



Periprosthetic Infection: Better Safe Than Sorry. Evidence-Based Scoping Review

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Abstract

Background: Periprosthetic joint infection (PJI) is a devastating complication following total joint arthroplasty (TJA) with increased morbidity, prolonged hospital stays, and significant healthcare costs. Despite advancements in surgical techniques and perioperative protocols, infection rates remain between 1% and 2% for primary procedures, with higher rates in revision surgery [1]. As to be safe is better than to be sorry, we have conducted this evidenced-based review to address:

1. What are the key perioperative risk factors contributing to PJI?
2. Evidence-based best practices to mitigate these risks?

Methods: A comprehensive review of PJI identifying preoperative, intraoperative, and postoperative risk factors, preventive measures, and evidence-based strategies was conducted on PubMed, Scopus, and Web of Science databases with prioritization of high-quality meta-analyses, randomized controlled trials (RCTs), and systematic reviews, following Clinical Orthopaedics and Related Research (CORR) guidelines [2]. Step-by step approach to identify these risk factors and best practices mitigating each risk was proposed.

Discussion: PJI accounts for approximately 6,000 revision procedures annually in the UK, with a 4.5-fold increase in healthcare costs compared to uneventful primary TJA [3]. Preventive measures, including but not only patient optimization, strict antibiotic prophylaxis, enhanced surgical asepsis, early mobilization, and wound surveillance, significantly reduced infection rates [4]. Our evidence-based approach offers a unique practical insight to achieve this.

Conclusion: A multidisciplinary approach integrating preoperative risk stratification, patient intraoperative infection control, and structured postoperative surveillance can keep patient safe rather than sorry regarding periprosthetic infection. Since our approach strictly adhere to robust quality evidence-based guidelines with practical view, it can significantly reduce infection rates, improve outcomes, and decrease healthcare costs [5].

Keywords: Periprosthetic joint infection, Clinical Orthopaedics

Introduction

Total joint arthroplasty is a one of the most successful procedures in orthopaedic surgery history, yet periprosthetic joint infection (PJI) is one of the most devastating complications, often necessitating complex revision surgeries. Infection leads to increased morbidity, prolonged hospitalization, and higher health-

care costs [6]. While the incidence remains between 1% and 2% for primary procedures, it is significantly higher in revision surgeries [7]. In the UK, over 106,000 hip replacements and 103,300 knee replacements are performed annually, with PJI responsible for 6,000 revision procedures each year [8]. The economic burden of PJI is substantial, with a 4.5-fold increase in costs compared to uncomplicated TJA [9].

This review explores an evidence-based, multidisciplinary approach to reducing PJI through optimized preoperative, intraoperative, and postoperative strategies.

Preoperative considerations

Patient selection

Proper patient selection and risk stratification are critical. Key preoperative considerations include:

A. Arthroplasty surgery should be strictly limited to Indicated symptomatic patients only as surgery should be medically justified and well understood by the patient [10].

B. Patients should be free of major cardiac events for at least 6 months before the planned arthroplasty surgery [11].

C. Surgery should be planned to keep at least 6 months window from last intraarticular steroid injection [12].

Medical comorbidities and risk reduction

Advanced osteoarthritis that dictates replacement surgery is more prevalent in elder population. New modern life and better healthcare systems promotes more aging which is associated with more medical comorbidities. There is no doubt that optimization of these medical comorbidities in patient planned for arthroplasty surgery is associated with more favourable outcomes and less complications. Here we will spot the more prevalent medical comorbidities in arthroplasty patients, their association with PJI and how to mitigate this risk.

A. Diabetes Mellitus: collective evidence supports that poor glycaemic control increases PJI risk 1.8-fold. For a safe arthroplasty surgery with reduced risk of perioperative infection and wound healing complications, it is recommended to maintain HbA1c below 8.0 mg/dl before surgery to reduce this risk [13].

B. Obesity: BMI is one of the important parameters to optimize perioperatively in arthroplasty patients. Evidence reports that BMI >40 increases infection risk 3-fold; BMI >50 increases this risk 9-fold [14]. BMI ≤35 seems to be the benchmark for reducing obesity-associated perioperative complications, but robust supporting evidence is still lacking.

C. Chronic Kidney Disease (CKD) is another medical comorbidity that contributes to a significantly increasing risk of perioperative infection in arthroplasty patients. Dialysis-dependent patients have higher PJI rates and poorer functional outcomes [15].

D. Anaemia: Haemoglobin is essential for tissue oxygenation. Good tissue oxygenation plays a vital role in promoting tissue healing and minimizing infection risk. Preoperative anemia (Hb <12 g/dL) is considered an independent predictor of infection [16].

E. Rheumatoid Arthritis & Immunosuppressive Therapy: For a long time, rheumatoid arthritis patients were always challenging to surgeons with poor soft tissue, delayed healing, and a higher risk of infection compared to non-rheumatoid patients. Thankfully, medical treatments, especially with the advent of DMARDs, have led to significant control of rheumatoid arthritis. Nevertheless, it remains unsafe to operate on patients who are still on certain immunosuppressive drugs. Evidence suggests that TNF inhibitors (e.g., infliximab, adalimumab) should be stopped 4 weeks preoperatively [17].

Nutritional optimization

Malnutrition is a strong predictor of poor wound healing and increased risk of infection. To ensure safe surgical outcomes and proper wound healing, guidelines recommend a serum albumin level >3.5 g/dL and a total lymphocyte count >1500 cells/mm³ [18]. This can be achieved through a thorough preoperative assessment and nutritional supplementation for ≥14 days in high-risk patients [19].

Lifestyle modifications

A. Smoking is a major contributor to poor surgical outcomes and complications. Several studies have associated smoking with a twofold increase in the risk of infection in various surgical procedures. Evidence consistently shows that smoking cessation for at least 6–8 weeks before surgery significantly reduces the risk of prosthetic joint infection (PJI) [20].

B. Alcohol dependence is similarly associated with an increased risk of poor wound healing and infection. Evidence underscores that excessive alcohol consumption (>252 g/week) significantly elevates the risk of prosthetic joint infection (PJI) [21].

Anticoagulants

Preoperative use of antiplatelet and anticoagulant agents within 90 days of surgery is associated with a significantly increased risk of prosthetic joint infection (PJI) [22]. Clopidogrel and warfarin should be discontinued 5 days prior to surgery, while rivaroxaban and apixaban should be stopped 2 days before the procedure [23].

Preoperative screening

A. Skin examination and the identification of any lesions that may increase the risk of surgical site infection (SSI) are essential to minimizing the postoperative infection risk [24].

B. MRSA poses a significant challenge to orthopaedic surgery, particularly in arthroplasty, due to its resistance to treatment and its association with considerable morbidity. Screening using groin and nasal swabs should be routinely performed prior to surgery. Patients who test positive for MRSA require a 5-day treatment regimen with chlorhexidine body wash and nasal spray to achieve clearance before the procedure [25].

C. Dental hygiene is one of the most commonly overlooked sources of hematogenous infection in patients with prosthetic joint infection (PJI) during preoperative assessment. Evidence supports the necessity of preoperative dental assessment, and patients with poor dentition should be identified and optimized prior to elective arthroplasty [26].

Patient education

The patient is the primary recipient of arthroplasty surgery, and their adherence to preoperative instructions and postoperative recommendations is a significant determinant of surgical success and optimal outcomes. Therefore, patient education is essential in the prevention and management of prosthetic joint infection (PJI). Furthermore, continuous professional development for healthcare providers is imperative to ensure up-to-date knowledge and effective management of PJI [27].

Admission protocols

The GIRFT (Getting It Right First Time) guidelines have significantly transformed arthroplasty surgery practices since the introduction of its pathway, contributing to enhanced outcomes and

streamlined clinical processes. As outlined in the GIRFT guidance, patients should be admitted to a dedicated, ring-fenced orthopaedic elective ward, ensuring a focused and optimized environment for elective orthopaedic procedures [28]. Furthermore, it is recommended that essential support services, including radiology, pathology laboratories, and other relevant diagnostic facilities, be available during operating hours to facilitate timely decision-making and improve the efficiency of surgical planning and execution [29].

In addition, preoperative patient warming has been emphasized as a routine practice in the prevention of surgical site infections and the enhancement of patient recovery. GIRFT guidelines advocate for the use of conductive fabric or forced-air warming blankets for at least 30 minutes prior to surgery, thereby minimizing the risks associated with perioperative hypothermia, which has been linked to adverse outcomes such as increased infection rates and delayed wound healing [30]. The implementation of these practices, as per GIRFT recommendations, underscores the importance of a comprehensive, evidence-based approach to optimize surgical outcomes in arthroplasty procedures.

Intraoperative considerations

Surgical environment and infection control

Every stage of the surgical procedure plays a critical role in influencing outcomes, particularly in reducing the risk of infection. Factors such as surgical team scrubbing, skin preparation, meticulous surgical technique, and careful soft tissue handling all contribute to infection prevention. Attention to detail at each step is essential to minimizing the risk of periprosthetic joint infection. This scoping review highlights key precautions at every stage of the surgical process to mitigate this risk effectively.

A. The skin is the second most common source of bacterial contamination after surgical personnel. While complete elimination of skin commensals is not possible, proper skin preparation can significantly reduce their contribution to periprosthetic joint infection (PJI). Various skin surgical preparation solutions are available; however, alcoholic chlorhexidine has demonstrated superior efficacy in preventing PJI compared to alcoholic povidone-iodine, making it the preferred choice for preoperative skin antisepsis [31].

B. Surgical personnel are the most common source of bacterial contamination leading to periprosthetic joint infection (PJI). To mitigate this risk, minimizing operating room traffic, ensuring proper surgical scrubbing and gloving techniques, and adhering to strict aseptic protocols are essential. Double gloving has been shown to reduce bacterial contamination by approximately 50%, reinforcing its importance as a key infection control strategy during surgery [32].

C. Proper theatre design and zoning are fundamental requirements for ensuring safe arthroplasty surgery. For decades, the role of laminar airflow (LAF) in reducing periprosthetic joint infection (PJI) has been a subject of intense debate. Since Charnley's introduction of laminar flow in the 1960s and Lidwell et al.'s study in the early 1980s, LAF was widely regarded as a crucial measure for infection prevention. The "room within a room" concept further reinforced the need for sterile or ultra-clean zones within arthroplasty theatres equipped with LAF.

However, with advancing research in the 21st century, this perspective has evolved. Recent evidence comparing laminar airflow to conventional ventilation has demonstrated no significant difference in PJI rates between the two systems. These findings suggest that other factors, such as aseptic technique, surgical environment control, and perioperative infection protocols, may play a more substantial role in infection prevention than theatre ventilation alone [33].

Anaesthesia considerations

Anaesthetic choice has been linked to variations in PJI risk, with regional anaesthesia demonstrating lower infection rates compared to general anaesthesia (odds ratio 0.74, $p < 0.01$) [34]. Moreover, strategies aimed at minimizing intraoperative and postoperative opioid use are associated with a reduced need for postoperative urinary catheterization, which has been identified as a risk factor for increased infection rates [35]. These findings suggest that anaesthesia selection and opioid management should be key considerations in infection prevention protocols.

Antibiotic prophylaxis

Perioperative antibiotic prophylaxis is widely recognized as the most critical measure for preventing periprosthetic joint infection (PJI). The optimal regimen-whether a single dose at induction or prolonged antibiotic coverage-has been a longstanding topic of debate, with conflicting evidence supporting both approaches. Current guidelines, based on emerging evidence, advocate for a single dose of cefazolin administered within 30 minutes before surgical incision as the standard of care for minimizing PJI risk [36]. Additionally, antibiotic-loaded bone cement (ALBC) has demonstrated efficacy in reducing infection rates among high-risk patients. However, its routine use in primary total joint arthroplasty remains controversial due to inconsistent evidence regarding its overall effectiveness [37].

Surgical technique and blood conservation

Surgical technique is a key factor influencing soft tissue trauma and postoperative hematoma, both of which contribute to the risk of periprosthetic joint infection (PJI). Therefore, meticulous adherence to surgical principles is essential in minimizing infection risk. Current evidence outlines specific surgical strategies designed to reduce the incidence of PJI, emphasizing the importance of precise technique throughout the procedure.

- Meticulous soft tissue handling and layered closure techniques are crucial for minimizing bacterial contamination and reducing infection risk [38].
- While a tourniquet facilitates a bloodless surgical field and reduces operative time, its use in total knee arthroplasty (TKA) has been linked to a higher risk of postoperative infection. This association underscores the need for a careful assessment of its benefits against potential complications. [39].
- The administration of tranexamic acid (TXA), both systemically at anesthesia induction and locally at the conclusion of arthroplasty surgery, has been shown to significantly reduce intraoperative blood loss, consequently decreasing the risk of postoperative infection [40].

Dressing

The selection of wound dressing is a critical factor in infection control following total joint arthroplasty. Negative pressure wound therapy (NPWT) has been shown to reduce deep infections by 45% in high-risk patients, indicating its potential benefit in selected cases [41]. Additionally, silver-impregnated dressings have demonstrated a statistically significant reduction in surgical site infection (SSI) rates compared to standard dressings ($p=0.02$), underscoring their role in optimizing postoperative wound management [42].

Drain

Historically, surgical drains were widely used in total joint arthroplasty to minimize postoperative hematoma and reduce the risk of infection. The rationale was that continuous drainage would prevent fluid accumulation, thereby promoting wound healing and lowering infection rates. However, recent evidence challenges this assumption, suggesting that closed suction drains provide no significant advantage over a no-drain approach. Moreover, their use may increase the risk of retrograde infection by creating a potential conduit for bacterial entry. Given these findings, the routine use of drains in arthroplasty should be reconsidered, with a greater emphasis on alternative strategies for optimizing wound management and infection control [43].

Postoperative strategies

Early mobilization and fluid management

A. Early mobilization is a critical factor in preventing infection and promoting overall recovery after joint surgery. Studies have demonstrated that initiating weight-bearing within 24 hours of surgery is associated with a significant reduction in the rates of periprosthetic joint infection (PJI). This early movement not only helps in minimizing the risk of infection but also contributes to faster rehabilitation and a reduced length of hospital stay. By encouraging early weight-bearing, patients are able to enhance circulation, reduce the likelihood of complications such as deep vein thrombosis, and promote quicker functional recovery. These findings underscore the importance of timely mobilization in improving both clinical outcomes and overall patient recovery [44].

B. Perioperative fluid management continues to be a contentious issue in the care of arthroplasty patients, as clinicians must navigate the delicate balance between fluid restriction and over-

load. On one hand, fluid restriction may increase the risk of acute kidney injury (AKI), while on the other, excessive fluid administration can contribute to complications such as edema and infection. Historically, these opposing concerns have led to ongoing debate regarding the optimal fluid strategy. Recent evidence, however, supports the use of restrictive fluid management protocols, demonstrating that they can effectively lower the risk of postoperative edema and infection. These findings emphasize the importance of careful perioperative fluid administration, requiring clinicians to tailor fluid management strategies to the individual needs of each patient to optimize both recovery and complication prevention [45].

Extended antibiotic prophylaxis (EAP) and surveillance

Prolonged antibiotic prophylaxis beyond 24 hours does not significantly reduce PJI rates and has been linked to an increased risk of acute kidney injury (AKI) [46]. These findings suggest that adherence to recommended antibiotic protocols is crucial for balancing infection prevention while avoiding unnecessary complication

Pain management and discharge planning

Multimodal analgesia, incorporating paracetamol and NSAIDs, is preferable to opioid-based pain management strategies as it minimizes opioid-related complications and reduces infection risk [47]. Furthermore, structured discharge and follow-up protocols have been associated with lower rates of emergency department visits and hospital readmissions, highlighting their role in optimizing patient recovery and reducing postoperative complications [48].

Discussion

The prevention of periprosthetic joint infection (PJI) necessitates a comprehensive, multi-faceted approach that incorporates preoperative patient optimization, intraoperative infection control, and structured postoperative surveillance. Each stage plays a critical role in minimizing the risk of infection and promoting recovery.

Preoperative optimization is foundational in preventing PJI. Strict patient selection and effective management of comorbidities are essential. Key factors include controlling HbA1c levels to <8.0 , maintaining a BMI <35 , and providing adequate nutritional support to improve healing and reduce the risk of infection [49]. These

measures ensure that patients are in the best possible condition prior to surgery, improving their overall resilience and ability to withstand the procedure and recovery.

Intraoperative infection control is equally important. Adherence to established antibiotic prophylaxis protocols, combined with rigorous surgical asepsis, is crucial in minimizing infection risk [50]. Additionally, fluid management during surgery remains a significant consideration. The balance between avoiding acute kidney injury (AKI) due to fluid restriction and preventing edema or infection from fluid overload must be carefully managed. Recent evidence supports the use of restrictive fluid management protocols, which have been shown to reduce postoperative edema and infection rates, emphasizing the need for careful and tailored fluid administration throughout the perioperative period.

Postoperatively, early mobilization and appropriate pain management are essential to enhance recovery and reduce the risk of complications. Early weight-bearing, within 24 hours of surgery, has been linked to lower rates of PJI and a shorter length of hospital stay, contributing to quicker rehabilitation and better overall outcomes [51].

While these evidence-based strategies form the foundation of current PJI prevention protocols, further research is necessary to explore advanced host-modulated infection prevention strategies. Innovations such as antibiotic-releasing implants and immunomodulatory therapies hold promise for enhancing infection control and improving outcomes for high-risk patients [52]. Continued exploration in these areas may provide additional tools for preventing PJI, ultimately refining and improving current approaches to patient care.

Conclusions

In conclusion, periprosthetic joint infection (PJI) continues to pose a significant challenge in the field of arthroplasty, affecting both patient outcomes and healthcare resources. However, a comprehensive prevention strategy that integrates evidence-based practices at every stage of the surgical process—ranging from pre-operative patient optimization and intraoperative infection control to postoperative surveillance—can play a pivotal role in reducing infection rates. Key strategies such as strict patient selection,

adherence to antibiotic prophylaxis, early mobilization, and careful fluid management have demonstrated clear benefits in minimizing the risk of PJI. Moreover, ongoing research into advanced infection prevention methods, such as antibiotic-releasing implants and immunomodulatory therapies, holds promise for further enhancing infection control. By adopting a holistic, evidence-driven approach, it is possible to significantly reduce the incidence of PJI, leading to improved patient outcomes and more effective arthroplasty procedures [53].

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