ORIGINAL

Usefulness of a multidisciplinary surgical site infection team in colorectal surgery

Shohei Eto, Kozo Yoshikawa, Yukako Takehara, Toshiaki Yoshimoto, Chie Takasu, Hideya Kashihara, Masaaki Nishi, Takuya Tokunaga, Toshihiro Nakao, Jun Higashijima, Takashi Iwata, and Mitsuo Shimada

Department of Surgery, Graduate School of Medical Sciences, Tokushima University, Tokushima, Japan

Abstract : Background : Surgical site infection (SSI) is an adverse event that places a major burden on patients and staff. In this study, we examined the occurrence of SSI and the characteristics of patients referred to the SSI team after colorectal surgery. Methods : In total, 955 patients underwent colorectal surgery at our hospital from 2014 to 2019. Of these 955 patients, 516 received therapeutic support by the SSI team from 2017 to 2019. All patients were evaluated using an SSI surveillance sheet, and we checked for reports of SSI once a month. Each attending physician performed SSI prophylaxis (use of new instruments before wound irrigation and closure). Results : SSI occurred in 80 (8.4%) patients. The incidence of SSI and the incidence of surface SSI were higher in the patients who did not receive intervention by the SSI team than in the patients who did. Organ/space SSI occurred in 18 patients. Among patients with surface SSI, *Enterococcus* was the most commonly detected bacteria. Among the 18 patients with organ/space SSI, 5 developed anastomotic leakage and 4 developed intra-abdominal abscesses. Conclusions : An SSI team for prevention and treatment of infection may contribute to reduction of SSI. J. Med. Invest. 68 : 256-259, August, 2021

Keywords **:** *surgical site infection, colorectal surgery, infection control team, stoma closure*

INTRODUCTION

Risk management in hospitals has become important for prevention of accidents involving medical staff and patients. Surgical site infection (SSI) is a surgery-related adverse event that places a major burden on patients and staff. Therefore, reduction of the incidence and increased awareness of SSI are important in medical institutions (1-4). The risk of infection after colorectal surgery has increased during recent years because of the aging of society and a higher number of immunocompromised hosts, and treatment of this infection can be difficult (5-10). To address this problem, formation of an infection control team (ICT) may be useful for prevention of infection and therapeutic collaboration (11). In our hospital, SSI prevention has been performed by an SSI team since 2017. The team includes five doctors, four nurses (ICT and operation room), one pharmacist, and one clinical microbiologist. The ICT is responsible for infection prevention and control as well as support for treatment of health care-associated infections. This study was performed to examine the occurrence of SSI and the characteristics of patients referred to the SSI team after colorectal surgery and to describe the practical implementation of infection prevention and control measures.

PATIENTS AND METHODS

In total, 955 patients underwent colorectal surgery at our hospital from 2014 to 2019. Of these 955 patients, 516 received therapeutic support by the SSI team from 2017 to 2019 ; the remaining 439 patients did not (2014-2016). Patients who underwent emergency surgery and peritonitis surgery were excluded from this study. The patients' pathogenic bacteria and treatments were retrospectively examined. SSI conferences were held by the SSI team. All patients were evaluated using an SSI surveillance sheet, and we checked for reports of SSI once a month. The incidence of SSI among the patients was also examined.

The study protocol was approved by the ethics committee of Tokushima University Graduate School of Medicine (TOCMS 3215).

Improvements

Each attending physician performed SSI prophylaxis based on empirical data (4, 12-22). An SSI conference was held once a month to check for any reports of SSI and discuss methods for improvement. For SSI prevention, the surgeon first changed gloves and obtained new instruments before closing the wound. The wound was then irrigated by syringe pressure irrigation (100 mL) and pouring of irrigation fluid over the wound (500 mL). Finally, interrupted suture closure was performed with antibiotics and absorbable thread. Circular sutures were applied in patients requiring stoma closure.

In all patients, surgical prophylaxis was performed using evidence-based standards and guidelines, such as injection of a first-generation cephalosporin within 1 hour before incision and discontinuation of prophylaxis within 48 hours after surgery. Antibiotics proposed by the ICT were used in all patients who were treated with ICT assistance, and selection of the antibiotics was performed at the discretion of the ICT until bacteria were no longer detected. In patients undergoing surgery with instrumentation, vancomycin or linezolid was selected as the initial treatment if gram-positive cocci were found in a wound smear test. De-escalation to narrow-spectrum antimicrobial agents with relatively few side effects was performed if causative bacteria were identified and drug susceptibility was revealed, depending on the patient's clinical symptoms. In patients with methicillin-resistant staphylococci, long-term sulfamethoxazole/trimethoprim and rifampicin were used to treat the infection

Received for publication April 6, 2021 ; accepted April 19, 2021.

Address correspondence and reprint requests to Kozo Yoshikawa, MD, Department of Surgery, Graduate School of Medical Sciences, University of Tokushima, 3-18-15 Kuramoto-cho, Tokushima 770-8503, Japan and Fax : +81-88-631-9698.

until bacteria were no longer detected.

The effectiveness of SSI control by the ICT was evaluated by examining the origins of infection found by ICT collaboration, the causative bacteria, and the detection rates of methicillin-resistant bacteria in all patients with SSI and in those with SSI after surgery using instrumentation.

Statistical analysis

The statistical analysis was performed using statistical software (JMP 8.0.1 ; SAS Institute Cary, NC, USA). The Mann–Whitney U test was used to compare continuous variables, and the chi-square test was used to compare categorical data. Statistical significance was defined as $p < 0.05$.

RESULTS

In total, 955 patients (colon/rectum/stoma : 660/142/153 patients, respectively) were retrospectively analyzed (Table 1). Among these patients, 516 received intervention by the SSI team (after group). SSI occurred in 80 (8.4%) patients (colon/rectum/stoma : 45/16/19 patients, respectively). The incidence of SSI tended to be higher among the patients who did not receive intervention by the SSI team (before group) than in the after group [49/439 (11.1%) vs. 31/516 (6.0%), respectively ; $p = 0.09$]. The patients' characteristics (age, sex, location, open surgery/laparoscopy, body mass index, blood loss, operation time, comorbidity, and use of drainage tube) were not significantly different between the two groups. A total of 62 patients developed surface SSI. During the course of the study, the incidence of surface SSI decreased from 8.7% (38/439 patients) in the before group to 4.7% (24/516 patients) in the after group ($p = 0.01$). Eighteen patients developed organ/space SSI (before group, n = 11 ; after group, n = 7 ; $p = 0.19$).

Comparison of the patients with and without SSI in the after group showed no significant differences in the patients' characteristics (age, sex, location, open surgery/laparoscopy, body mass index, blood loss, operation time, comorbidity, and use of drainage tube) (Table 2).

Among patients with surface SSI, *Enterococcus* was the most commonly detected bacteria (Table 3). *Enterobacter*, *Escherichia coli*, *Bacteroides*, and *Candida* were also detected. Among patients with organ/space SSI, five patients developed anastomotic leakage and four patients developed intra-abdominal abscesses. *Escherichia coli* and *Enterococcus* were detected by bacterial culture. No multidrug-resistant bacteria were found in this study.

Table 1. Patients' characteristics

Factor	Before (n = 439)	After (n = 516)	*p* value
Age (years)	70.8 ± 6.4	71.6 ± 5.6	0.23
Sex (male/female)	262/177	309/207	0.31
Location			
colon/rectum/stoma	288/74/77	372/68/76	0.25
Open/Laparoscopy	148/291	193/323	0.19
BMI	24.4 ± 2.7	23.8 ± 2.5	0.55
Blood loss	25.1 ± 8.1	22.9 ± 6.5	0.33
Operation time (min)	226 ± 28	215 ± 35	0.18
Comorbidity			
Hypertension/DM	129/48	161/67	0.22
Drainage tube +/-	147/292	155/361	0.24
SSI	49	31	0.09
Surface/Organ·Space	38/11	24/7	0.31
Colon	23	22	0.30
Reutum	8	8	0.34
Stoma	18	1	0.05

Data are presented as mean ± standard deviation or number of patients.
BMI body mass index
DM diabetes mellitus
SSI surgical site infection

Table 2. Comparison of SSI and non-SSI (after SSI intervention)

Factor	SSI (*n* = 31)	Non-SSI (*n* = 485)	*p* value
Age (years)	70.2 ± 7.4	72.4 ± 5.8	0.17
Sex (male/female)	19/10	289/196	0.26
BMI	24.6 ± 4.7	22.9 ± 3.4	0.13
Blood loss (g)	20.7 ± 6.1	23.3 ± 7.1	0.38
Operation time (min)	221 ± 28	211 ± 25	0.23
Open/Laparoscopy	9/22	184/301	0.20
Drainage tube +/-	15/16	82/173	0.12
Surface/Organ·Space	24/7		

Data are presented as mean ± standard deviation or number of patients.
SSI surgical site infection
BMI body mass index

Table 3. Bacteria detected in patients with SSI

Bacteria	SSI (n = 29)
Enterococcus	14
Enterobacter	9
E. coli	4
Bacteroides	4
Candida	2

Data are presented as number of patients.
SSI surgical site infection

DISCUSSION

SSI is the most common and costly of all hospital-acquired infections, accounting for 20% of such infections (4). Surgical site infections are associated with an increased length of stay and a 2- to 11-fold increase in the risk of mortality. Although most patients recover from an SSI without long-term adverse sequelae, death in 77% of patients with an SSI can be attributed to the infection itself. The incidence of SSI ranges from 2% to 5% in patients undergoing inpatient surgery. These estimates are likely underestimated given the surveillance challenges after discharge (7, 8, 23-27).

Numerous risk factors for the development of SSI have been identified. These risk factors can be broadly separated into intrinsic and extrinsic factors. Intrinsic factors are patient-related factors that may be either modifiable or nonmodifiable, and extrinsic factors comprise procedure-related, facility-related, preoperative, and operative factors. Potentially modifiable patient-related risk factors include the glycemic control and diabetic status, dyspnea, the alcohol and smoking status, a low preoperative albumin concentration, a high total bilirubin concentration, obesity, and immunosuppression. Nonmodifiable

patient-related factors include increasing age, recent radiotherapy, and a history of skin or soft tissue infection. Procedure-related factors include emergency and more complex surgery and the wound classification. Facility-related risk factors include inadequate ventilation, increased operating room traffic, and appropriate sterilization of equipment. Preoperative risk factors include pre-existing infection ; inadequate skin preparation ; hair removal ; and the choice, administration, and duration of antibiotics. Intraoperative risk factors include the duration of surgery, blood transfusion, maintenance of asepsis, poor-quality surgical hand scrubbing and gloving, hypothermia, and poor glycemic control (7, 8, 28). In the present study, however, there was no significant difference between two groups.

For SSI prevention, the gloves were changed and new instruments were obtained before closing the wound. The wound was then thoroughly irrigated. Finally, interrupted sutures were placed with antibiotics and absorbable thread (12-14). Circular closure after stoma reversal has a lower risk of stoma site SSI than does conventional primary closure, although wounds may take longer to heal with the use of this approach (18). Appropriate surgical techniques have resulted in a lower incidence of SSI ; therefore, we decided to adopt the same methods.

A previous study showed that multidisciplinary care or case-relevant communication reduced the incidence of SSI in patients undergoing digestive surgery (11, 27). We formed an SSI team based on these guidelines and started an initiative to reduce SSI (4). Previously, each surgeon used his or her own operative technique. The SSI team intervened and unified the procedures. The surgeons were made aware of the risks of wound infection, the increased cost of care, and the need for appropriate prevention. We then reviewed the patients with SSI and developed a surveillance sheet to identify the incidence and organisms by technique. In addition, appropriate use of antibiotics was established in collaboration with the ICT. Notably, we found a significant decrease in the incidence of surface SSI after colorectal surgery by using the correct wound closure techniques and SSI team intervention. However, the incidence of deep (organ/space) infection was not significantly changed by intervention from the SSI team. The occurrence of deep infection, such as leakage or intra-abdominal abscesses, was thought to be due to factors associated with the surgical technique.

Limitations of this study are its retrospective design and low number of patients. Furthermore, the patients' nutritional and general conditions were not examined.

In conclusion, SSI is difficult to completely prevent, even with many preventive measures in place. Intervention by our SSI team tended to reduce the incidence of SSI, and this may lead to reductions in the length of hospital stay and medical costs. In the future, it may be important to examine risk factors and to consider not only surgical techniques but also preoperative interventions for high-risk patients to reduce the overall incidence of SSI. However, collaboration with an SSI team for prevention and treatment of infection may contribute to reduction of SSI.

CONFLICT OF INTERESTS-DISCLOSURE

The authors have no conflicts of interest directly relevant to the content of this article.

ACKNOWLEDGEMENTS

We thank Angela Morben, DVM, ELS, from Edanz Group (https://en-author-services.edanz.com/ac), for editing a draft of this manuscript.

REFERENCE

1. Kobayashi K, Imagawa S, Kato D, Ando K, Hida T, Ito K : Collaboration with an infection control team for patients with infection after spine surgery. Am J Infect Control 45(7) : 767-770, 2017
2. Saishu T : Risk management for surgery. Rinsho Seikeigeka Zasshi 38 : 1247-52, 2003
3. Evans RP : American Academy of Orthopaedic Surgeons Patient Safety Committee. Surgical site infection prevention and control : an emerging paradigm. Surg Am : 91(Suppl 6) : 2-9, 2009
4. Ban KA, Minei JP, Laronga C, Harbrecht BG, Jensen EH, Fry DE, Itani KM, Dellinger EP, Ko CY, Duane TM : American College of Surgeons and Surgical Infection Society : Surgical Site Infection Guidelines, 2016 Update. J Am Coll Surg 224 : 59-74, 2017
5. Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, Lynfield R, Maloney M, McAllister-Hollod L, Nadle J, Ray SM, Thompson DL, Wilson LE, Fridkin SK : Multistate pointprevalence survey of health care-associated infections. N Engl J Med 370 : 1198-1208, 2014
6. Atlanta, GA : National Healthcare Safety Network. Surgical Site Infection (SSI) Event. : Centers for Disease Control and Prevention ; 2013.
7. Neumayer L, Hosokawa P, Itani K, El-Tamer M, Henderson WG, Khuri SF : Multivariable predictors of postoperative surgical site infection after general and vascular surgery : results from the patient safety in surgery study. J Am Coll Surg 204 : 1178-1187, 2007
8. Campbell DA Jr, Henderson WG, Englesbe MJ, Hall BL, O'Reilly M, Bratzler D, Dellinger EP, Neumayer L, Bass BL, Hutter MM, Schwartz J, Ko C, Itani K, Steinberg SM, Siperstein A, Sawyer RG, Turner DJ, Khuri SF : Surgical site infection prevention : the importance of operative duration and blood transfusiondresults of the first American College of Surgeons-National Surgical Quality Improvement Program Best Practices Initiative. J Am Coll Surg 207 : 810-820, 2008
9. Kaul AF, Jewett JF : Agents and techniques for disinfection of the skin. Surg Gynecol Obstet 152: 677-685, 1981
10. Webster J, Osborne S : Preoperative bathing or showering with skin antiseptics to prevent surgical site infection. Cochrane Database Syst Rev : 2 : CD004985, 2015
11. Tschan F, Seelandt JC, Keller S, Semmer NK, Kurmann A, Candinas D, Beldi G : Impact of case-relevant and case-irrelevant communication within the surgical team on surgical-site infection. Br J Surg 102(13) : 1718-25, 2015
12. Tanner J, Parkinson H : Double gloving to reduce surgical cross-infection. Cochrane Database Syst Rev 3 : CD003087, 2006
13. Ortiz H, Armendariz P, Kreisler E, Garcia-Granero E, Espin-Basany E, Roig JV, Martin A, Parajo A, Valero G, Martinez M, Biondo S : Influence of rescrubbing before laparotomy closure on abdominal wound infection after colorectal cancer surgery: results of a multicenter randomized clinical trial. Arch Surg 147 : 614-620, 2012
14. Ghuman A, Chan T, Karimuddin AA, Brown CJ, Raval MJ, Phang PT : Surgical site infection rates following implementation of a colorectal closure bundle in elective colorectal surgeries. Dis Colon Rectum 58 : 1078-1082, 2015
15. Cohn SM, Giannotti G, Ong AW, Varela JE, Shatz DV, McKenney MG, Sleeman D, Ginzburg E, Augenstein JS, Byers PM, Sands LR, Hellinger MD, Namias N : Prospective randomized trial of two wound management strategies for dirty abdominal wounds. Ann Surg 233 : 409-413, 2001

16. Bhangu A, Singh P, Lundy J, Bowley DM : Systemic review and meta-analysis of randomized clinical trials comparing primary vs delayed primary skin closure in contaminated and dirty abdominal incisions. JAMA Surg 148 : 779-786, 2013
17. Pommerening MJ, Kao LS, Sowards KJ, Wade CE, Holcomb JB, Cotton BA : Primary skin closure after damage control laparotomy. Br J Surg 102 : 67-75, 2015
18. Lee JT, Marquez TT, Clerc D, Gie O, Demartines N, Madoff RD, Rothenberger DA, Christoforidis D : Pursestring closure of the stoma site leads to fewer wound infections : results from a multicenter randomized controlled trial. Dis Colon Rectum 57 : 1282-1289, 2014
19. O'Neal PB, Itani KM: Antimicrobial formulation and delivery in the prevention of surgical site infection. Surg Infect (Larchmt) 17 : 275-285, 2016
20. Bennett-Guerrero E, Pappas TN, Koltun WA, Fleshman JW, Lin M, Garg J, Mark DB, Marcet JE, Remzi FH, George VV, Newland K, Corey GR : Gentamicin- collagen sponge for infection prophylaxis in colorectal surgery. N Engl J Med 363 : 1038-1049, 2010
21. McHugh SM, Collins CJ, Corrigan MA, Hill ADK, Humphreys H : The role of topical antibiotics used as prophylaxis in surgical site infection prevention. J Antimicrob Chemother 66 : 693-701, 2011
22. Bakhsheshian J, Dahdaleh NS, Lam SK, Savage JW, Smith ZA : The use of vancomycin powder in modern spine surgery: systematic review and meta-analysis of the clinical evidence. World Neurosurg 83 : 816-823, 2015
23. Bratzler DW, Dellinger EP, Olsen KM, Perl TM, Auwaerter PG, Bolon MK, Fish DN, Napolitano LM, Sawyer RG, Slain D, Steinberg JP, Weinstein RA : Clinical practice guidelines for antimicrobial prophylaxis in surgery. Am J Health Syst Pharm 70 : 195-283, 2013
24. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR : Guideline for prevention of surgical site infection, 1999. Infect Control Hosp Epidemiol 20 : 247-278, 1999
25. Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, Lynfield R, Maloney M, McAllister-Hollod L, Nadle J, Ray SM, Thompson DL, Wilson LE, Fridkin SK : Multistate pointprevalence survey of health care-associated infections. N Engl J Med 370 : 1198-1208, 2014
26. National Healthcare Safety Network. Surgical Site Infection (SSI) Event. Atlanta, GA : Centers for Disease Control and Prevention ; 2013.
27. Park CM, Ha TS, Lee WY, Chung DR, Park YA, Choi JR, Jeong NY : Implementing a multidisciplinary care bundle to reduce colon surgical site infections. Ann Surg Treat Res 99(5) : 285-293, 2020
28. Anderson DJ, Podgorny K, Berrios-Torres SI, Bratzler DW, Dellinger EP, Greene L, Nyquist AC, Saiman L, Yokoe DS, Maragakis LL, Kaye KS : Strategies to prevent surgical site infections in acute care hospitals : 2014 update. Infect Control Hosp Epidemiol 35 : 605-627, 2014