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ORIGINAL ARTICLE

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Surgical site infection surveillance after open gastrectomy and risk factors for surgical site infection

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Abstract Surgical site infection (SSI) surveillance was examined in gastric cancer patients who had undergone an open gastrectomy between 1997 and 2003 at Keio University Hospital in Tokyo, Japan. National Nosocomial Infections Surveillance (NNIS) reports and several studies have discussed SSI risk factors, but only open gastrectomy was analyzed by regression analysis. The purpose of this study was to examine these issues by performing a regression analysis for the prediction of SSI. SSI was defined by the surgical patient component according to the NNIS system (1999) produced by the Centers for Disease Control and Prevention. Patients undergoing an open gastrectomy were followed up and monitored for SSIs. Risk factors for SSI, after all factors were considered, were studied using single and multivariate analysis. The study enrolled 984 patients who had undergoing an open gastrectomy. Using multivariate and logistic regression analysis, the duration of the operation was identified as the only risk factor for SSI at open gastrectomy. Although numerous potential risk factors in surgical patients were examined, the duration of the operation was the only significant risk factor for SSIs after open gastrectomy.

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Key words Surgical site infection (SSI) · Surveillance · Open gastrectomy · Multivariate analysis · Risk factors

Introduction

Several studies have shown that surgical site infections (SSIs) account for most hospital-acquired infections. SSI is an important clinical indicator of the quality of patient care. In addition, SSI surveillance provides important feedback to surgeons and health workers and has been shown to be an important component of strategies to reduce SSI risk.

Keio University Hospital, located in central Tokyo, is a referral teaching hospital with 1072 beds. SSI surveillance of general-gastrointestinal and cardiac surgeries was performed at our hospital from 1997 to 2003. The National Nosocomial Infection Surveillance system (NNIS) risk index (1999)[1] prepared by the Centers for Disease Control and Prevention (CDC) has been used since the beginning of SSI surveillance at our hospital. An SSI rate for open gastrectomy in our hospital was 13.8% during 1997–2003. Japan has a large number of digestive tract surgeries each year, especially for the treatment of gastric cancer. For this reason, the SSI rate and its risk factors were examined in patients who had undergone open gastrectomy. The NNIS reports and many studies have discussed SSI risk factors, but only open gastrectomy was examined by multivariate analysis. The purpose of this study was to examine these issues by performing a multivariate analysis based on a logistic regression model for prediction of SSI.

Methods

The SSI was defined using the surgical patient component according to the CDC/NNIS system (1999).[1] Our definition of SSIs included both incisional and deep infections. Patients undergoing an open gastrectomy were followed and monitored for SSIs. Patients undergoing laparoscopic

gastrectomy were excluded. A record for each patient undergoing open gastrectomy was generated, and each record included information on possible risk factors, such as wound class,[2,3] the duration of the operation, and the American Society of Anesthesiology (ASA) score.[4–6] Risk index category was determined by the NNIS manual.

Using a composite index for predicting the risk of SSI after operation, a number of potential risk factors were examined, including age, gender, body mass index (BMI), diabetes mellitus status, duration of operation, and operative procedure. These characteristics were evaluated in every patient who had undergone open gastrectomy during the period of the study. Well-trained infection control personnel employed by the university hospital prospectively followed all patients who underwent a surgical procedure for gastric cancer from August 1997 to December 2003. According to the NNIS system, risk index categories 0–3 were created. For the analysis, the incidence of SSIs per 100 surgeries was calculated. These data were compared for the groups with and without SSIs. All data analyzed were collected from daily charts, reviews, rounds of the involved wards, and microbiology reports. The 75th percentile regarding the duration of operation in our data was calculated.

Statistical analysis

After the operation all patients were divided in two groups according to whether they had had an SSI. All evaluated factors were compared between the two groups using a univariate analysis such as Student's *t*-test or the χ^2 test. To investigate the factors associated with SSIs, a multivariate analysis was performed using a logistic regression model, and significant variables were selected by stepwise regression. Odds ratios and their 95% confidence intervals (CI_{95}) were calculated using a logistic regression model. $P < 0.05$ was considered statistically significant. Statistical analyses were performed using SPSS v.12.0 software (SPSS Japan, Tokyo, Japan).

Results

From August 1997 to December 2003, the study enrolled 1116 patients who had undergone gastrectomy. There were 136 SSIs among 984 open gastrectomies. Population parameters such as age, gender, BMI, diabetic mellitus, ASA score, duration of the operation, wound class, operative procedure, and the NNIS risk index category for the surgical patient component are shown in Figs. 1–8. The 75th percentile for the duration of operation in our data was 300 min. The operative procedure at open gastrectomy (divided cardiotomy, distal gastrectomy, pylorectomy, total gastrectomy) and the duration of the operation in patients with and without an SSI is shown in Table 1. The duration of the operation was significantly longer in patients with an

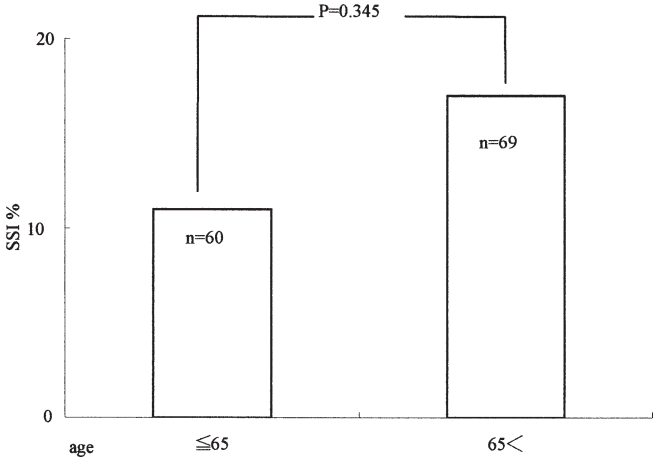

Fig. 1. Incidence of surgical site infections (*SSI*) compared by age

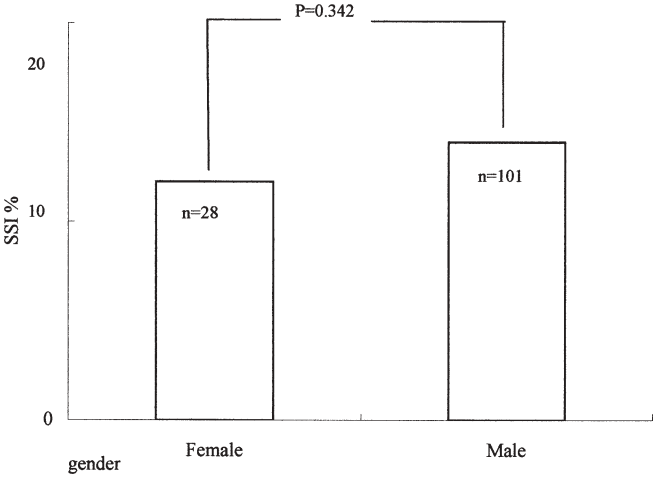

Fig. 2. Incidence of SSIs compared by sex

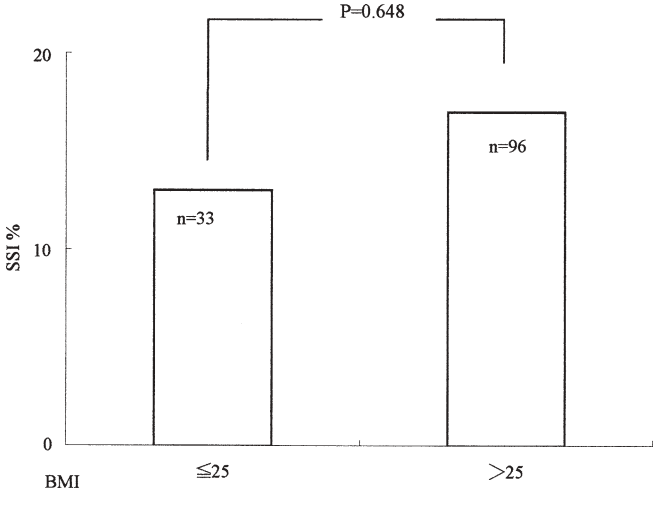

Fig. 3. Incidence of SSIs compared by body mass index

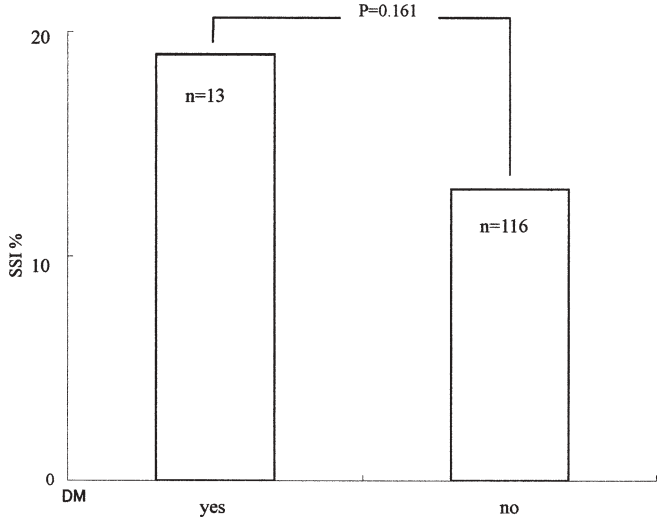

Fig. 4. Incidence of SSIs compared by diabetes mellitus status

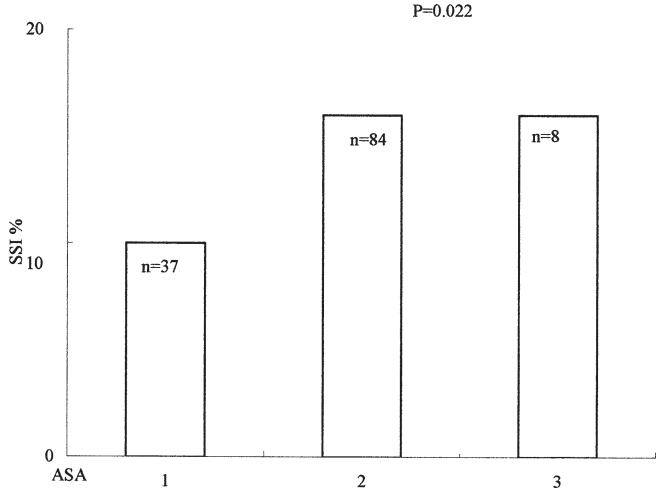

Fig. 5. Incidence of SSIs compared by American Society of Anesthesiologists (ASA) score

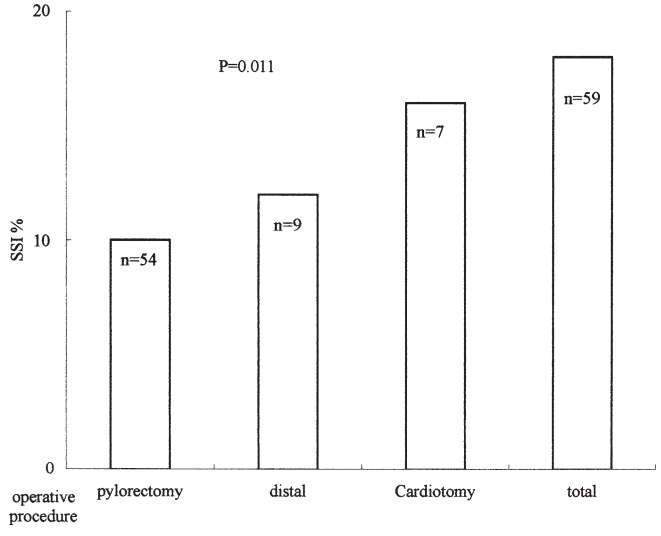

Fig. 6. Incidence of SSIs compared by operative procedure at open gastrectomy

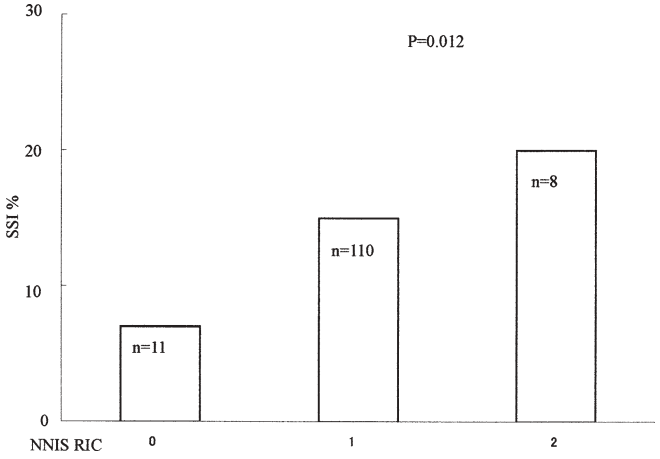

Fig. 7. Incidence of SSIs compared by National Nosocomial Infection Surveillance (NNIS) risk index

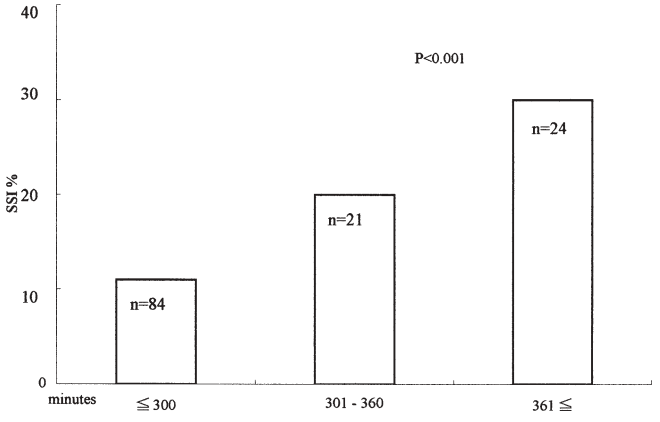

Fig. 8. Incidence of SSIs compared by duration of the operation

SSI than in those without ($P < 0.001$). However, no significant differences were observed among the four open gastrectomy procedures examined in this study ($P = 0.011$). The results of the logistic regression model after stepwise regression are shown Table 2. The duration of the operation was identified as the only significant risk factor for SSI. No significant differences in age, gender, BMI, or diabetes mellitus status were seen between the positive and negative SSI groups. Based on this analysis, the duration of the operation was found to be significantly correlated with the occurrence of SSIs ($P < 0.01$). Thus, a significant difference in the duration of the operations was observed between the two groups.

Discussion

The present study showed that an SSI was not closely associated with the operative procedure or other possible risk factors except the duration of the operation. The duration

Table 1. Operative procedure and duration of the operation

Type of gastrectomy	No. of SSI (–) operations	Duration of operation (min)			No. of SSI (+) operations	Duration of operation (min)		
		Average	SD	SE		Average	SD	SE
Cardiotomy	37	286.3	91.0	15.2	7	330.1	43.2	17.6
Distal gastrectomy	64	212.6	105.1	13.3	9	209.7	57.6	20.3
Pylorectomy	463	224.1	67.1	3.1	54	255.5	90.3	12.4
Total gastrectomy	261	264.6	72.5	4.5	59	312.0	116.0	15.2
Final tally	825	238.9	77.1		129	280.6	105.9	

SSIs, surgical site infections

Table 2. Final logistic regression model using step-wise method for open gastrectomy

Predictive factor: duration of operation (min)	Coefficient	Odds ratio	95% CI	*P*
				<0.001
0–300 (reference)	0	1	–	
301–360	0.849	2.338	1.411–3.874	
≥361	1.255	3.506	2.072–5.932	

Age, sex, body mass index, American Society of Anesthesiologists score, diabetes mellitus status, wound class, duration of operation, and operative procedure are considered in this model

of the operation in our data and in the NNIS data were slightly different because of differences in the operative procedures included in the studies. According to the ICD-9 CM code in the CDC's NNIS manual, open gastrectomy does not include lymphangiectomy, whereas in Japan most patients with open gastrectomy undergo lymphangiectomy as well. To evaluate the correlation between the operative procedure and the duration of the operation at open gastrectomy, we divided the procedure into four categories: cardiotomy, distal gastrectomy, pylorectomy, total gastrectomy. Using these data, no significant correlation was observed between the operative procedure and the duration of the operation. These data mean that the duration of the operation as a risk factor for SSI does not depend on the operative procedure undertaken. However, the number of patients with SSIs in some of the operative groups was quite small, so further study of this issue is warranted. No significant differences other, than the duration of operation, were observed between patients with or without an SSI.

The SSI rate for open gastrectomy was reported by the NNIS up until 1996[7–15] but is no longer reported annually. Our SSI rate for open gastrectomy during 1997–2003 was greater than the comparable reported NNIS data for open gastrectomy in 1996[7] and that for other digestive surgery data in 2002.[14,15] However, SSI surveillance is more common in this hospital than in the United States and some other countries[16] because of the long hospital stays that are standard in Japan and because all the patients who undergo operations are followed and receive postoperative care in our outpatient clinic. Although the validity of similar risk indices for Japan and the United States has been questioned, the NNIS Basic Risk Index is easy and simple to use, and it may be the best available tool for comparing SSI rates.[17] In conclusion, the duration of the operation was the only risk factor for SSIs after open gastrectomy, as determined by the logistic regression backward stepwise method.

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