

# Surgical site infection in *India*: 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. <sup>1</sup>
- SSIs are associated with substantial economic costs. In India, where an estimated 72% of healthcare expense is out-of-pocket, the additional cost associated with SSI (e.g. additional treatment, loss of ability to work) represents a potentially significant burden to patients and their families.

## objective

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

## methods

- A literature search of epidemiological and economic studies conducted between 1995-2010 in the EMBASE and Medline databases was performed.
- The search strategy included SSI-related terms, epidemiological and economic terms. The literature search identified 1112 potentially relevant citations.
- Citations were 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 India were also excluded.

## results

### Incidence

- Following detailed assessment of these citations, a total of 13 citations were included in this review.
- Of the included publications, nine were prospective surveillance studies, three retrospective cohorts and one case series.
- Seven studies reported the use of the Centres for Disease Control (CDC) definition of an SSI. Eight studies assessed SSI during the pre- and post-discharge period, however none of the studies reported the incidence of SSI pre- and post-discharge separately.
- Only studies with a sample size of more than 15 subjects have been presented here.

### Incidence

- Six studies reported an overall SSI incidence of 9-23%, for all surgical procedures in India.<sup>2,3,4</sup> However, the incidence of SSI varied more widely between surgical procedures. As shown in **Table 1**, higher incidences were generally observed for gastrointestinal (3-36%)<sup>2,5,6</sup> and cardiothoracic surgery (5-19%).<sup>7,8</sup> The incidence of SSI following neurosurgical procedures appeared lower (0.5–2.5%)<sup>9,10,11</sup>, however, these studies only considered SSI during the pre-discharge period, and would not have captured cases that might have occurred post-discharge. Other surgical procedures examined included breast surgery and genito-urinary surgery, with incidences ranging from 4-18%,<sup>2,6,12</sup>

Table 1: Incidence of surgical site infection by surgical procedure

Source	Surgical procedure specified	Observation period	Incidence (n/N)
Cardio-thoracic and vascular surgery			
Bhatia 2003	CABG	Pre- and post-discharge	18.7% (116/615)
Pawar 2005	Cardiac surgery with intra-aortic balloon counterpulsation	Pre-discharge and readmitted patients	5.1% (7/136)
Gastro-intestinal surgery			
Lilani 2005	Oesophageal, appendix, gastric and bowel surgery	Pre- and post-discharge	16.6% (3/18)
Shindholimath 2003	Laparoscopic cholecystectomy	Pre- and post-discharge	6.2% (7/113)
Suchitra 2009	Appendectomy	Pre- and post-discharge	3.4% (9/266)
Suchitra 2009	Gastrectomy	Pre- and post-discharge	36.4% (12/33)
Neurosurgery			
Agarwal 2003	Includes craniotomies, external ventricular drainage, centriculoperitoneal shunts	Pre-discharge only	1.6% (40/2558)
Sharma 2009	All routine and emergency neurosurgery procedures	Pre-discharge only	2.5% (786/31927)
Suri 2000	Neurosurgical patients in ICU	Pre-discharge only	0.5% (11/2320)
Other surgical procedures			
Ashraf 2009	Repeat breast surgery	Pre- and post-discharge	18.2% (231/1267)
Lilani 2005	Hepatobiliary surgery	Pre- and post-discharge	14.3% (3/21)
Lilani 2005	Hernia surgery	Pre- and post-discharge	4.3% (3/70)
Lilani 2005	Urinary and genital surgery	Pre- and post-discharge	7.0% (3/43)
Suchitra 2009	Hysterectomy	Pre- and post-discharge	10.4% (31/299)
Suchitra 2009	Prostatectomy	Pre- and post-discharge	15.2% (29/191)

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

### Risk factors

- The incidence of SSI also varied with several risk factors. As shown in **Table 2**, specific patient and procedure factors showed significant association with SSI risk through multivariate analysis.<sup>5,6,7,12</sup>

## results cont.

Table 2: Risk factors associated with surgical site infection in India

Source	Procedure	Follow-up	Risk variable	Risk estimate	p-value
Ashraf 2009	Repeat breast surgery	Pre- and post-discharge	Antibiotic prophylaxis	RR 0.62	<0.01
Bhatia 2003	CABG	Pre- and post-discharge	Diabetes	OR 1.85	0.014
			Obesity	OR 1.75	0.023
			Hypertension	OR 0.57	0.032
			Female gender	OR 3.02	0.0004
Shindholimath 2003	Cholecystectomy	Pre- and post-discharge	Bactibilia	OR 9.51	0.01
			Wound contamination	OR 2.59	0.01
Suchitra 2009	All procedures	Pre- and post-discharge	Diabetes	OR 3.85	<0.001
			Age > 45 years	OR 3.74	0.012
			Labourers, drivers	OR 4.39	<0.001

**Abbreviations:** CABG, Coronary artery bypass graft. OR, Odds ratio; RR, Relative risk.

### Pathogens

- Six of the included studies reported information on the pathogens present at the SSI.<sup>2,6,7,9,12,13</sup> As shown in **Table 3**, the pathogens commonly isolated were *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli*. The proportion of methicillin-resistant and methicillin-sensitive *Staphylococcus aureus* varied between studies.

Table 3: Pathogens associated with surgical site infections in India

Source	No. of infections	Surgical procedure	<i>Staphylococcus aureus</i>		<i>Pseudomonas aeruginosa</i>	<i>Escherichia coli</i>	Others
			MRSA	MSSA			
Agarwal 2003	40	Neurosurgery	35%	22.5%	10%	15%	17.5%
Ashraf 2009	193	Breast surgery	13.5%	24.3%	26.4%	0%	35.8%
Bhatia 2003	113	CABG	12.4%	3.5%	4.4%	15%	64.7%
Kownhar 2008	62	Not stated	8.1%	29%	32%	4.8%	26.1%
Lilani 2005	19	Elective surgery	10.5%	21%	21%	10.5%	37%
Suchitra 2009	135	Any procedure	14.1%	19.3%	24.4%	7.4%	34.8%

**Abbreviations:** CABG, Coronary artery bypass graft; MRSA, Methicillin resistant *Staphylococcus aureus*; MSSA, Methicillin resistant *Staphylococcus aureus*.

### Economic burden: Hospital stay

- Three studies examined the association between SSI and length of stay in hospital.<sup>2,6,7</sup> As shown in **Table 4**, SSIs were associated with an increase in post-operative hospital stay of between 5–18 days.

Table 4: Association of length of hospital stay and surgical site infection

Source	Surgical procedure	Type of stay	Length of stay (days)		
			SSI	No SSI	Difference
Bhatia 2003	CABG	Post-operative stay	15 (mild)	10	5
			19 (moderate)		9
			25 (severe)		15
Lilani 2005	Elective surgery	Post-operative stay	24.82	6.19	18.63
Suchitra 2009	All procedures	Ward stay	17.2	5.5	11.7
		ICU stay	8.7	1.6	7.1

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

### Economic burden: Cost of treatment

- The study by Bhatia 2003 found that 50% of patients with SSI needed a change in antibiotics. The increase in cost of treatment was 3.8% among patients with mild SSI, 14.7% for moderate infections, and 29.4% among patients with severe infections.
- The study by Suchitra 2009 estimated the additional cost incurred by patients who develop a SSI. The total expense (including hospital and medicine bills) by patients with SSI was significantly higher compared to patients without SSIs (29,000 vs 16,000 rupees, p<0.001).

## discussion

- The findings of this systematic review suggest that SSI represents a significant burden to patients and the healthcare system in India. The overall incidence of SSI was approximately 10%. Surgery involving the gastrointestinal tract and cardiovascular system were associated with a higher rates of SSI.
- Several patient-associated risk factors such as obesity and diabetes, as well as procedure-associated factors such as surgery duration and pre-operative hospital stay, also influenced the risk of SSI.
- One limitation of this review was lack of a meta-analysis of the results. However, variation in study design made it difficult to combine data. Studies used different definitions of SSI cases, follow-up methods and durations varied, and different risk factors were accounted for in each study.

## conclusion

- In India, where a substantial portion of healthcare expense is out-of-pocket, the additional cost associated with SSI represents a significant burden to patients and their families. The increase in hospital stay also lays additional burden to an already resource-constrained healthcare system. Interventions aimed at reducing SSI would provide cost-savings and improve the efficiency of the healthcare system.

### source of funding

Johnson and Johnson Medical, Asia-Pacific

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