Journal of Orthopaedic Experience & Innovation
Clinical, Economic, and Innovative Orthopaedic Experience

Abedi, Armita, and Javad Parvizi. 2024. "'In My Experience...Top Ten Steps for Prevention of Surgical Site Infection after Joint Arthroplasty.'" *Journal of Orthopaedic Experience & Innovation* 5 (1). https://doi.org/10.60118/001c.92106.

Editorial

"In My Experience...Top Ten Steps for Prevention of Surgical Site Infection after Joint Arthroplasty"

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Keywords: total joint arthroplasty, total knee replacement, total hip replacement, prosthetic joint infection, surgical site infection, PJI, SSI

https://doi.org/10.60118/001c.92106

Journal of Orthopaedic Experience & Innovation

Vol. 5, Issue 1, 2024

Prevention strategies can help orthopedic surgeons optimize circumstances to reduce the incidence of SSI and PJI.

INTRODUCTION

One of the most feared and serious complications after joint arthroplasty is surgical site infections (SSI) including periprosthetic joint infections (PJI). It is associated with an immense psychological burden for the patient, an increase in morbidity and mortality (Zimmerli, Trampuz, and Ochsner 2004; Zmistowski et al. 2013; Bozic and Ries 2005; Gundtoft et al. 2017; Astagneau et al., n.d.), and it generates enormous economic consequences (Ban et al., n.d.). Prevention is a crucial strategy for combating SSI/PJI (Alijanipour, Heller, and Parvizi 2014).

The Centers for Disease Control and Prevention engaged in developing essential SSI prevention guidelines in 2017 (Berríos-Torres et al. 2017). The World Health Organization (WHO) also introduced global SSI prevention guidelines, with the latest update in 2018 (World Health 2018). The SHEA, APIC, and IDSA were also recently put forth (Calderwood et al. 2023). The second International Consensus Meeting (ICM) took place in Philadelphia in 2018 (ICM Philly, n.d.). During ICM global experts gathered to address the prevention, diagnosis, and treatment of orthopedic infections and created practical recommendations with global application.

Prevention strategies can help orthopedic surgeons optimize circumstances to reduce the incidence of SSI and PJI. In the following ten steps, we will provide an overview of the top-ten SSI/PJI prevention strategies, to enhance infection prevention in orthopedic surgery.

STEP 1
HOST OPTIMIZATION

Before surgery, risk stratification and preoperative optimization of patients need to be taken into account (Tubb, Polkowksi Gg Fau - Krause, and Krause, n.d.). There may be contraindications in patients scheduled for elective joint replacement, such as an active infectious lesion near the intended incision (Jiranek W Fau - Kigera et al., n.d.). However, aside from contraindications modifiable risk factors such as uncontrolled diabetes, hypertension, malnutrition, high body mass index, corticosteroid use, immunosuppression, chronic liver, or chronic kidney disease, need optimization prior to surgery (Cizmic Z Fau - Feng et al., n.d.).

Preoperative hyperglycemia is a notably prominent risk factor, for which there exists a significant proportion of undiagnosed cases, along with an increasing prevalence within the patient population (Capozzi et al., n.d.; Shohat et al. 2018). The American Diabetes Association considers HbA1C > 7% as an indication of uncontrolled diabetes (*Standards of Medical Care in Diabetes-2022 Abridged for Primary Care Providers*, n.d.). While HbA1C is the current marker to assess the patient's glycemic status, it may not have true validity, as previously anticipated (M. Tarabichi et al. 2017; Radin, n.d.). Fructosamine is another biomarker for glycemic control — and in fact, the prognostic value of fructosamine has been shown to have greater potential than HbA1C in predicting adverse events following arthro-

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plasty (Shohat, Goswami, et al., n.d.; Shohat, Tarabichi M Fau - Tischler, et al., n.d.; Shohat et al. 2019).

There are numerous other conditions and modifiable risk factors that also need to be addressed prior to surgery. Patients with comorbidities such as metabolic syndrome, anemia, heavy smokers, uncontrolled liver or kidney disease also need to be seen by specialists and their underlying comorbidities optimized.

STEP 2
BIOBURDEN REDUCTION

The human body, including skin, harbor trillions of microorganisms some of which can act as pathogens and cause SSI. Thus, prior to surgery it is incumbent that we attempt to reduce the number of microbes in the skin by application of antiseptic solutions and decolonization agents. Organisms also reside on and around hair follicles. Removal of hair in proximity to surgical incision, using clippers, right prior to surgery is also an important SSI prevention strategy (Berríos-Torres et al. 2017; Dumville et al., n.d.).

Application of antiseptic solution containing alcohol just prior to surgery is an established and effective strategy to reduce bioburden. However, caution is necessary to avoid damaging the superficial skin layers during preparations, as this may lead to an increased risk of infection. The International Consensus, CDC, as well as WHO all recommend the use of an antiseptic cleansing agent that contains alcohol (Berríos-Torres et al. 2017; World Health 2018; Jiranek W Fau - Kigera et al., n.d.). Other bioburden reduction protocols may include universal application of a non-antibiotic solution to the nares, treatment of active infections in the body such as urinary tract infection, oral cavity infections, and infection of nail or skin.

STEP 3
PERIOPERATIVE ANTIBIOTIC PROPHYLAXIS

Perioperative antimicrobial prophylaxis is a well-established and documented component of standard care aimed at reducing the risk of SSI after total joint arthroplasty (TJA) (AlBuhairan, Hind, and Hutchinson 2008; Garvin and Hansenn, n.d.). Recent guidelines advocate for the use of either first or second-generation cephalosporins due to their broad-spectrum antimicrobial activity (Aboltins Ca Fau - Berdal et al., n.d.). At this point, cefazolin remains the optimal antibiotic, boasting excellent tissue penetration, excellent in vivo activity against common pathogens, including some gram-negative bacteria, minimum toxicity, and adequate half-life (Cunha Ba Fau - Gossling et al., n.d.). Ensuring that this prophylaxis is weight-based is crucial, meaning heavier patients should receive higher doses of antibiotics for optimal coverage (15mg/kg) (Aboltins Ca Fau - Berdal et al., n.d.). Attention must be given to the timing of antibiotic administration, as it should occur 30 to 60 minutes before the skin incision for optimal coverage (Aboltins Ca Fau - Berdal et al., n.d.). It is important to note that cephalosporins can be administered for patients with penicillin allergies, as cross-reactivity between cephalosporin and penicillin is rare (Coleman et al. 2020). Based on numerous recent studies, it appears that administration of cephalosporin to patients with penicillin allergy, even anaphylactic, is safe. The best approach is to administer test dose of cephalosporin to patients with anaphylactic allergy to penicillin in the operating room.

The recommendation by CDC and WHO is one single dose of prophylactic antibiotic prior to incision with no additional dose needed after wound closure (Berríos-Torres et al. 2017; World Health 2018). Currently, a prospective randomized study led by Duke University and supported by the American Association of Hip and Knee Surgeons is underway that compares the rate of SSI in patients receiving one versus three doses of prophylactic antibiotics after total joint arthroplasty. The outcome of this high-level study will provide valuable guidance to determine the best strategy for antibiotic prophylaxis in patients undergoing TJA. During ICM 2018 the issue of prophylaxis against methicillin-resistant *Staphylococcus aureus* (MRSA) was also discussed. It was determined that four groups of patients undergoing TJA should receive dual antibiotic (cephalosporin plus vancomycin or teicoplanin) prophylaxis. This includes institutionalized patients (nursing home or dialysis units), healthcare workers, MRSA carriers, and patients with recent or remote history of infection with MRSA (Courtney et al., n.d.). Although a recently published randomized study on patients undergoing TJA, including patients with MRSA, found no further reduction in SSI with the addition of vancomycin (Peel et al., n.d.). Therefore, the addition of vancomycin must be reserved for patients at high risk of developing an MRSA infection. It is important to note that administration of vancomycin, which needs to be slow to prevent red-may syndrome, must start at least 60 minutes prior to skin incision (Bissell, Riggi, and Morrison, n.d.).

STEP 4
RESPECT FOR SOFT TISSUES

The handling of soft tissues constitutes a critical domain in the prevention of SSI and is often underemphasized. Meticulous care should be exercised during dissection, and any unnecessary direct handling of soft tissues should be minimized to the absolute minimum extent. It is crucial to recognize that gloves may harbor bacterial contamination (Kearns et al. 2011). Excessive tension on the skin and soft tissues must be avoided, and consideration must be given to the incision size, which should be small but adequate to enable accurate visualization of the joint and insertion of implant elements. Soft tissues must be respected to avoid complications such as skin necrosis, blistering, and challenges with wound healing.

STEP 5
EXPEDITIOUS SURGERY

There is ample evidence that there is a direct correlation between operative time and the subsequent incidence of

SSI, a point agreed upon by 99% of delegates at the ICM 2018 (ICM Philly, n.d.; Najafi, Fernández-Rodríguez, and Parvizi 2023). It is theorized that the longer the procedure, the higher the chances of field contamination. Moreover, in cases of prolonged surgery, an inadequate re-dosing of antibiotic prophylaxis with concern to half-life of the agent, can result in a substantial decrease in the tissue levels (S. Tarabichi et al. 2022; Haridas and Malangoni 2008). A recent study found that for each 25-minute increase in operative time, there is an almost 25% increase in the PJI rate, emphasizing the importance of expeditious surgery (Wang et al. 2019).

STEP 6
MINIMIZATION OF BLOOD LOSS

It is an established fact that administration of allogeneic blood transfusions increases the risk of subsequent (Cizmic Z Fau - Feng et al., n.d.). Thus, any efforts that minimize blood loss and the need for allogeneic blood transfusion is important. Some of these efforts include the correction of anemia prior to surgery, performing surgery under regional hypotensive anesthesia, and utilizing a tourniquet (ICM Philly, n.d.; Lu et al., n.d.). Furthermore, perioperative administration of tranexamic acid, endorsed by the ICM 2018, to all patients undergoing orthopedic procedures is yet another effective measure to reduce blood loss (ICM Philly, n.d.; Schmied et al., n.d.; Kolin et al. 2023; Yazdi et al. 2020). The administration of tranexamic acid needs to be weight-based and administered approximately 20 minutes prior to surgery. Topical hemostatic agents may also reduce the risk of postoperative bleeding (Lu et al., n.d.). Care should be taken in the use of prophylactic agents for venous thromboembolism, as extensive use increases the risk of bleeding (Shohat, Ludwick, et al. 2022).

STEP 7
REDUCTION OF TRAFFIC IN THE OPERATING ROOM

There is evidence to suggest that there is a correlation between the number of airborne pathogens in the operating room (OR) and subsequent SSI (Baldini A Fau - Blevins et al., n.d.; Persson 2019). Therefore, it is necessary to implement strategies that will help reduce the number of airborne particles in the OR. It is acknowledged that the main source of pathogens in the OR is the OR personnel. Hence, it is crucial to implement a strict protocol aimed at minimizing any traffic within the OR. It is strictly advised that the number of personnel in the OR be reduced and restricted to those who have a task to perform (Panahi et al., n.d.). It is also important to avoid unnecessary opening/closing the OR door, as each opening/closing of the door introduces new bacteria and particles into the OR, as well as generating air currents that may contaminate the surgical field (Hamilton et al. 2018).

STEP 8
ANTISEPTIC IRRIGATION SOLUTION

Removal of bioburden prior to closure has been studied extensively, and both the ICM, CDC, WHO, and the recent guideline by SHEA/APIC/IDSA endorse the use of antiseptic irrigation solutions for effective debridement of surgical site (Berríos-Torres et al. 2017; World Health 2018; Calderwood et al. 2023; Blom A Fau - Cho et al., n.d.). These guidelines all endorse the use of dilute, sterile povidone-iodine solutions. The available evidence shows that PVP-I is effective against all organisms, including fungi, with minimal to no cytotoxicity (Siddiqi et al. 2021).

STEP 9
STERILIZATION OF IMPLANTS AND INSTRUMENTS

Implants and instruments are potential sources of contamination (Zimmerli et al. 1982). Prior to surgery, implants and surgical instruments must be sterilized to prevent SSI and PJI (Aboltins et al. 2019). Validated sterilization methods for orthopedic implants include radiation, ethylene oxide gas, and vaporized hydrogen peroxide ("Sterlization for Medical Devices" 2023). It is recognized that intraoperative contamination of implants is frequent (Bible et al. 2013). When inserting the implants, great care must be taken to avoid any direct handling of the portion of implant that will be placed against bone. Furthermore, the implant should be protected from direct contact with the patient's skin. This avoids contamination by bacteria residing in the skin and the soft tissues. Recent protocols propose multiple strategies to combat intraoperative implant exposure. This includes minimizing implant exposure to OR air, changing gloves prior to handling implants, as well as evaluating the sterility of surgical tray wraps (Schömig et al. 2020).

STEP 10
WOUND MANAGEMENT

Wound management needs to be taken very seriously. Wound drainage, wound hematoma, and wound dehiscence are complications that lead to an increase in SSI. Drainage, hematoma, and cellulitis need to be treated aggressively. Research shows that there is a direct link between the use of anticoagulation and the potential for the development of hematoma and other wound related problems (V. Singh et al. 2020; Parvizi et al. 2007). In recent years, there has been a global shift towards the use of aspirin, as a safe, effective, inexpensive VTE prophylaxis (Najafi et al. 2022; Shohat, Goel, et al. 2022; Delegates* 2022). Wound related issues such as hematoma formation and persistent wound drainage are minimized with the use of aspirin.

Persistent wound drainage was discussed during the ICM 2018, and an algorithm has been developed (Wagenaar et al. 2019). If persistent wound drainage goes beyond five to seven days, patients may need to be returned to the OR for further interventions, such as opening up the wound and

closing the fascia and the wound again (Wagenaar et al. 2019). There is also a role for the use of negative pressure wound therapy, both prophylactically and therapeutically for patients at high risk of wound related complications (D. P. Singh et al. 2019).

Another essential part of care lies in the use of appropriate wound closure and skin dressing (ICM Philly 2018). Although the most optimal method of wound closure is not known, the use of triclosan-impregnated suture has been shown to reduce the incidence of SSI, at least in other surgical disciplines (World Health 2018; Guideline 2019). The use of occlusive dressing is also known to reduce the incidence of SSI and PJI in patients undergoing orthopedic procedures (Grosso et al. 2017).

In conclusion, many different variables influence the development of SSI and PJI. The ten steps outlined in this article represent key preventive measures that are known to be effective. Looking ahead, we envision that within the next 5-10 years, we will have pinpointed specific variables that demand attention for individual patients, contributing to a reduction in future infection rates.

Submitted: January 08, 2024 EDT, Accepted: January 08, 2024 EDT

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