Surgical site infection in *Australia*: 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 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 Australia.**

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 1382 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 Australia were also excluded.**

results

Study characteristics

- **Following detailed assessment of these citations, a total of 32 citations were included in this review.**
- **Studies were predominantly conducted in public hospitals in the states of NSW, QLD, VIC and WA in Australia**
- **Of the studies included, 34% were prospective cohorts, while 38% were case series. The remaining studies comprised cross-sectional surveys and retrospective cohorts.**
- **Most of the studies employed the Centres for Disease Control (CDC) definition of an SSI, while a few studies used their own clinical definition. The majority of studies assessed SSI during the pre-discharge period, however a few studies assessed SSI during the post-discharge period only (typically for a month following discharge).**

Incidence

- **Six studies reported an overall SSI incidence of 2-10% for all surgical procedures.[2-7]**
- **The incidence of SSI varied more widely across different surgical procedures. Higher incidences were generally observed for gastrointestinal (3-13%)[3,4,8] and cardiothoracic surgery (1-18%)[4,6,9-14], while the incidence of SSI after orthopaedic surgery appeared lower (1-8%).[2-6,15,16]**
- **Five studies examined the incidence of SSI pre- and post-discharge.[3,5,8,17,18] As shown in Table 1, a substantial portion of SSIs were detected after discharge from hospital.**

Table 1: Incidence of surgical site infection by surgical procedure

Source	Procedure	Study sample size	Incidence	% post-discharge
Orthopaedic surgery				
Mitchell 1999	All orthopaedic procedures	245	6.1%	33%
Kent 2001	Hip replacement	358	4.7%	47%
Kent 2001	Knee replacement	225	5.8%	62%
Gynaecological surgery				
Mitchell 1999	All elective procedures	209	10.0%	72%
Kent 2001	Caesarean	116	3.4%	47%
Noy 2002	Caesarean	247	17.0%	82%
Kent 2001	Hysterectomy	131	2.3%	35%
Gastrointestinal surgery				
Kent 2001	Cholecystectomy	180	10.0%	72%
Platell 1997	Colorectal surgery	553	11.6%	33%
Cardiothoracic surgery				
Hall 1998	Cardiac surgery	1000	5.9%	64%
Mitchell 1999	Cardiothoracic surgery	642	12.8%	78%
Mitchell 1999	Vascular surgery	59	6.8%	75%

Risk factors

- **The incidence of SSI also varied in the presence of certain risk factors.**
- **Table 2 shows SSI incidence by National Nosocomial Infection Surveillance (NNIS) risk score.[3,6,19,20,21]**
- **Specific patient and procedure associated risk factors were identified through multivariate analysis. Several factors (e.g. diabetes, obesity, surgery duration) showed consistent association with SSI risk. These are presented in Table 3.[9,13,14,19,22,23].**

Table 2: Association of NNIS risk scores with surgical site infection incidence

Source	Procedure	Follow-up	NNIS score			
			0	1	2	3
Kent 2001	Any procedure	Pre- and post-discharge	4.5% (39/874)	6.9% (27/391)	20% (10/50)	50% (1/2)
Morton 2008	Any procedure	Pre-discharge only	0.1% (321/36860)	1.7% (338/19589)		0% (0/0)
Harrington 2004	CABG	Pre-discharge only	0% (0/33)	7.0% (242/3438)	10.3% (103/1002)	100% (1/1)
Russo 2002	CABG	Pre-discharge only	0% (0/34)	8.0% (164/2045)	13.2% (35/266)	0% (0/0)
Russo 2005	CABG	Pre-discharge only	2.9% (1/359)	4.4% (111/2500)	6.0% (52/863)	0% (0/0)

***Abbreviations*: CABG, , Coronary artery bypass graft.**

results cont.

Table 3: Risk factors associated with surgical site infection

Source	Procedure	Follow-up	Risk variable	Risk estimate (95% CI)	p-value
Type 2 diabetes					
Robinson 2007	Cardiac surgery	Pre- and post-discharge	Diabetes	OR 2.5 (1.79, 3.47)	<0.05
Deng 2004	CABG	Not reported	Diabetes	OR 2.7 (1.09, 6.74)	<0.05
Friedman 2007	CABG	Pre-discharge only	Diabetes	OR 1.6 (1.3, 2.1)	<0.05
Harrington 2004	CABG	Pre-discharge only	Diabetes	RR 1.6 (1.2, 2.1)	>0.001
Spelman 2000	CABG	Pre-discharge only	Diabetes	RR 2.09 (1.2, 3.63)	0.009
Weight					
Friedman 2007	CABG	Pre-discharge only	Overweight	OR 1.2 (0.8, 1.6)	0.49
Friedman 2007	CABG	Pre-discharge only	Obese	OR 1.5 (1.0, 2.2)	0.04
Friedman 2007	CABG	Pre-discharge only	Morbidly obese	OR 2.6 (1.7, 4.1)	<0.001
Harrington 2004	CABG	Pre-discharge only	Obese	RR 1.8 (1.4, 2.3)	<0.001
Robinson 2007	Cardiac surgery	Pre- and post discharge	Overweight & Obese	OR 1.72 (1.10, 2.68)	0.02
Spelman 2000	CABG	Pre-discharge only	Obese	RR 2.82 (1.58, 5.03)	0.001
Surgery duration					
Clements 2007	13 procedures	Pre- and post discharge	>2-3 hours	OR 1.31 (1.06, 1.62)	0.01
Clements 2007	13 procedures	Pre- and post discharge	>3-5 hours	OR 1.55 (1.17, 2.06)	0.002
Clements 2007	13 procedures	Pre- and post discharge	> 5 hours	OR 3.01 (1.97, 4.61)	<0.001

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

Pathogens

- **As shown in Table 4, the most common pathogen associated with SSIs in Australia was *Staphylococcus aureus*, with approximately equal proportions being methicillin-resistant and methicillin-sensitive.[14,19,24].**

Table 4: Pathogen associated with surgical site infections in Australia

Source	Number of infections	*Staphylococcus aureus*		*Pseudomonas aeruginosa*	*Mixed / Enteric flora*	Others
		MRSA	MSSA			
Chen 2008	31	23%	39%	0%	13%	25%
Harrington 2004	296	32%	24%	0%	13%	31%
Spelman 2000	61	32%	27%	5%	18%	18%

***Abbreviations*: MRSA, Methicillin-resistance *Staphylococcus aureus*; MSSA, Methicillin-sensitive *Staphylococcus aureus*.**

Economic burden

- **As shown in Table 5, SSIs were associated with increased length of stay in hospital and increased treatment cost.[8,25-27]**
- **The study by Graves 2009 estimated that over 21,000 cases of SSI occur annually, which result in the loss of 53,536 hospital bed-days, representing an economic burden of over AU$53 million.**
- **The economic burden of SSI was examined by Graves 2008. It was estimated that 31% of the cost was related to hospital stay, and 14% to post-discharge healthcare; while the remaining costs were attributable to production losses by the patient (20%) and informal carer (35%).**

Table 5: Economic costs associated with surgical site infection in Australia

Study	Procedure	Additional cost associated with SSI	Extended hospital stay associated with SSI
Graves 2009	All procedures	AU$53 million / year	Loss of 53,536 bed-days in hospitals / year
Graves 2008	All procedures	Pre-discharge SSI: AU$2,047 Post-discharge SSI: AU$725	17.4 additional days
Jenney 2001	CABG	AU$12,419 per case of SSI	1.3 additional days in ICU 6.1 additional days in Ward
Platell 1997	Colorectal surgery	---	9 additional days

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

discussion

- **The findings of this systematic review suggest that SSI represents a significant burden to patients and the healthcare system in Australia. The overall incidence of SSI was approximately 5-10%. Surgery involving the gastrointestinal tract and cardiovascular system were associated with a higher rates of SSI.**
- **The results show that a large portion of SSIs often occur after discharge from hospital. This in turn has the potential to increase the economic burden to community health services and the families of patients.**

conclusion

- **SSI represents a substantial burden on the healthcare system and patients, mainly attributable to the extended length of stay in hospital and additional cost of treatment required.**
- **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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