Surgical site infection in *Japan*: A systematic review of the incidence and economic burden

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introduction

- A surgical site infection (SSI) is a type of hospital-acquired infection (HAI) that arises following surgery and is specifically related to the surgical site. It is estimated that SSIs may account for between 10-30% of all HAIs. [1].
- SSIs are associated with substantial economic costs, mainly attributable to the extended length of stay in hospital. Indirect costs, such as additional treatment and loss of productivity by the patient, further add to the burden of SSI.

objective

- The aim of this systematic literature review is to collate and describe studies examining the epidemiological and economic burden of SSI in Japan.

methods

- A literature search of epidemiological and economic studies conducted between 1995-2010 in the EMBASE and Medline databases was performed. For publications that were not in English, the methods and results sections were translated into English.
- The search strategy included SSI-related terms, epidemiological and economic terms. The literature search identified 2061 potentially relevant citations.
- Citations were searched for those that contained relevant search terms in the titles. These citations were then reviewed to identify relevant publications. Studies were excluded if they did not describe the rate, incidence, prevalence or cost of SSI. Studies which describe an intervention and studies not conducted in Japan were also excluded.
- Differences in study design make it difficult to combine data between studies. These differences include different timeframes, follow-up durations and presence or absence of risk factors (e.g. antibiotic prophylaxis). As such, the incidence of SSI can only be defined by range, and not synthesised to form a single estimate.

results

Study characteristics

- Following detailed assessment of these citations, a total of 35 publications were included in this review.
- Of the studies included, 22 were retrospective cohorts, 12 prospective and one case-control study.
- The majority of the studies were conducted in public hospitals. SSIs were defined according to either the Centres for Disease Control (CDC) or the Japan Nosocomial Infection Surveillance (JNIS) guidelines.
- While most studies conducted post-discharge surveillance, only one study reported the incidence of SSI separately for the pre- and post-discharge period.

Incidence

- Six studies reported an overall SSI incidence of 6–7%, for all surgical procedures in Japan.[2,3,4,5,6,7] However, the incidence of SSI varied more widely between surgical procedures. Where multiple studies report on the same surgical procedure, the study with the largest sample size was selected to be presented here. As shown in Table 1, the majority of studies examined gastrointestinal surgery, which was generally associated with a higher incidence of SSI (1–23%).[2,8,9,10,11] The incidence of SSI appeared lower for cardiothoracic surgery (1–5%).[2,7] Similarly, other surgical procedures examined, such as caesarean section and musculoskeletal surgery, had a low SSI incidence of 0–3%.[2,7]

Table 1: Incidence of surgical site infection by surgical procedure

Source	Surgical procedure	Study sample size	Incidence
Gastrointestinal surgery			
Harihara 2006	Appendectomy	982	10.2%
Shimizu 2006	Biliary surgery	218	23.4%
Harihara 2006	Cholecystectomy	2543	1.9%
Imai 2008	Colon surgery	1747	22.7%
Uchino 2009	Colorectal surgery	562	12.6%
Harihara 2006	Gastric surgery	2389	10.0%
Harihara 2006	Liver and pancreatic surgery	917	16.2%
Harihara 2006	Rectal surgery	796	16.6%
Toeda 2001	All gastrointestinal surgery	1843	15.9%
Cardiothoracic surgery			
Harihara 2006	Coronary artery bypass	454	5.5%
Harihara 2006	Heart surgery	760	1.4%
Yoshida 2006	Thoracic surgery	403	1.5%
Other surgical procedures			
Harihara 2006	Artificial hip-joint	167	0.6%
Harihara 2006	Caesarian section	355	0.0%
Harihara 2006	Genitourinary	258	2.7%
Harihara 2006	Hernia	1276	1.1%
Harihara 2006	Mammary gland	850	1.3%
Harihara 2006	Musculo-skeletal	1049	0.4%
Yoshida 2006	Herniorrhaphy	97	2.1%
Yoshida 2006	Mastectomy	208	0.5%

Pre- and post-discharge rates

- Only one study (Ambiru 2008[12]) reported the incidence of SSI separately for the pre- and post-discharge period; 62% of the infections were detected during the 30-day pre-discharge surveillance period and 38% during the post-discharge surveillance.

Risk factors

- The incidence of SSI also varied with several risk factors. Table 2 lists the specific patient and procedure factors, which showed significant association with SSI risk through multivariate analysis.[8,11,13,14,15,16]

results cont.

Table 2: Risk factors of surgical site infection in Japan

Source	Procedure	Risk factor	Risk estimate (95% CI)	p-value
Patient associated factors				
Nakano 2008	Off-pump CABG	Type 2 diabetes	HR 1.8 (1.2, 2.8)	0.0071
Imai 2008	Colon surgery	BMI ≥25	OR 1.65 (1.08, 2.52)	0.021
Okabayashi 2009	Hepatic resection	BMI >23.6	OR 3.7 (1.2, 11.2)	0.019
Imai 2008	Gastric surgery	Age ≥ 70 yr	OR 2.41 (1.24, 4.68)	0.01
Kobayashi 2009	Hepatectomy	Age ≥65 yr	OR 3.4 (1.15, 10.1)	0.027
Nakano 2008	Off-pump CABG	Female gender	HR 2.2 (1.4, 3.4)	0.0003
Procedure associated factors				
Imai 2008	Colon surgery	Laparoscopy vs open	OR 0.60 (0.39, 0.94)	0.024
	Gastric surgery	Laparoscopy vs open	OR 0.25 (0.07, 0.95)	0.042
Nakamura 2008	Colorectal surgery	Open vs laparoscopy	OR 3.33 (1.21, 9.20)	0.021
Uchino 2009	Colorectal surgery	Pre-operative hospital stay > 6 days	OR 1.73 (1.01. 3.00)	0.047
Konishi 2006	Colon surgery	No oral antibiotics	OR 3.3 (1.3, 9.7)	0.017
Konishi 2006	Rectal surgery	Pre-operative radiation	OR 2.8 (1.2, 6.6)	0.016

Abbreviations: BMI, Body mass index; CABG, Coronary artery bypass, HR, Hazard ratio; OR, Odds ratio.

Pathogens

- Several studies examined the pathogen associated with SSIs in Japan. The results from studies which examined more than 20 cultures are shown in Table 3.[4,7,17,18,19,20] The pathogens commonly associated with SSI were *Staphylococcus* spp., *Pseudomonas aeruginosa* and various *Enterococci*.

Table 3: Pathogens associated with surgical site infection in Japan

Source	Procedure	No. of infections	*Staphylococcus aureus*		*Pseudomonas aeruginosa*	*Staphylococcus* spp.	*Escherichia coli*	*Enterobacter spp.*	*Enterococcus spp.*	Other gram-negative bacilli	Other gram-positive bacilli	Others
			MSSA	MRSA								
Kimura 2007	24 surgical procedure	51	5.9		3.9	23.5	2	9.8	15.7	15.7	3.9	19.6
Kobayashi 2008	Colorectal surgery	54	NS	7.5	13.2	13.2	7.5	9.4	32	11.3	NS	5.9
Nishikawa 2008	Colorectal resection	26	NS	NS	7.7	19.2	NS	7.7	23.1	30.7	11.5	0.1
Shinagawa 2008	Abdominal surgery	236	11.6		5.8	NS	4.5	4	18.3	33	14.2	8.6
Takeyama 2005	Radical cystectomy	40	2.6	34.2	5.3	NS	5.3	NS	21.1	NS	NS	31.5
Yoshida 2006	General surgery	218	5.5	3.2	9.2	NS	5.5	8.3	16.1	12.9	NS	39.3

Abbreviations: **MRSA, Methicillin resistant *Staphylococcus aureus*; MSSA, Methicillin sensitive *Staphylococcus aureus***

Economic burden

- No economic evaluation studies of SSI in Japan were identified. However, as shown in Table 4, six studies examined the association between hospital stay and SSI.[9,13,15,16,21,22] Patients with SSIs experienced significantly longer hospital stays (6–27 additional days). The study by Sakamoto 2003 observed that following cardiac surgery, patients with SSIs had longer ICU stays compared to patients without SSIs.

Table 4: Length of hospital stay associated with surgical site infection

Source	Surgical procedure	Type of stay	Length of stay (days)			
			SSI	No SSI	Difference	P value
Kobayashi 2009	Hepatectomy	Post-operative stay	23.7	10.2	13.5	<0.001
Nakamura 2008	Colorectal surgery	Post-operative stay	14.1	8.1	6	<0.001
Nakano 2008	Off-pump CABG	Hospital stay	44.2 ± 50.8	17 ± 14	27.2	<0.0001
Okabayashi 2009	Hepatic resection	Hospital stay	36 ± 20	17 ± 9	19	<0.001
Sakamoto 2003	Cardiac surgery	ICU stay > 5 days	52.9%	21.7%	31.2%	0.002
Shimizu 2006	GI surgery	Post-operative stay	30.1	16.5	13.6	<0.0001

Abbreviations: **CABG, Coronary artery bypass graft; GI, Gastrointestinal; ICU, Intensive care unit.**

discussion

- The overall incidence of SSI in Japan was approximately 6–7%. Surgery involving the gastrointestinal tract and cardiovascular system were associated with a higher rate of SSI. Risk factors such as obesity, age and procedure associated factors, also influenced the risk of SSI.
- SSIs were shown to be associated with extended length of stay in hospital. Further studies evaluating the economic consequences of SSI (i.e. loss of productivity, additional outpatient treatment) would certainly provide a more accurate measure of the economic burden of SSIs.

conclusion

- SSI represents a burden to the healthcare system and patients, mainly attributable to the extended length of stay in hospital. Consequently, strategies and interventions aimed at reducing the incidence of SSIs could provide cost-savings and improve the efficiency of the healthcare system.

source of funding

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