that had changed from the previous year was that physicians were having difficulty determining whether to administer additional antibiotics intraoperatively. Our department began cooperation with the anesthesiology department, the surgery department, and the hospital pharmacy, and as of November 2007, we decided that 6 types of preventative antibiotics should be kept in the operating room, each one active against a common organ-specific pathogen (Table 2). With organ-specific antibiotics readily available, administration of the appropriate drugs immediately and every 3 hours after surgery became the standard policy. As a result, the incidence of SSI decreased to approximately 6% by February 2008. In addition, due to cooperation between departments that use the surgery area, with the exception of the pediatric surgery department, this system has been in place since February 2008.

Starting in April 2010, we began to practice subcutaneous buried suturing with absorbable suture material. In the summer of 2011, the number of surgical
Figure 1. Incidences of SSI per type of operative procedure.
APPY, appendectomy; BILI, liver/pancreas; CHOL, cholecystectomy; COLN, colon; ESOP, esophagus; GAST, Gastric; HER, herniorrhaphy; OGIT, other gastrointestinal tract; REC, rectum; SB, small bowel; XLAP, laparotomy; SPLE, splenectomy.

Figure 2. Surgery-related infection rates plotted at 3-month intervals for the period July 2005 to March 2012 and in correspondence to the three phases of surveillance system implementation. Months are indicated by numbers 1–12.
patients for whom culture-confirmed MRSA infection was diagnosed increased. In our department, approximately 30 doctors work in a total of 5 wards, and it became clear that the conditions under which these infections arise are difficult to identify. For this reason, we began a system of using a hand-shaped sign at each patient’s bedside to ensure that precautionary measures are taken to prevent contact infection, and we took steps to make sure that this system was and is thoroughly understood. In addition, once a week, from the list of patients admitted to our hospital, those for whom cultures have been performed are listed, and irrespective of SSI, infection status is monitored in real time. With these measures in place, the ward doctors were able to understand the status of infection throughout the 5 wards.

Discussion

Since July 2005, we have relied on a team system for surveillance of SSIs. Our SSI team represents a multidisciplinary approach to surveillance that has proved to be a beneficial information-based campaign aimed at the prevention of nosocomial infections. While we understand that management of SSI is extremely important, the particular importance of controlling SSI outbreaks by shaping a surveillance system so that it matches the unique environment of each particular hospital and responds to the changing trends in nosocomial infection at each hospital has become clear. We have also learned that, in standardizing precautionary measures to be taken before and after surgery, gradual introduction of changes and new procedures is most effective.

From the standpoint of patient care, prevention and control of SSIs are clearly important for safeguarding patients’ health. In addition, prevention and control of SSIs are important for providing patients’ an optimal surgical experience, which includes timely hospital discharge so that they may return to their normal daily routine as soon as possible.

Prevention and control of SSIs must also be looked at from the standpoint of hospital costs. SSIs increase hospital costs. All aspects of care related to SSIs, including extended hospital stays, are costly. Now that the Diagnosis Procedure Combination (DPC) has been introduced to technologically advanced hospitals in Japan, the need to reduce costs associated with SSIs is quite clear. Hospitals nationwide, including ours, have exerted substantial effort to control costs. Establishment of an effective surveillance system has been an important aspect of our department’s role in that effort. The importance of improving treatment of SSIs as well as preventing SSIs was stressed in reports published as early as 2009. The importance of publishing the outcome data so that the results can be evaluated properly and so that the presumed reduction in medical costs can be calculated came to light. Our department had already recognized the importance of taking these steps and thus began the work of establishing a hospital SSI team in 2005.

According to data published in the Japanese So-

### Table 2. Use of Antibiotics in the Operating Room.

**Use of antibiotics in the operating room**

- Consider the implications of using prophylactic antibiotics, and use the designated antibiotics.
- Furthermore, “Surgery Area” should be written on the sheet by default.
- Order the number of antibiotics that you expect to use.
- If there are issues with kidney function, administer additional antibiotics every 12 hours, at 03:00 and 15:00. (This can be performed by the anesthetist.)
- Elective surgery: Up to 3 pm on the previous day.
- Emergency surgery: Order in every case. (The anesthetist can prepare it.)
- When you want to use an antibiotic that is not kept in reserve in the operating room, order it from the outpatient clinic or ward and bring it with you to the operating room.
- There are 2 pharmacists stationed in the surgery area.
- Even the anesthetist can administer antibiotics for SSI treatment and should understand the indications for additional administration.

**Antibiotics that are kept in the operating room**

1. Piperacillin
2. Sulbactam/Ampicillin
3. Sulbactam/Cefoperazone
4. Cefazolin
5. Flomoxef
6. Cefmetazole
ciety of Infection Prevention and Control Commission Report (2013)\textsuperscript{2}, SSIs tend to occur most often after esophageal surgery, colonic surgery, and rectal surgery (Fig. 3), which are quite often performed as emergency surgeries. In general, SSIs occur in relatively high numbers in emergency surgery cases. In 2012, Miyamoto, et al. documented a 31.3% incidence of SSIs among 217 patients who underwent emergency gastroenterological surgery, an incidence that was much higher than the 14.1% among the 2038 patients who underwent elective surgery\textsuperscript{11}. The 217 emergency surgery cases reported by Miyamoto et al. represented 9.6% of the total 2255 surgeries they performed. Emergency surgeries performed at our hospital during the study period represented 23.2% (1489/6418) of the total surgeries performed, and this high percentage explains the high numbers of SSIs that occurred in our esophageal, colonic, and rectal surgery cases as well as the high overall incidence of SSIs we encountered. Our incidences are also high in comparison to the Japanese Healthcare Associated Infections Surveillance (JHAIS) figures reported for 2013\textsuperscript{2}.

We learned quite early in our attempt to refine our surveillance program that instruction of all personnel involved is of critical importance. The setbacks in infection rates that we witnessed were due in part to inadequate instruction. Our doctors had difficulty understanding what antibiotics should be administered intraoperatively and in what quantities. We asked the doctors and nurses to provide us with detailed comments, especially on difficulties they encountered. Our team, then, discussed the matters and gave appropriate feedback.

The characteristics of nosocomial infections are ever-changing. Surveillance must be continual and must yield new and improved countermeasures to deal with the ever-present threat of nosocomial infections. Our experience has taught us that continuous monitoring, clear communication, and detailed instruction are the hallmarks of such a surveillance system.

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