



Original Article

# Risk factors for postoperative spinal infection: A retrospective analysis of 5065 cases

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## ABSTRACT

**Background:** Multiple factors increase the risk for spinal surgical site infection (SSI): prior SSI, obesity, diabetes mellitus, advanced age, American Society of Anesthesiologists class, alcohol abuse, low prealbumin levels, smoking, history of cancer, chronic steroids, immunosuppressive drugs, rheumatoid arthritis, and hypothyroidism.

**Methods:** Here, we performed a retrospective medical record review at one facility involving 5065 patients from 2010 to 2015. In 2011, there was an increase in the infection rate (1.07%) which prompted this analysis, resulting in the subsequent introduction of a protocol to reduce the infection risk.

**Results:** The overall infection rate in this series was 0.59%. The lowest infection rate was 0.00% for anterior cervical discectomy and fusion. The highest rate of infections occurred among patients undergoing posterior cervical fusions, lumbar fusions, and tumor resections. Higher infection rates were also correlated with diabetes mellitus, obesity, and increased surgical time.

**Conclusions:** Since 2011, we instituted a protocol to limit the risks of spinal SSIs, particularly for patients exhibiting increased medical comorbidities.

**Keywords:** Infection, Risk factors, Spine surgery, Surgical site infection

## INTRODUCTION

Postoperative infection in spine surgery occurs from <1% to as high as 12% of the time.<sup>[1]</sup> The mean direct hospital cost of a single readmission for a postoperative spine surgical site infection (SSI) had been reported as high as \$ 16,242.<sup>[2]</sup>

In 2011, we noted an increase in SSI at our institution. These SSI correlated with the following predisposing risk factors/comorbidities: obesity, diabetes mellitus, advanced age, higher American Society of Anesthesiologists (ASA) class, alcohol abuse, low prealbumin levels and malnutrition status, smoking, history of cancer, chronic steroid use, rheumatoid arthritis, and hypothyroidism. Here, we reviewed our findings and the protocol we introduced to avoid SSI in 2011 along with a review of literature.

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## METHODS

We performed a retrospective medical record review of SSI from 2010 to 2015 with the institutional review board approval. The multiple risk factors and comorbidities studied included diabetes, obesity, smoking, age, and ASA. In 2012, we implemented new additional preoperative and perioperative measures to reduce SSI infection risk.

### Preoperative counseling and measures

Preoperatively, as appropriate, patients were advised regarding weight loss, smoking cessation, and discontinuation of immunosuppressant medications. Those with inadequate prealbumin levels received high protein supplements.<sup>[5]</sup> For those with a history of diabetes about to undergo spinal surgery,<sup>[4]</sup> hemoglobin A1C levels had to be below 7.5 for those without additional risk factors and below 7.0 for those with additional SSI risk factors.

### Skin prep protocol

Three days before surgery, patients were advised to perform local washing of the operative site with Hibiclens. For high-risk patients, a three-step regimen was initiated that included: first isopropyl alcohol, next Betadine, and finally Hibiclens. In the preoperative holding area, the patients' surgical site was wiped with chlorhexidine gluconate.

### Preoperative antibiotic protocol

Cefazolin was used as a first-line antibiotic; we utilized a standard dose of 2 g. However, patients over 80 kg received 3 g. The second-line antibiotic was vancomycin dosed at 1 g; patients over 90 kg received 1.5 g. The antibiotic chosen was redosed when the length of the operative procedure exceeded 4 h. Intravenous antibiotics were continued for 24–48 h postoperatively, dependent on the drain status. In high-risk patients, 5 days of additional oral antibiotics were given at discharge.

### Intraoperative irrigation

In high-risk patients, the surgical wound was irrigated with 3 l of saline with antibiotics before skin closure. In addition, in 2014, vancomycin powder was introduced and placed topically in the operative bed.

### Silver dressing

In high-risk patients, silver nitrate impregnated dressings were utilized over wounds with staples or sutures. The operative dressing was maintained for 3 days in most cases, followed by daily dry dressing changes and a Betadine cleanse of staples when present. The wound was kept dry and covered for 1 week.

### Foley catheter

The Foley catheter was discontinued on postoperative day 1, unless longer placement was indicated.

### Glucose monitoring

In diabetic patients, glucose levels were monitored closely intraoperatively, and postoperatively; they were treated appropriately.

### Immunosuppressant medications

These medications were routinely discontinued 2 weeks before surgery and resumed at the first 2 weeks postoperative visit.

## RESULTS AND DISCUSSION

The population comprised a total of 5065 spine cases performed by one service in the same facility. A total of 30 (0.59%) infections were documented utilizing positive wound cultures taken during operative wound revisions. The peak rate was seen in 2011, with 11 (1.07%) SSIs out of 1031 cases performed that year.

In general, longer procedures were associated with an increased risk of SSI.<sup>[6]</sup> Notably, of 1684 of 5065 cases (33.2%) lasting 61–90 min, the infection rate was 0.26%. However, with 526 (10.4%) procedures lasting 151–180 min, the infection rate increased to 1.9% and constituted 33.3% (10 of 30) of the total infections in that sample [Table 1].

The 5065 cases were divided into eight categories [Table 2]. The peak rate of infection was seen in the posterior cervical fusion category (e.g., 2 [6.25%] SSIs in 32 procedures). Tumors yielded the next highest rate of infection (3.45%). This was followed by 19 (1.60%) infections of 1188 lumbar fusion procedures. Notably, lumbar fusions exhibited the highest risk of infection among other spine surgeries due to the length of the procedure, the higher frequency of revision surgery, age >60, and additional risk factors. The lowest rate of infection was seen for anterior cervical discectomy and fusion, posterior cervical nonfusion cases, and other categories (e.g., [0%] of 1254 cases). The rate of SSI in revision surgery was 8 (1.03%) of 775.

We were not able to identify a correlation between the risk of infection and the ASA classification score.

With the initiation of the current protocol, since 2011, over the next 6 years, despite a gradual increase in the medical complexity/comorbidities of the patient population, there were no further increases in the SSI rates [Tables 3 and 4].

**Table 1:** Procedure length in the population and SSI group.

Length of procedure (min)	Population total	SSI total
0–30	30	0
31–60	1205	1 (0.08%)
61–90	1941	5 (0.26%)
91–120	866	5 (0.58%)
121–150	646	7 (1.08%)
151–180	526	10 (1.90%)
181–210	274	7 (2.55%)

SSI: Surgical site infection

**Table 2:** A numerical representation of the infection rate for each category of surgical procedure performed over the period of 2010-2015 in this single surgeon practice.

Procedure	Total cases	Infection (%)
Microdiscectomy/lumbar hemilaminectomy (MCD/HL)	1922	5 (0.26)
Laminectomy (LAMI)	640	3 (0.47)
Lumbar pedicle screw fixation (PSF)	1188	19 (1.60)
Tumor/tethered cord release (TR/TCR)	29	1 (3.45)
Posterior cervical fusion (PCF)	32	2 (6.25)
Anterior cervical discectomy and fusion (ACDF)	1134	0 (0.00)
Posterior cervical nonfusion (PCNF)	42	0 (0.00)
Other (OTH)	78	0 (0.00)

**Table 3:** Rate of surgical site infection based on risk factor.

Risk factor	Population total	Infection total	Rate of SSI (%)
Diabetes mellitus	827	10	1.20*
Obesity			
BMI 30–34.9	1017	7	0.69*
BMI 35–39.9	444	5	1.13*
BMI 40+	184	3	1.63*
Current smoker	1225	6	0.49
Age			
18–40	859	3	0.35
41–60	2315	12	0.52
61+	1889	15	0.79*
Redo surgery	775	8	1.03*
Steroid use	911	3	0.33

\*Indicates a rate higher than the SSI rate in the population of 0.59%.  
BMI: Body mass index, SSI: Surgical site infection

### Organisms involved in infection

In literature, *Staphylococcus aureus* is the principal agent cited in SSI following spine surgery.<sup>[3]</sup> Other agents commonly identified include coagulase-negative

**Table 4:** Number of risk factors.

Number of risk factors*	Population	Infection	Rate (%)
0	314	0	0
1	617	2	0.32
2	1009	6	0.59
3	1156	6	0.52
4	1046	7	0.67
5	591	4	0.68
6	219	5	2.28

\*Risk factors included obesity, diabetes mellitus, smoking, hypothyroidism, steroid use, use of immunosuppressant drugs, rheumatoid factor, depression, chronic narcotic use, alcohol use, fibromyalgia, cancer

**Table 5:** Organisms isolated during intraoperative cultures in the SSI group.

Organism	Incidence
Single species	
Methicillin-sensitive <i>Staphylococcus aureus</i>	8
Methicillin-resistant <i>Staphylococcus aureus</i>	4
<i>Escherichia coli</i>	4
Coagulase-negative Staph	4
<i>Citrobacter amalonaticus</i>	1
<i>Enterococcus faecalis</i>	1
<i>Staphylococcus intermedius</i>	1
<i>Proteus mirabilis</i>	1
Alpha-hemolytic streptococci	1
<i>Candida albicans</i>	1
<i>Candida parapsilosis</i>	1
Multispecies	
<i>Enterobacter cloacae</i> , Methicillin-resistant	1
<i>Staphylococcus aureus</i> , yeast	
<i>Escherichia coli</i> , methicillin-sensitive	1
<i>Staphylococcus aureus</i>	
Methicillin-resistant <i>Staphylococcus aureus</i> , <i>Escherichia coli</i>	1

SSI: Surgical site infection

staphylococci, *Staphylococcus epidermidis*, beta-hemolytic *Streptococcus*, and Gram-negative organisms such as *Proteus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella*, and *Enterobacter* [Table 5].<sup>[3]</sup>

### CONCLUSIONS

SSIs increase the costs of spinal surgery, resulting in readmissions and/or increased length of hospital stay. Obesity and diabetes independently contributed to higher SSI rates. Our data showed that multiple risk factors may quadruple the expected SSI rate. However, the introduction of a new infection prevention protocol in 2011 kept the infection rate as low as 0.59%, regardless of the case complexity, attendant comorbidities, and increased case mix index over the ensuing 6 years.

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### Conflicts of interest

There are no conflicts of interest.

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