Current status of postoperative infection after colorectal surgery: subanalysis of data from the 2015 Japan Postoperative Infectious Complications Survey

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Abstract

Background: Most surveillance programs for postoperative infection focus on surgical site infections (SSI). However, remote infections, as postoperative infections, are of emerging clinical importance. We investigated the incidence of both SSI and remote infection following colorectal surgery by performing a subanalysis of a multicenter survey after gastrointestinal surgery.

Methods: From September 2015 to March 2016, 1724 patients underwent colorectal surgery in 28 affiliated institutions in Japan. We retrospectively recorded patients’ age, sex, surgical site, surgical approach, wound classification, performance status at discharge, and postoperative infection status.

Results: Postoperative infections occurred in 236 (13.7%) patients; 150 and 86 patients underwent colon and rectal surgeries (postoperative infection incidence: 13.7% and 14.8%), respectively. Laparoscopic surgery was associated with a significantly lower incidence of postoperative infection compared with open surgery for both colon and rectal surgery (p < 0.001). Among all patients with postoperative infections, 211 (89.4%) had single infections, and 25 (10.6%) had multiple infections. SSI and remote infection in patients with single postoperative infections occurred in 143 (60.6%) and 68 (28.8%) patients, respectively. The most common multiple postoperative infections
were “incisional and organ/space SSIs”, and “organ/space SSI and bacteremia of unknown origin”, with three cases each.

Conclusions: This study revealed the distribution of the overall prevalence of postoperative infections, including both SSI and remote infections. Considering the substantial influence of remote infections on patients’ quality of life and the social burden, prospective periodic surveillance for both SSI and remote infection is necessary for detailed evaluation and prevention.

Key words: postoperative infection, surgical site infection, remote infection, colorectal surgery
Introduction

Studies evaluating postoperative infections have predominantly investigated the incidence and factors associated with postoperative surgical site infection (SSI). SSI incidence is gradually decreasing in the United States and Japan, particularly after colon and gastrointestinal surgeries.\textsuperscript{1–4} However, another type of postoperative infection, remote infection at distant sites, also occurs, and is an important complication affecting a patient’s prognosis and quality of life (QOL). Remote infections are being recognized increasingly more often, and the incidence and factors associated with postoperative respiratory tract infection, which is a major remote infection, have been reported.\textsuperscript{5} Remote infection following colorectal cancer surgery has also been reported.\textsuperscript{6} SSI and remote infection may occur alone or at the same or different times; therefore, considering only one is insufficient to accurately determine a patient’s prognosis, QOL, and the socioeconomic burden. Thus, surveillance and feedback on the overall state of postoperative infections are essential. To address this need, the Japan Society of Surgical Infection organized the Japan Postoperative Infectious Complications Survey in 2015 to perform a multicenter joint study of the incidence of postoperative infection in digestive surgery.\textsuperscript{7} The present report is a subanalysis of these data, for colorectal surgery.
Materials and Methods

Patients and Data Registration

Patients’ data were obtained from 28 healthcare facilities affiliated with the member teaching institutions of the Japan Society of Surgical Infection, which comprised 16 university hospitals, 11 general hospitals, and one cancer center. The participating institutions providing their data are listed in the acknowledgements. The survey period was September 2015 to March 2016, and data for 6582 patients who underwent digestive surgery in these institutions were retrospectively collected. Patients’ data were encrypted to anonymize their identities and encoded online (https://entry3.eps.co.jp/infection_svlce/PasswordReSet.aspx). The date of surgery and the patient age group were the only details entered directly; other items were encoded using a pulldown menu. This subanalysis was performed in patients who underwent colorectal surgery.

Definitions of postoperative infections

Remote infection was categorized as respiratory tract infection (RTI), urinary tract infection (UTI), catheter-related blood stream infection (CR-BSI), antibiotic-associated
diarrhea (AAD), drain infection, and bacteremia of unknown origin (BUO), according to the National Healthcare Safety Network infection criteria as follows: (1) RTI was defined as a new onset of infiltration on chest radiographs, fever and cough, and leukopenia ($< 4000 \text{ cells/mm}^3$) or leukocytosis ($\geq 12,000/\text{mm}^3$). (2) UTI was characterized by fever ($> 38^\circ C$) without other causes, urinary urgency, urinary frequency, dysuria, suprapubic tenderness, and urine culture with $10^5$ colony-forming units/ml of the bacteria, or UTI diagnosis by a physician. (3) CR-BSI was defined as $\geq 1$ positive blood cultures, identification of a pathogenic organism in the catheter, and absence of infection by the organism detected in the blood culture in sites other than the catheter. (4) AAD was characterized by diarrhea and *Clostridioides difficile* toxin or positive stool culture with a virulent strain of *Clostridioides difficile* or pseudomembrane findings on colonoscopy. (5) Drain infection was defined as infections occurring secondary to content reflux from the drains, not of residual abscesses, determined as drain infection according to the general assessment of a physician. (6) BUO was characterized by one or more of the following: fever ($> 38^\circ C$) with no other cause, hypotension (systolic pressure $\leq 90 \text{ mmHg}$) or oliguria ($< 20 \text{ ml/h}$), and the diagnosis of sepsis by a physician regardless of positive or negative blood culture results.
SSI was classified as incisional SSI and organ/space SSI. The wound classification status of patients with postoperative infection was categorized as class I (clean), II (clean–contaminated), III (contaminated), or IV (dirty–infected) according to the Centers for Disease Control and Prevention definitions and wound classifications. The occurrence of postoperative infection was monitored for 30 postoperative days. Patients’ wound classification, sex, age group, and each postoperative infection incidence were analyzed according to the surgical site and whether affected patients underwent laparoscopic or open surgeries. Patients’ performance status at discharge was considered an indicator of postoperative infection prognosis.

This study was performed in accordance with the Helsinki Declaration and was approved and patients agreed to use the patient's own data by the ethics committee of the Nippon Medical School Tama–Nagayama Hospital (Approval No. 625).

Statistical Analysis

Bell Curve for Excel (Social Survey Research Information Co., Tokyo, Japan) was used for all statistical analyses. We used Fisher’s exact probability test, and p <0.05 was considered statistically significant.
Results

Data for 1724 patients were encoded as colorectal surgery; of these, 1143 and 581 were colonic and rectal surgeries, respectively. Overall, postoperative infections occurred in 236 (13.7%) patients, comprising 154 men and 82 women (65.3% and 34.7%, respectively). The median age for patients with postoperative infection was 60 y (range: 10–90 y). Regarding colon surgeries, postoperative infection occurred in 75 (20.5%) patients who underwent open surgery and 75 (9.7%) patients who underwent laparoscopic surgery. Regarding rectal surgeries, postoperative infection occurred in 42 (23.1%) patients who underwent open surgery and 44 (11.0%) patients who underwent laparoscopic surgery. Laparoscopic surgeries were associated with significantly lower incidences of postoperative infection compared with open surgeries for both colon and rectal surgeries (p < 0.001; Table 1).

Of 236 patients with postoperative infections, class II was the most common category regarding wound contamination (210 (89.0%) patients), and a performance status of 0 at discharge was the most common score (132 (55.9%) patients); however, 5 (2.1%) deaths (performance status of 5) also occurred (Table 2).

Single postoperative infections occurred in 211 (89.4%) patients. In contrast, multiple postoperative infections occurred in 25 patients; 10.6% of all patients with
postoperative infection. The details of patients with single postoperative infections appear in Table 3. SSI and remote infection occurred in 143 (60.6%) and 68 (28.8%) patients, respectively. Organ/space SSI was the most common type of single postoperative infection (75 (35.5%) patients), and incisional SSI was the second most common type (68 (32.2%) patients). Among 25 patients with multiple postoperative infections, the majority of patients had two infections (21 (84.0%) patients); however, one patient (4.0%) had five postoperative infections (Table 4). Table 5 shows the details of the patients with multiple postoperative infections. The most common type of multiple postoperative infections were “incisional and organ/space SSIs”, and “organ/space SSI and BUO”, with three cases each (Table 5).

The incidence rates for the individual postoperative infections according to the surgical approach in colon and rectal surgeries are shown in Figure 1 and 2. Regarding colon surgeries, the prevalence of all postoperative infections was lower with laparoscopic surgeries compared with open surgeries and with statistically significant differences for incisional SSI, organ/space SSI, RTI, and BUO (P = 0.04, 0.008, < 0.001, and 0.01, respectively) (Fig. 1). Regarding rectal surgeries, laparoscopic surgery was associated with a lower incidence of postoperative infection for incisional SSI, organ/space SSI, UTI, and AAD, but the difference was statistically significant only for
organ/space SSI (P = 0.002) (Fig. 2).

**Discussion**

This subanalysis of data from the 2015 Japan Postoperative Infectious Complications Survey is the first report, to our knowledge, clarifying the overall prevalence of postoperative infections, including both SSI and remote infection, in colorectal surgery, with a large sample size of 1724 patients. The overall incidence of postoperative infection was 13.7%. Among 236 patients with postoperative infections, single infections and multiple infections occurred in 211 (89.4%) and 25 (10.6%) patients, respectively. SSI and remote infections in patients with single postoperative infections occurred in 143 (60.6%) and 68 (28.8%) patients, respectively. Furthermore, laparoscopic surgery was associated with a significantly lower incidence of postoperative infection compared with open surgery.

Since the publication of the Guidelines for the Prevention of Surgical Site Infections by the Centers for Disease Control and Prevention, SSI surveillance systems have been implemented, and nationwide SSI surveillance has been performed in the USA and Japan. Notably, a large gap remains regarding postoperative mortality after colorectal cancer between the USA (3.3%) and Japan (0.4%). Although our current study’s
cohort included more high-risk patients with benign diseases, such as diverticular perforation, than in the above-mentioned report, the mortality of 0.3% was consistent. Greater numbers of advanced institutions registered in postoperative infection prevention programs might have contributed to the low mortality.

It is considered meaningful to divide and compare outcomes of postoperative surveillance according to the surgical site and approaches because these variables could greatly influence outcomes and social burdens, which, in turn, encourages detailed preventive measures against postoperative infections. A previous report confirmed the superiority of laparoscopic surgery regarding SSI occurrence; however, the benefits of laparoscopic surgery regarding the occurrence of remote infection have not been defined. The advantage of laparoscopic surgery regarding SSI occurrence was also shown in the current study. Furthermore, consistent advantages were seen in remote infection occurrence, especially for colon surgery.

The incidence rate of remote infection was comparatively lower than that for SSI, in our study (3.9% vs. 8.3%, respectively); however, specific remote infections such as pneumonia and sepsis, could contribute to worsened patients’ QOL and increased medical expenses as much as or more than for SSI. Therefore, surveillance only for SSI is insufficient to determine the overall burden to patients secondary to postoperative
Regarding the characteristics of individual remote infections in colorectal surgery, AAD occurs primarily as a *Clostridioides difficile* infection of the gastrointestinal tract, and among gastrointestinal surgeries, the incidence is reported to be higher after colorectal surgery.\(^{17-22}\) Yamamoto et al.\(^{21}\) reported a 4.3% *Clostridioides difficile* infection incidence rate, and Yasunaga et al.\(^{18}\) reported a 0.37% incidence in colorectal cancer surgery. Compared with their reports, the *Clostridioides difficile* infection incidence in the present study was low (0.3%; 6 patients). This difference may be explained by the fact that our data were collected from member teaching institutions of the Japan Society of Surgical Infection, where preventive and symptomatic measures regarding infection are presumably more rigorous. The risks of *Clostridioides difficile* infection in colorectal surgery are reported to increase significantly with diarrhea, particularly in cases of leakage in rectal surgery;\(^{21}\) thus, precautions are necessary to prevent the development of secondary organ-space SSI.

RTI in colorectal surgery is a risk factor for operative mortality.\(^{16}\) Previous studies have examined the relationships between RTI incidence and the associated risk factors in colorectal surgery,\(^{6,22,23}\) and RTI incidence is reported as 2.9%,\(^{6}\) 5.2%,\(^{22}\) and 6.2%.\(^{23}\) In these reports, RTI may be related to decreased perioperative nutrition, immunity, and
respiratory function. RTI occurred in 13 patients in the present study (0.9%), and the RTI incidence was significantly lower in patients who underwent laparoscopic colon surgery than in those who underwent open colon surgery. Although quality studies on RTI in colorectal surgery are limited, one study involving 384 patients reported that postoperative pulmonary infection occurred in few patients who underwent laparoscopic surgery (1.8%) vs those who underwent open surgery (3.5%). Schwenk reported no superiority regarding laparoscopic surgery and RTI incidence in their meta-analysis. Clinical guidelines have shown that the use of anesthetics to control pain and respiration via transnasal gastric tubes can inhibit RTIs.

UTIs occurred in 24 patients in the present study (1.4%) and tended to occur somewhat more frequently after rectal surgery than after colon surgery. UTIs were presumably caused by nerve dissection around the pelvic viscera, which may cause nerve disorders that result in incontinence, long-term urinary catheter placement, and reflux. Although the difference was not significant in the present study, UTIs tended to occur more often following open colonic and rectal surgery, indicating that the early removal of catheters in less-invasive laparoscopic surgeries may prevent UTIs.

The following are limitations in our study: (1) Data may have been biased because they were provided by educational institutions that emphasize the importance of
measures against postoperative infection. (2) Collected data from each patient were limited. The absence of detailed patients’ background and surgical variables hampered our ability to clarify the plausible mechanisms leading to postoperative infections.

In conclusion, this study revealed the overall distribution of postoperative infection prevalence, including both SSI and remote infection. Considering the substantial influence of remote infection in patients’ QOL and the social burden, prospective periodic surveillance focused on both SSI and remote infection is necessary for detailed evaluation and prevention.
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Fig. 1. Details of the postoperative infections in patients undergoing colon surgery according to the surgical approach.

Fig. 1. Colon

Fig. 1. Details of the postoperative infections in patients undergoing colon surgery according to the surgical approach.
Fig. 2. Details of the postoperative infections in patients undergoing rectal surgery according to the surgical approach.

Fig. 2. Rectum

Fig. 2. Details of the postoperative infections in patients undergoing rectal surgery according to the surgical approach.
Table 1. Prevalence of postoperative infection according to surgical site and surgical approach

| Surgical site and approach | Postoperative infection (%) | P value |
|----------------------------|-----------------------------|---------|
| Colon (n=1143)             |                             |         |
| Open (n=366)              | 75 (20.5)                   | < 0.001 |
| Laparoscopic (n=777)      | 75 (9.7)                    |         |
| Rectum (n=581)            |                             |         |
| Open (n=182)              | 42 (23.1)                   | < 0.001 |
| Laparoscopic (n=399)      | 44 (11.0)                   |         |
| Total (n=1724)            | 236 (13.7)                  |         |
| Wound classification | Colon (n=150) | Rectum (n=86) |
|----------------------|---------------|---------------|
|                      | Open (n=75)   | Laparoscopic (n=75) | Open (n=42) | Laparoscopic (n=44) |
| II                   | 210 (89.0)    | 58            | 72          | 37          | 43          |
| III                  | 7 (3.0)       | 3             | 2           | 2           | 0           |
| IV                   | 19 (8.1)      | 14            | 1           | 3           | 1           |

| Performance status at discharge |
|---------------------------------|
| 0                               | 132 (55.9)    | 32            | 52          | 18          | 30          |
| 1                               | 69 (29.2)     | 20            | 17          | 21          | 11          |
| 2                               | 11 (4.7)      | 5             | 3           | 3           | 0           |
| 3                               | 11 (4.7)      | 6             | 2           | 0           | 3           |
| 4                               | 8 (3.4)       | 8             | 0           | 0           | 0           |
| 5                               | 5 (2.1)       | 4             | 1           | 0           | 0           |
Table 3. Details of the patients with single postoperative infections

| Total (n=211) (%) | Colon (n=135) | Rectum (n=76) |
|-----------------|--------------|---------------|
|                 | Open (n=68) | Laparoscopic (n=67) | Open (n=37) | Laparoscopic (n=39) |
| SSI 143 (67.8)  | 75 (35.5)   | 23             | 20           | 18                 | 14             |
| Organ/space SSI |              |                |              |                    |                |
| Incisional SSI  | 68 (32.2)   | 22             | 24           | 9                  | 13             |
| RI 68 (32.2)    |              |                |              |                    |                |
| AAD             | 18 (8.5)    | 3              | 9            | 4                  | 2              |
| UTI             | 17 (8.1)    | 2              | 5            | 5                  | 5              |
| CR-BSI          | 13 (6.2)    | 5              | 5            | 1                  | 2              |
| RTI             | 12 (5.7)    | 8              | 3            | 0                  | 1              |
| Drain           | 4 (1.9)     | 1              | 1            | 0                  | 2              |
| BUO             | 4 (1.9)     | 4              | 0            | 0                  | 0              |

SSI: surgical site infection, RI: remote infection, AAD: antibiotic-associated diarrhea, UTI: urinary tract infection, CR-BSI: catheter-related bloodstream infection, RTI: respiratory tract infection, Drain: drain infection, BUO: bacteremia of unknown origin
Table 4. Details of the patients with multiple postoperative infections

|                  | Total (n=25) (%) | Colon (n=15) | Rectum (n=10) |
|------------------|------------------|--------------|---------------|
|                  | Open (n=7)       | Laparoscopic (n=8) | Open (n=5) | Laparoscopic (n=5) |
| Two Pls          | 21 (84.0)        | 3            | 8            | 5            | 5            |
| Three Pls        | 2 (8.0)          | 2            | 0            | 0            | 0            |
| Four Pls         | 1 (4.0)          | 1            | 0            | 0            | 0            |
| Five Pls         | 1 (4.0)          | 1            | 0            | 0            | 0            |

Pl: postoperative infection
Table 5. Combined details for the patients with multiple postoperative infections

| Two PIs (n=21) |     |
|----------------|-----|
| Organ/space SSI + Incisional SSI | 3 |
| Organ/space SSI + BUO | 3 |
| Organ/space SSI + UTI | 2 |
| Organ/space SSI + CR-BSI | 2 |
| Organ/space SSI + AAD | 2 |
| Incisional SSI + CR-BSI | 2 |
| Incisional SSI + UTI | 2 |
| Incisional SSI + AAD | 2 |
| Incisional SSI + RTI | 1 |
| CR-BSI + RTI | 1 |
| RTI + AAD | 1 |
| Three PIs (n=2) |     |
| Organ/space SSI + CR-BSI + RTI | 1 |
| Organ/space SSI + incisional SSI + UTI | 1 |
| Four PIs (n=1) |     |
| Organ/space SSI + Incisional SSI + CR-BSI + UTI | 1 |
| Five PIs (n=1) |     |
| BUO + CR-BSI + UTI + RTI + AAD | 1 |

Pl: postoperative infection, SSI: surgical site infection, RI: remote infection, AAD: antibiotic-associated diarrhea, UTI: urinary tract infection, CR-BSI: catheter-related blood stream infection, RTI: respiratory tract infection, Drain: drain infection, BUO: bacteremia of unknown origin