In conclusion, in patients undergoing spinal surgery, the low level of MRSA carriage and MRSA SSI are arguments against routine MRSA screening. In hospitals with a high incidence of *S. aureus* spinal SSI and high rates of MRSA infections, MRSA screening could be useful.

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QUESTION 3: Is there a role for routine decolonization of patients undergoing spine surgery? If so, what is the optimal agent(s)?

RECOMMENDATION: There is evidence to support the use of institutionalized screening and decolonization programs in methicillin-resistant *Staphylococcus aureus* (MRSA) carriers to reduce the rate of surgical site infection (SSI), however the optimum agents for decolonization have not been determined.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 91%, Disagree: 0%, Abstain: 9% (Super Majority, Strong Consensus)

RATIONALE

There is evidence to support the use of institutionalized screening and decolonization programs to reduce the rate of SSI, however the optimum agents for decolonization have not been determined [1]. Preoperative nasal MRSA colonization is associated with increased risk postoperative spinal SSI. Thakkar et al. reported screening positive MRSA SSI rates of 12% compared with screening positive for MSSA (5.73%) and screening negative (1.82%) [2]. Furthermore, Ramos et al. found increased rates of SSI in hip and knee arthroplasty and spine fusions, reporting a 4.35% SSI rate in colonized (nasal MRSA and MSSA) patients versus a 2.39% rate in noncolonized patients [3].

While widely utilized preoperatively, there is minimal evidence specifically supporting the use of chlorhexidine gluconate (CHG) showers preoperatively. The 2015 Cochrane review written by Webster et al. reported minimal evidence supporting isolated use of CHG showers preoperatively. Four reviewed trials comparing CHG to placebo found no effect, and only one trial comparing CHG showers to controls reported an improvement in SSI rate [4].

The majority of reviewed literature bundles the use of nasal decolonization with other interventions (CHG wipes, CHG showers, etc.). Multiple reviews on the effectiveness of bundled interventions for decolonization in surgical patients (including orthopaedic surgery) report reduced SSI rates with nasal decolonization and CHG wipes [5,6]. Reported studies on nasal decolonization protocols have largely shown benefit in reducing SSIs. Mullen et al. used CHG wipes and alcohol-based nasal decolonization preoperatively and reported a mean reduction rate in SSI of 81% (1.76 per 100 to 0.33 per 100) [7].

Chen et al. reviewed 19 studies of decolonization protocols on orthopaedic procedures and found significant efficacy in reducing SSIs, reporting reduction of *S. aureus* SSIs ranging from 40–200% and reduction of MRSA SSI from 29–149% [8]. Bode et al. performed a randomized, double blinded trial to determine if decolonization would reduce the SSI rate. Of 6,771 general, orthopaedic and neurologic surgery patients, 18.5% tested positive for *Staphylococcus* and were decolonized with 5 days of CHG showers and mupirocin nasal ointment. SSI rates significantly reduced from 7.7 to 3.4% using eradication compared with the placebo control [9]. These interventions are likely cost-effective as well, as Slover determined that the cost-efficacy threshold for their institution's screening and decolonization protocol would be met with a spine SSI reduction of only 10% [10].

It is our recommendation that patients who screen positive for nasal MSSA and MRSA should be decolonized using 2% mupirocin ointment applied intranasally and 2% chlorhexidine gluconate (CHG) showers for five days preoperatively. Additionally, in patients positive for MRSA, intravenous vancomycin 15 mg/kg should be administered preoperatively prior to skin incision and for 24 hours postoperatively.

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QUESTION 4: How should patients currently using disease-modifying antirheumatic drugs (DMARDs) be managed in the perioperative period?

RECOMMENDATION: Spine surgeons caring for patients with rheumatic diseases must be aware that there are specific issues involved in their perioperative management. The optimal strategy for managing DMARD medications during the perioperative period of spine surgery is unknown due to the lack of evidence and it is largely based on low-quality evidence and expert opinion. A rheumatologist should be involved in the medication management around the time of surgery.

1. For nonbiologic DMARDs such as methotrexate (MTX), leflunomide, hydroxychloroquine and/or sulfasalazine, continuation of the current dose throughout the perioperative period is recommended.
2. For biologic DMARDs such as etanercept, we recommend that physicians withhold the biologic medication and plan elective surgery at the end of the dosing cycle for that specific medication. As an example, patients taking a weekly dose should schedule the surgery in the second week after the first withheld dose. These agents should not be restarted until external wound healing is complete, which is typically around two weeks. Exception: In patients taking tofacitinib (twice daily dose), withholding of tofacitinib for at least one week prior to surgery is recommended.
3. For medications typically used for systemic lupus erthematosus (SLE) patients, such as mycophenolate mofetil, azathioprine, cyclosporine and tacrolimus, the decision to withhold medications prior to surgery should be made on an individual basis.

LEVEL OF EVIDENCE: Moderate

DELEGATE VOTE: Agree: 100%, Disagree: 0%, Abstain: 0% (Unanimous, Strongest Consensus)

RATIONALE

Nonbiologic DMARDs

Although a reasonable concern exists about the potential of nonbiologic DMARDs to increase the risk of infection by affecting the immune response [1,2], stopping DMARDs prior to surgery may result in a flare-up of disease activity, which may adversely affect rehabilitation. Therefore, we suggest that patients continue the current dose of nonbiologic DMARDS throughout the perioperative period, including methotrexate (MTX), leflunomide, hydroxychloroquine and/or sulfasalazine. In clinical practice, the nonbiologic DMARD dose is often missed for one day and up to three days while the patient is hospitalized. Several studies of rheumatoid arthritis (RA) patients undergoing elective orthopaedic surgery have found that continued use of MTX through the perioperative period is safe [3,4]. A systematic review including four studies with RA patients undergoing elective orthopaedic surgery evaluated the effects of continuing MTX versus stopping MTX in the perioperative period [5]. Continued MTX therapy was safe perioperatively and was associated with a reduced risk of flares. There was no evidence to suggest that stopping MTX preoperatively reduced the incidence of infection or improved wound healing. However, in all of the studies, the mean dose of MTX was less than 15 mg per week.

The limited data on the use of leflunomide during the perioperative period is conflicting [6,7]. In one study, there were significantly more wound complications in patients taking leflunomide at the time of elective orthopaedic surgery compared with patients on MTX [7].

There are also limited data suggesting it is safe to continue hydroxychloroquine and sulfasalazine in the perioperative period. In a retrospective study of 367 orthopaedic surgeries among 204 RA patients, two-thirds of whom were receiving nonbiologic DMARDs including hydroxychloroquine and sulfasalazine, there was no increased infection associated with nonbiologic DMARD use [8].

Biologic DMARDs

We recommend that surgeons withhold biologic medication and plan the elective surgery at the end of the dosing cycle for that specific medication. As an example, patients taking weekly etanercept should aim to schedule the surgery in the second week after the first withheld dose. Patients taking adalimumab in two-week intervals should plan the surgery in the third week after the first withheld dose. In a similar manner, patients on monthly intravenous abatacept should schedule the surgery in the fifth week after the first withheld dose. Patients taking rituximab should wait until month seven after the last dose to schedule the surgery, presumably when B cells have returned to the circulation. However, nonelective procedures should not be delayed in patients who have been recently treated.