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Review article

Prophylaxis of surgical site infection in adult spine surgery: A systematic review ☆

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ABSTRACT

Introduction: Surgical site infection (SSI) remains a significant source of morbidity in spine surgery, with reported rates varying from 0.7 to 16%.
Objective: To systematically review and evaluate the evidence for strategies for prophylaxis of SSI in adult spine surgery in the last twenty years.
Methods: Two independent systematic searches were conducted, at two international spine centers, encompassing PubMed, ClinicalTrials.gov, Cochrane Database, EBSCO Medline, ScienceDirect, Ovid Medline, EMBASE (Ovid), and MEDLINE. References were combined and screened, then distilled to 69 independent studies for final review.
Results: 11 randomized controlled trials (RCTs), 51 case-controlled studies (CCS), and 7 case series were identified. Wide variation exists in surgical indications, approaches, procedures, and even definitions of SSI. Intra-wound vancomycin powder was the most widely studied intervention (19 studies, 1 RCT). Multiple studies examined perioperative antibiotic protocols, closed-suction drainage, povidone-iodine solution irrigation, and 2-octyl-cyanoacrylate skin closure. 18 interventions were examined by a single study only. There is limited evidence for the efficacy of intra-wound vancomycin. There is strong evidence that closed-suction drainage does not affect SSI rates, while there is moderate evidence for the efficacy of povidone-iodine irrigation and that single-dose preoperative antibiotics is as effective as multiple doses. Few conclusions can be drawn about other interventions given the paucity and poor quality of studies.
Conclusions: While a small body of evidence underscores a select few interventions for SSI prophylaxis in adult spine surgery, most proposed measures have not been investigated beyond a single study. Further high level evidence is required to justify SSI preventative treatments.

1. Introduction

Despite efforts to reduce its incidence, surgical site infection (SSI) remains a common and costly complication of adult spine surgery. SSI is associated with greater length of stay, morbidity, and mortality. It has been estimated by the Society for Healthcare Epidemiology of America (SHEA) that up to 60% of SSIs are preventable if evidence based guidelines are followed [5]. However, the incidence of spinal SSI has been reported from 0.7 to 16%. Risk factors for SSI have been well studied and reported in a number of systematic reviews [147,109], and mitigation against these is one area for focus of prevention of SSI. Prophylactic measures – preoperative, intraoperative, or postoperative – are another focus to reduce SSI rates.

Since the first systematic review on prophylactic strategies against SSI in spine surgery by Brown et al. in 2004 [16], there has been an expansion of the number of preventative measures introduced and studied in the spine literature, most notably intra-wound application of vancomycin powder. However, as noted by van Middendorp et al. [147], many studies are of lower methodologic quality and there is significant heterogeneity in the use of prophylactic strategies that are not part of the intervention studied in these papers [147]. As such, our objectives were to not only

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identify all strategies studied to date for prophylaxis of SSI in adult spine surgery but also to systematically review and evaluate the evidence, serving as an update of similar such reviews. Given the changes to spine surgery in terms of technique and instrumentation, as well as to the perioperative routines such as administration of preoperative antibiotics that may affect SSI rates, we limited our review to studies published in the last twenty years.

2. Methods

2.1. Study design

We conducted a formal systematic review of any published literature from the last twenty years assessing prophylactic measures against surgical site infection in adult spine surgery. Two concurrent independent searches, one each in Canada and in Australia, were performed to optimize capture of all relevant studies. The level of evidence was assessed for each study included. The strength of evidence was then graded for each prophylactic measure.

2.2. Search strategy

The Canadian search was run from inception on August 8, 2016, with a second search on October 12, 2016, encompassing PubMed, ClinicalTrials.gov, Cochrane Database of Systematic Reviews, EBSCO Medline, ScienceDirect, Ovid Medline, EMBASE (Ovid), and MEDLINE with limits of English language, Clinical Trial, Humans, and Adults age 19+. Search terms used were (spine OR spinal) AND (infection) AND (prophylaxis OR prevention OR antibiotics OR surgery OR surgical).

The Australian search encompassed MEDLINE with the MeSH Heading search terms (exp = (surgical wound infection) AND exp = (spinal)) NOT (exp = (surgical wound infection) AND (exp = (laminectomy) OR exp = (laminoplasty) OR exp = (spinal fusion)) refined by MeSH qualifier (prevention control). The references from this search were then screened for additional potentially relevant studies.

2.3. Study selection

We included studies which reported prophylactic measures to prevent SSIs following adult spinal surgery. Excluded studies included those which reported treatment of pre-existing SSIs, evaluation of pediatric patient populations, and those articles published in languages other than English or articles without an abstract.

2.4. Determining level of evidence and grading recommendations

Two authors, one each in Canada and Australia, independently extracted data and rated quality of the included studies. Extracted data included prophylactic measures, comparative measures, spinal level, surgical indication, approach, and procedure, whether instrumentation was placed, and outcome. Study quality was assessed based on study design, method of data collection, sample size, reporting of bias- prone issues, and definition of SSI, in similar fashion to the review by van Middendorp et al. Levels of evidence were assigned per an existing guideline (Table 1) [156], and consensus reached between all four authors if there were any disagreements. Grade of recommendation, again based on an existing guideline (Table 2) [157], was then made for each prophylactic measure based on existing guidelines.

Table 1
Levels of evidence for therapeutic studies (adapted from Wright et al. 2003 [156]).

Level I	• Randomized controlled trial with significant difference or no significant difference but with narrow confidence intervals • Systematic review of homogenous Level I randomized controlled trials
Level II	• Prospective cohort study • Poor quality randomized controlled trial • Systematic review of Level II studies or non-homogenous Level I studies
Level III	• Case-control study • Retrospective cohort study • Systematic review of Level III studies
Level IV	• Case series
Level V	• Expert opinion

Table 2
Grade of recommendation for reviews of surgical studies (adapted from Wright et al. 2005 [157]).

Grade A	Good evidence (Level I studies with consistent findings) for or against recommending intervention
Grade B	Fair evidence (Level II or III studies with consistent findings) for or against recommending intervention
Grade C	Conflicting or poor-quality evidence (Level IV or V studies) not allowing a recommendation for or against intervention
Grade I	There is insufficient evidence to make a recommendation

3. Results

3.1. Search results

The Canadian search returned 13,418 unique titles, of which 98 articles were deemed potentially relevant. The Australian search returned 47 unique titles, with an additional 49 potentially relevant titles found from screening of those references, resulting in a total of 96 articles deemed potentially relevant. The final pool of articles from both searches were then combined and screened by all authors, then distilled down to 69 independent studies included for our review.

3.2. Overview of included studies

11 randomized controlled trials (RCTs), 51 case-controlled studies (CCS), and 7 case series were identified (Table 3). 7 studies were characterized as level I evidence, 16 as level II, 38 as level III, and the remaining 8 as level IV. We noted wide variation in surgical indications, approaches, procedures, and even definitions of SSI. Intra-wound vancomycin powder was the most widely studied intervention, with 21 studies (one RCT, 18 CCS, 2 case series). 13 studies looked at perioperative antibiotic protocols (4 RCTs, 7 CCS, 2 case series), of which 5 looked at the efficacy of single-dose preoperative antibiotics compared to multiple-dose perioperative antibiotics (1 RCT, 4 CCS) while the remainder compared different durations or selection guidelines of perioperative antibiotics. 8 studies looked at closed- suction wound drainage alone (2 RCTs, 5 CCS, 1 case series). 2 studies looked at povidone-iodine solution irrigation alone (2 RCTs). 3 studies looked at use of 2-octyl-cyanoacrylate for skin closure (2 CCS, 1 case series). 7 studies looked at the efficacy of a combination of multiple interventions (7 CCS) (see Table 4).

15 standalone interventions were examined by only a single study each (2 RCTs, 11 CCS, 2 case series).

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