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QUESTION 4: Should vancomycin powder be applied to the wound in patients undergoing spinal surgeries? Are there any potential harms associated with this practice?

RECOMMENDATION: Yes. Evidence suggests that vancomycin powder applied to the wound during spinal surgery reduces the risk of infection. However, the majority of studies lack a control arm and it is not known if vancomycin powder is better than antiseptic agents. There is insufficient evidence for or against the potential harm associated with this practice.

LEVEL OF EVIDENCE: Moderate

DELEGATE VOTE: Agree: 79%, Disagree: 14%, Abstain: 7% (Super Majority, Strong Consensus)

RATIONALE

Surgical site infection is a known risk of spine surgery with or without instrumentation, and gram-positive organisms are the most common pathogens in such infections. Many practitioners now apply vancomycin powder intraoperatively to reduce the risk of infection. Given concern for vancomycin's adverse effects and antimicrobial resistance, it is critical to consider a risk-benefit analysis of this practice.

A number of studies addressed the efficacy of vancomycin powder use in spine surgery. These have been the subject of several systematic reviews. Xie et al. reviewed 19 retrospective cohort studies and 1 prospective case study, with results suggesting benefit in all but 2 of these with an overall infection risk of 2.83-fold higher for patients not receiving vancomycin powder compared to those receiving it [1]. The authors pointed out study heterogeneity with regard to powder, drug dosage and exposure of bone graft and instrumentation to the drug, citing these as areas for future investigation. This trend toward benefit was confirmed in five other systematic reviews [2–6].

With regard to adverse effects, Ghobrial et al. performed a systematic review of 16 studies with 6,701 patients [7]. Of these, 1 patient developed nephropathy, 2 patients experienced hearing loss, 1 patient had an elevated vancomycin level and 19 patients developed culture-negative seroma. The authors highlighted the lack of in vivo evidence regarding vancomycin resistance. There was a trend toward gram-negative and polymicrobial infections among vancomycin powder recipients in one study [8].

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QUESTION 5: What is the optimal perioperative antibiotic prophylaxis for patients undergoing spine surgery? What considerations should be made in cases of drug allergies?

RECOMMENDATION: The optimal prophylactic antibiotic for an uncomplicated spine surgery is a first- or second-generation cephalosporin given intravenously within 60 minutes of initial incision.

In patients with a history of anaphylactic reaction after use of beta lactams or in countries with a high rate of methicillin-resistant *Staphylococcal* infections, vancomycin in a weight-adjusted dose (15 mg/kg) should be used. Clindamycin 600 mg intravenously is an alternative to vancomycin.

LEVEL OF EVIDENCE: Moderate

DELEGATE VOTE: Agree: 79%, Disagree: 7%, Abstain: 14% (Super Majority, Strong Consensus)

RATIONALE

Current literature supports the use of prophylactic antibiotics for spinal procedures with or without instrumentation to decrease the

risk of surgical site infections (SSI), with a first- or second-generation cephalosporin being the antibiotic of choice [1–6]. In addition, clin-

ical guidelines set forth by the American Society of Health-System Pharmacists (ASHP), the Infectious Diseases Society of America (IDSA), the Surgical Infection Society (SIS), the Society for Healthcare Epidemiology of America (SHEA) and the North American Spine Society support the use of first-generation cephalosporins [1,7,8]. Although comparative studies to evaluate the optimal timing for preoperative antibiotic have not been conducted for spine surgery, it is well-established that intravenous cephalosporins given within 60 minutes before initial incision is effective [9,10].

In a comparative study evaluating the addition of vancomycin powder for posterior thoracic and lumbar spine surgery, Sweet et al. found that vancomycin powder reduced the rate of SSI compared to intravenous cephalosporin alone (0.2% vs. 2.6%, $p < 0.0001$).

Regarding prophylaxis regimens combining antibiotic agents, randomized clinical trials exist which show a reduced rate of postsurgical infections if a combination of a cephalosporin and gentamicin or vancomycin and gentamicin is used, compared to placebo [11,12]. However, there are no studies available which compare combination regimens with the standard prophylaxis with cefazolin. A study by Pons et al. comparing ceftizoxime versus the combination prophylaxis with vancomycin and gentamicin found no decreased infection rate, but higher toxicity with the combination regimen [13].

There is no specific recommendation for adapted prophylaxis in obese patients in spine surgery. However, in periprosthetic joint infections, adaptation is discussed in patients with a weight more than 100 kg since infection rate was twice that in other patients [13-15].

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QUESTION 6: What are the optimal prophylactic antibiotics for patients with neurogenic bladder who are undergoing spine surgery?

RECOMMENDATION: The recommended standard perioperative antibiotic prophylaxis in spine surgery is cefazolin, but a broader-spectrum prophylaxis may be necessary in patient subpopulations more prone to acquiring surgical site infections (SSIs). In the case of neurogenic bladder, preoperative urine culture and individualized antibiotic prophylaxis are associated with a significant decrease in SSIs due to gram-negative bacilli (GNB).

LEVEL OF EVIDENCE: Moderate

DELEGATE VOTE: Agree: 79%, Disagree: 14%, Abstain: 7% (Super Majority, Strong Consensus)

RATIONALE

Prevention of SSI is of utmost importance in patients undergoing spine surgery, and perioperative antibiotic prophylaxis is a key measure to avoid this complication [1,2]. However, the superiority of one agent or schedule over any other has not been clearly demonstrated [1,2]. The recommended standard perioperative antibiotic prophylaxis in spinal surgery is cefazolin [1]. Isolated reports have shown that a broader-spectrum prophylaxis may be necessary in patient subpopulations more prone to acquiring poly-microbial SSI, such as those with neuromuscular deformities or spinal cord injury. In a retrospective observation study, Dessy et al. demonstrated that an enhanced antibiotic prophylaxis using intravenous (IV)

cefuroxime for 24 hours plus vancomycin until drain removal in instrumented spinal surgery, and IV cefuroxime for 24 hours in non-instrumentation cases reduced the rate of SSIs in spine surgery [3].

There are no published data regarding the best antibiotic treatment to be used as prophylaxis in patients with neurogenic bladder. The North American Spine Society (NASS) evidence-based guidelines on antibiotic prophylaxis in spinal surgery have pointed out that potential subgroups of patients requiring effective prophylaxis against GNB may exist, although they have not been clearly defined [1]. In the case of patients with neurogenic bladder, they are more prone to urinary tract colonization and infection [4-5]. Although