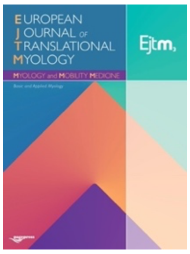
Infection prevention in total knee arthroplasty

European Journal of Translational Myology



pISSN: 2037-7452 eISSN: 2037-7460

https://www.pagepressjournals.org/index.php/bam/index

Eur J Transl Myol 2026 [Online ahead of print]

To cite this Article:

Rovere G, Bosco F, Cuttaia C, et al. **Infection prevention in total knee arthroplasty: current concepts, controversies, and a clinical algorithm.** *Eur J Transl Myol* doi: 10.4081/ejtm.2026.15177

Submitted: 23 March 2026

Accepted: 9 April 2026

Early access: 25 May 2026

Infection prevention in total knee arthroplasty

Infection prevention in total knee arthroplasty: current concepts, controversies, and a clinical algorithm

Giuseppe Rovere,[1,2] Francesco Bosco,[3] Claudia Cuttaia,[4] Ludovico Lucenti,[3] Luigi Meccariello,[5] Michele Mercurio,[6] Andrea Fidanza,[7] Lara Cristiano,[8] Giuseppe Marongiu,[9] Amarildo Smakaj,[10,11] Domenico De Mauro,[12] Andrea Perna,[13] Pasquale Farsetti,[2] Fernando De Maio,[2] Lawrence Camarda[3]

[1]Department of Surgical Sciences, Policlinico Tor Vergata University Hospital, Rome; [2]Department of Clinical Sciences and Translational Medicine, Section of Orthopaedic and Traumatology, University of Rome Tor Vergata, Roma; [3]Department of Precision Medicine in Medical, Surgical and Critical Care (Me.Pre.C.C.), University of Palermo, Palermo; [4]Catholic University of the Sacred Heart, Rome; [5]Department of Orthopedics and Traumatology, AORN San Pio Hospital, Benevento; [6]Department of Orthopedic and Trauma Surgery, "Magna Graecia" University, "Mater Domini" University Hospital, Catanzaro; [7]Department of Life, Health and Environmental Sciences, University of L'Aquila, L'Aquila; [8]Studio Radiologico S. Domenico, Lamezia Terme; [9]Orthopaedic and Trauma Clinic, Department of Surgical Sciences, Policlinico Duilio Casula, Cagliari State University, Cagliari; [10]U.O.C. of Orthopaedics and Traumatology, Bambino Gesù Children's Hospital, IRCCS, Rome; [11]Link Campus University, Rome; [12]Department of Orthopedics, Ageing and Rheumatological Sciences, Fondazione Policlinico Universitario A. Gemelli IRCCS, Rome; [13]Unità di Chirurgia Vertebrale, Dipartimento di Ortopedia e Traumatologia, Fondazione Casa Sollievo Della Sofferenza IRCCS, San Giovanni Rotondo, Italy

Abstract

Periprosthetic Joint Infection (PJI) remains one of the most serious and challenging complications following Total Knee Arthroplasty (TKA), with a substantial impact on patient outcomes and healthcare systems. Despite advances in surgical techniques and perioperative management, the incidence of PJI has not significantly declined, highlighting the need for more effective preventive strategies. This review aims to provide a comprehensive and clinically oriented overview of current infection prevention strategies in TKA, with a particular focus on risk stratification, perioperative optimization, and the development of a practical clinical algorithm to guide decision-making. A narrative review of the literature was conducted using major medical databases to identify relevant studies on PJI prevention in TKA. Priority was given to recent systematic reviews, meta-analyses, and high-quality clinical studies addressing patient-related risk factors, intraoperative measures, and postoperative management. PJI is a multifactorial complication influenced by the interaction between patient-related, surgical, and postoperative factors. Modifiable risk factors such as obesity, diabetes, malnutrition, and smoking play a pivotal role and should be optimized preoperatively. Intraoperative strategies, including strict aseptic technique, appropriate antibiotic prophylaxis, and minimization of operative time, are essential to reduce contamination risk. Postoperative measures focusing on wound management, hematoma prevention, and early detection of complications further contribute to infection prevention. Several aspects remain controversial, including the role of laminar airflow systems, antibiotic-loaded bone cement in primary TKA, and optimal decolonization strategies for *Staphylococcus aureus*. Effective prevention of PJI requires a structured, multimodal approach integrating all phases of care. Risk stratification enables personalized preventive strategies and improved perioperative planning. The clinical algorithm proposed in this review provides a practical framework to support decision-making and may help standardize infection prevention pathways. Future research should focus on validating risk-based approaches and emerging technologies to further reduce the burden of PJI in TKA.

Key words: periprosthetic joint infection; total knee arthroplasty; decolonization strategies for *Staphylococcus aureus*; risk stratification.

Total Knee Arthroplasty (TKA) is widely recognized as one of the most successful procedures in orthopaedic surgery, providing substantial pain relief and functional restoration in patients affected by advanced degenerative joint diseases, particularly osteoarthritis and rheumatoid arthritis. Over the past decades, progressive refinements in implant design, surgical techniques, and perioperative care have led to significant improvements in clinical outcomes and implant survivorship.

Infection prevention in total knee arthroplasty

More recently, technological innovations such as robotic-assisted surgery have further enhanced surgical precision in implant positioning, bone preparation, and soft tissue balancing, potentially contributing to improved functional outcomes and reduced revision rates.[1,2]

Despite these advances, Periprosthetic Joint Infection (PJI) remains one of the most devastating complications associated with TKA. Although relatively infrequent, with an incidence ranging from approximately 1–2% in primary procedures and up to 5% in revision settings, PJI is associated with substantial morbidity, repeated surgical interventions, and, in severe cases, implant failure and permanent functional impairment.[3]

The pathogenesis of PJI is inherently multifactorial, involving a complex interplay between patient-related susceptibility, intraoperative contamination, and postoperative events, including hematogenous dissemination from distant infection sites. Consequently, infection prevention requires a comprehensive and multidisciplinary approach that extends across all phases of patient care.

In recent years, increasing attention has been directed toward the identification of modifiable risk factors and the implementation of standardized prevention protocols. However, clinical practice remains heterogeneous, and several aspects of infection prevention continue to be debated.

The aim of this review is to provide an updated and clinically oriented overview of infection prevention strategies in TKA, integrating current evidence with practical recommendations. Particular emphasis is placed on risk stratification, multimodal prevention strategies, and existing controversies, culminating in the proposal of a structured clinical algorithm to guide decision-making in routine practice.

Burden of periprosthetic joint infection

PJI represents one of the most devastating complications following Total Knee Arthroplasty (TKA), with a disproportionate clinical and socioeconomic impact relative to its reported incidence. Although the occurrence of PJI after primary TKA is generally estimated at approximately 1–2%, and up to 4–5% in revision settings, its consequences are profound and often life-altering for affected patients. [1–3]

From a clinical perspective, PJI is associated with a complex and demanding therapeutic pathway. Management frequently requires multiple surgical interventions, including Debridement And Implant Retention (DAIR), one- or two-stage revision procedures, or, in extreme cases, arthrodesis or amputation. These are often combined with prolonged courses of systemic antibiotic therapy, which may extend over several weeks or months and carry their own risks of toxicity and complications.

Beyond the surgical burden, patients with PJI commonly experience significant functional impairment, persistent pain, and delayed rehabilitation. The impact on quality of life is substantial and, in many cases, comparable to that of chronic debilitating conditions. Furthermore, the psychological burden should not be underestimated, as repeated hospitalizations, uncertainty regarding treatment success, and prolonged recovery periods may lead to anxiety, depression, and reduced overall well-being. [2]

The economic implications of PJI are equally significant. The cost of managing a single infected arthroplasty is estimated to be several times higher than that of an uncomplicated primary TKA. This increase is primarily driven by extended hospital stays, multiple surgical procedures, long-term antibiotic treatments, and the need for coordinated multidisciplinary care involving orthopedic surgeons, infectious disease specialists, microbiologists, and rehabilitation teams. At a system level, PJI represents a major contributor to healthcare expenditure in orthopedics and places a considerable strain on already limited resources.

Importantly, PJI is also associated with increased morbidity and mortality. Recent studies have reported mortality rates comparable to those observed in certain oncological conditions, particularly in elderly and comorbid patients. This highlights the severity of the condition and reinforces the need for preventive strategies rather than reactive management.

Looking forward, the burden of PJI is expected to rise substantially. This trend is driven by the increasing number of TKA procedures performed worldwide, coupled with the growing prevalence of high-risk patient populations, including elderly individuals, obese patients, and those with multiple comorbidities such as diabetes and immunosuppression. In addition, the expanding indications for arthroplasty and improved life expectancy contribute to a larger pool of patients at risk over time.

Taken together, these considerations clearly demonstrate that PJI is not merely a surgical complication but a complex clinical and socioeconomic challenge. Consequently, the implementation of effective, evidence-based, and standardized prevention strategies is essential to reduce its incidence and mitigate its impact on both patients and healthcare systems.

Risk stratification of periprosthetic joint infection

PJI is a complex and multifactorial complication resulting from the interplay between host-related susceptibility, surgical factors, and postoperative conditions. A structured risk stratification approach is therefore essential to identify high-risk patients, guide perioperative optimization, and tailor preventive strategies accordingly (Table 1).[3–7]

Patient-related factors represent the most significant and, in many cases, modifiable contributors to PJI risk.

Obesity is a well-established independent risk factor, with increasing Body Mass Index (BMI) correlating with higher infection rates. Patients with BMI ≥30 kg/m² have a significantly elevated risk, while those with BMI ≥40 kg/m² demonstrate markedly worse outcomes, including increased complication rates, impaired wound healing, and higher revision rates.[4] The underlying mechanisms include prolonged operative time, increased soft tissue trauma, and reduced tissue perfusion.

Diabetes mellitus, particularly when poorly controlled, is strongly associated with increased susceptibility to infection. Hyperglycemia impairs neutrophil function, reduces host immune response, and delays wound healing, thereby facilitating bacterial proliferation. Several studies have demonstrated that inadequate glycemic control is linked to higher rates of postoperative complications, longer hospital stays, and increased healthcare costs.[5–7]

Malnutrition is another critical yet often under-recognized risk factor. Hypoalbuminemia and protein-energy malnutrition have been associated with impaired immune function and increased rates of surgical site complications, including PJI.[8-10] Preoperative nutritional assessment should therefore be considered an integral part of patient optimization.

Immunosuppression, whether due to systemic diseases or pharmacological therapies, significantly increases infection risk. Patients with conditions such as HIV infection or those undergoing immunosuppressive treatment following solid organ transplantation are particularly vulnerable due to their impaired ability to mount an effective immune response.[8,9]

Additional patient-related factors include advanced age, smoking, and the presence of chronic inflammatory or dermatological conditions such as psoriasis, all of which may contribute to increased susceptibility to infection.[10–20]

Intraoperative variables play a crucial role in determining the risk of PJI, particularly those related to surgical technique and operative environment.

Prolonged operative time has consistently been identified as a significant risk factor for infection, as it increases the duration of tissue exposure to potential contaminants and may reflect greater surgical complexity.[11] Minimizing operative time without compromising surgical accuracy is therefore a key objective.

Implant-related factors also contribute significantly to infection risk. Suboptimal implant positioning or fixation may lead to micro-motion and local inflammation, creating a favorable environment for bacterial adhesion and biofilm formation. The ability of implant materials to resist bacterial colonization and inhibit biofilm development is increasingly recognized as an important determinant of long-term outcomes.[12]

Strict adherence to aseptic techniques, including proper skin preparation, sterile handling of instruments, and operating room discipline, remains fundamental in reducing intraoperative contamination.

Postoperative factors further influence the risk of PJI, particularly those related to wound healing and local tissue conditions.

Wound complications, including prolonged drainage, dehiscence, and superficial infections, are strongly associated with subsequent deep infection. Hematoma and seroma formation create an ideal environment for bacterial proliferation and should be actively prevented through meticulous hemostasis and appropriate postoperative management.[20]

Early mobilization and structured rehabilitation protocols are essential for functional recovery; however, excessive mechanical stress on the surgical site during the early healing phase may compromise wound integrity and increase infection risk if not carefully managed.[13,14]

In addition, hematogenous spread from distant infection sites remains an important mechanism of late PJI. Infections such as urinary tract infections, dental infections, and respiratory tract infections may serve as sources of bacterial dissemination, particularly in vulnerable patients.[17–19]

The identification and stratification of risk factors allow for a more personalized approach to infection prevention. Patients can be categorized into low-, moderate-, and high-risk groups, enabling clinicians to implement targeted preventive measures.

High-risk patients may benefit from intensified strategies, including preoperative optimization programs, extended antibiotic prophylaxis, antibiotic-loaded materials, and advanced wound management techniques. Conversely, low-risk patients may be managed with standard protocols, avoiding unnecessary interventions and reducing healthcare costs.

Ultimately, risk stratification represents a fundamental step toward precision medicine in orthopaedic surgery, facilitating individualized care pathways and improving overall outcomes in TKA.

Prevention strategies

Infection prevention in TKA requires a comprehensive and multimodal approach that spans the entire perioperative pathway. Current evidence strongly supports the implementation of bundled strategies combining preoperative optimization, intraoperative aseptic measures, and meticulous postoperative care to effectively reduce the risk of PJI.[3]

A structured overview of key preventive strategies across the perioperative pathway is presented in Table 2.

Preoperative optimization

The preoperative phase represents a critical window for risk reduction, particularly through the identification and correction of modifiable risk factors.

Adequate glycemic control is essential, as hyperglycemia impairs immune function and wound healing, thereby increasing susceptibility to infection. Several studies have demonstrated that poorly controlled diabetes is associated with higher complication rates, prolonged hospitalization, and increased healthcare costs.[5–7]

Similarly, obesity has been consistently identified as a major risk factor for PJI, with higher Body Mass Index (BMI) correlating with increased operative time, impaired tissue perfusion, and delayed wound healing. Weight optimization strategies should therefore be encouraged in high-risk patients.[4]

Smoking cessation is strongly recommended, as tobacco use negatively affects tissue oxygenation and immune response. Evidence suggests that cessation at least four weeks prior to surgery significantly reduces surgical site infection rates.[20]

Infection prevention in total knee arthroplasty

Nutritional status also plays a crucial role in surgical outcomes. Hypoalbuminemia and protein-energy malnutrition have been associated with increased rates of wound complications and infection, highlighting the importance of preoperative nutritional assessment and supplementation.[10]

In addition, screening for *Staphylococcus aureus* colonization and implementing decolonization protocols have demonstrated a significant reduction in surgical site infections. A combined regimen of intranasal mupirocin and chlorhexidine body washes is widely adopted and supported by strong clinical evidence.[21–24]

Furthermore, the identification and treatment of remote infection sources—such as urinary tract infections, dental infections, and dermatological conditions—are essential to minimize the risk of hematogenous dissemination to the prosthetic joint.[17,18]

Intraoperative prevention

Strict adherence to aseptic technique remains the cornerstone of intraoperative infection prevention.

Skin preparation with alcohol-based chlorhexidine solutions is widely recommended due to its superior antimicrobial activity and prolonged residual effect compared to alternative antiseptics.[25–28] Povidone-iodine may represent a valid alternative in selected clinical scenarios, particularly in cases of chlorhexidine intolerance.[29]

Minimizing operative time is a key factor in reducing infection risk, as prolonged procedures increase exposure to potential contaminants and may reflect greater surgical complexity.[11] Efficient surgical workflow, without compromising precision, is therefore essential.

Additional intraoperative measures include the use of double gloving, periodic glove changes during critical surgical steps, and minimizing operating room traffic to reduce airborne contamination.[26]

Emerging antiseptic agents, such as hypochlorous acid solutions, have shown promising antimicrobial properties with low cytotoxicity, although further high-quality evidence is required to support their routine use.[30]

Antibiotic prophylaxis remains a fundamental component of infection prevention. Current guidelines recommend the administration of a first-generation cephalosporin, such as cefazolin, within 30–60 minutes prior to skin incision to ensure adequate tissue concentrations during surgery. Redosing is advised in prolonged procedures or in cases of significant blood loss.[31-35]

In selected high-risk patients, Antibiotic-Loaded Bone Cement (ALBC) may provide an additional protective effect by delivering high local antibiotic concentrations directly at the surgical site. This strategy has been associated with a reduction in early PJI rates, although its routine use in primary TKA remains debated.[36,37]

The role of operating room ventilation systems, including Laminar Airflow (LAF) and High-Efficiency Particulate Air (HEPA) filtration, remains controversial. While these systems reduce airborne particle load, their direct impact on infection rates is inconsistent, and strict adherence to aseptic protocols appears to be of greater clinical relevance.[31–33]

Postoperative management

Postoperative care plays a crucial role in maintaining a favorable environment for wound healing and preventing bacterial colonization.

Advanced wound management strategies, including Negative Pressure Wound Therapy (NPWT) and modern antimicrobial dressings, have been shown to reduce wound complications and improve healing outcomes, particularly in high-risk patients.[38–42] Silver-impregnated dressings, in particular, provide broad-spectrum antimicrobial activity and may help prevent biofilm formation.

The prevention of hematoma and seroma formation is essential, as these fluid collections can serve as a nidus for bacterial growth. Meticulous intraoperative hemostasis, combined with postoperative compression strategies and, when indicated, the use of closed suction drains, contributes to reducing this risk.[43–52]

Cryotherapy has emerged as a valuable adjunct in postoperative care. By reducing inflammation, edema, and pain, it contributes to improved wound healing and early functional recovery. Modern continuous cryotherapy systems provide controlled and consistent cooling, enhancing their effectiveness compared to traditional methods.[43–47]

Finally, patient education is a fundamental component of postoperative infection prevention. Patients should be instructed on proper wound care, hygiene measures, and the early recognition of infection signs such as redness, swelling, pain, or discharge. Early detection and prompt intervention are critical to prevent progression to established PJI.[53]

In high-risk patients, a more structured and intensified management approach is required, as summarized in Table 3.

Controversies and emerging concepts

Despite significant advancements in infection prevention strategies in TKA, several aspects remain controversial, reflecting the complexity and multifactorial nature of PJI.

The role of LAF systems is one of the most debated topics. While LAF has been shown to reduce airborne particle load and intraoperative contamination, its impact on actual PJI rates remains inconsistent across studies. Some reports suggest a protective effect, whereas others have failed to demonstrate a significant clinical benefit, highlighting that strict adherence to aseptic technique and operating room discipline may be more relevant than ventilation systems alone.[31–33]

Similarly, the routine use of Antibiotic-Loaded Bone Cement (ALBC) in primary TKA remains controversial. While ALBC has demonstrated efficacy in reducing infection rates in high-risk patients and revision procedures, its widespread use in primary arthroplasty is debated due to concerns regarding cost-effectiveness, potential alteration of mechanical properties, and the theoretical risk of promoting antibiotic resistance.[36,37]

The optimal strategy for *Staphylococcus aureus* screening and decolonization also continues to be discussed. Although targeted decolonization protocols have been associated with reduced surgical site infections, the choice between universal and selective screening strategies remains unclear. Universal decolonization may simplify perioperative workflows and reduce missed carriers but raises concerns about antimicrobial stewardship and the emergence of resistance.[21–24]

Another area of ongoing debate concerns the duration and regimen of antibiotic prophylaxis. While current guidelines support short-term perioperative administration, some authors have explored extended prophylaxis in high-risk patients, with conflicting results and concerns regarding adverse effects and antimicrobial resistance.[34,35]

Emerging technologies are rapidly evolving and may represent the next frontier in infection prevention. Antimicrobial coatings applied to implant surfaces aim to inhibit bacterial adhesion and biofilm formation, which are key mechanisms in the pathogenesis of PJI.[12] Although preclinical data are promising, robust clinical evidence is still limited.

Infection prevention in total knee arthroplasty

Novel antiseptic agents, such as hypochlorous acid solutions, have demonstrated broad-spectrum antimicrobial activity with low cytotoxicity, making them attractive candidates for both intraoperative and postoperative use. However, their role in routine clinical practice remains to be fully established.[30]

In addition, growing interest has been directed toward personalized prevention strategies based on individual patient risk profiles, integrating clinical, biological, and potentially genetic factors. This approach aligns with the broader concept of precision medicine, although its application in orthopedic infection prevention is still in its early stages.

Overall, these controversies highlight the need for further high-quality, prospective studies to define standardized, evidence-based protocols. In the meantime, a balanced approach combining established preventive measures with selective adoption of emerging technologies appears to be the most reasonable strategy.

Clinical algorithm for infection prevention in TKA

Given the multifactorial pathogenesis of PJI, the prevention of infection in TKA cannot rely on a single isolated intervention. Instead, effective prevention requires a structured and integrated approach that combines preoperative risk assessment, patient optimization, intraoperative contamination control, and meticulous postoperative surveillance. On this basis, a practical clinical algorithm is proposed to support decision-making and to translate current evidence into a reproducible pathway for daily clinical practice (Figure 1).

The figure illustrates a structured clinical algorithm for infection prevention in TKA, integrating preoperative risk stratification, patient optimization, intraoperative preventive measures, and postoperative management. The pathway emphasizes the identification and modification of patient-related risk factors, implementation of standardized aseptic and antibiotic protocols, and early detection of postoperative complications. This stepwise approach provides a practical framework to support clinical decision-making and aims to reduce the incidence of PJI.

The rationale behind the proposed algorithm is that infection risk is not static, but rather evolves throughout the perioperative course because of the interaction between host-related susceptibility, surgical variables, and postoperative events.[3–7,11,13,14] For this reason, the algorithm is organized into sequential phases reflecting the natural timeline of care in TKA.

Infection prevention in total knee arthroplasty

The first phase focuses on preoperative assessment and risk stratification, with particular attention to modifiable patient-related factors such as obesity, diabetes mellitus, malnutrition, immunosuppression, smoking, and active remote infections.[4–10,17,18,20] This step is intended to identify patients at increased risk and to guide appropriate optimization strategies before surgery. In this context, screening for Staphylococcus aureus colonization and implementation of decolonization protocols may represent an additional preventive measure, particularly in high-risk individuals.[21–24]

The second phase addresses preoperative optimization, emphasizing the correction of modifiable conditions that may predispose to infection. This includes glycemic control, nutritional support, smoking cessation, treatment of remote infectious foci, and, when indicated, laboratory assessment of inflammatory markers such as C-reactive protein and erythrocyte sedimentation rate.[5–7,10,20,25] The objective is not only to reduce infection risk, but also to improve the patient's overall capacity to tolerate surgery and heal appropriately.

The third phase concerns intraoperative infection prevention, which remains a cornerstone of PJI reduction. Within the algorithm, this phase includes timely systemic antibiotic prophylaxis, skin antisepsis, maintenance of strict aseptic technique, minimization of operative time, and consideration of local adjunctive strategies such as antibiotic-loaded bone cement in selected high-risk cases.[11,26–37] The algorithm also recognizes the importance of the operating room environment, while acknowledging that measures such as laminar airflow should be interpreted in the broader context of overall surgical discipline and contamination control.[31–33]

The final phase focuses on postoperative management, with emphasis on wound surveillance, hematoma prevention, advanced dressing strategies, cryotherapy, and early recognition of warning signs suggestive of infection.[38–56] This component is particularly relevant because postoperative wound complications, prolonged drainage, and fluid collections may represent the transition point between uncomplicated recovery and evolving PJI. Consequently, the algorithm highlights the importance of close follow-up and prompt intervention when early abnormalities are detected.[57-66]

Importantly, the proposed algorithm is not intended as a rigid protocol, but rather as a flexible clinical framework that can be adapted to different institutional settings and patient profiles. Its main purpose is to provide a practical synthesis of the available evidence, facilitate standardization of preventive pathways, and encourage a more personalized approach to infection prevention.

Infection prevention in total knee arthroplasty

In this perspective, the algorithm may help surgeons identify critical modifiable factors, improve perioperative planning, and reduce variability in clinical practice. Although prospective validation is still needed, its implementation may contribute to lowering the incidence of PJI and improving outcomes after TKA by promoting a systematic, multidisciplinary, and evidence-based approach.[15,19]

Conclusions

Periprosthetic joint infection remains a major challenge in total knee arthroplasty. Effective prevention requires a comprehensive and multidisciplinary approach integrating patient optimization, intraoperative protocols, and postoperative management.

Risk stratification enables personalized preventive strategies, while standardized clinical pathways may reduce variability and improve outcomes. Although significant progress has been made, ongoing controversies highlight the need for further research.

The proposed clinical algorithm provides a practical and reproducible framework to guide infection prevention and may contribute to improving the safety and long-term success of TKA. Although the proposed algorithm is grounded in current evidence and clinical practice, its generalizability should be interpreted with caution, as the available evidence remains heterogeneous. Further prospective and high-quality studies are required to validate its effectiveness across different clinical settings.

Corresponding Author

Lawrence Camarda, Department of Orthopaedics and Trau-

matology, University of Palermo, Via del Vespro, 90100,

Palermo, Italy

E-mail: lawrence.camarda@unipa.it

Infection prevention in total knee arthroplasty

Giuseppe Rovere: rovere292@hotmail.com

Francesco Bosco : francescobosco@icloud.com

Claudia Cuttaia : claudiacuttaia2002@gmail.com

Ludovico Lucenti : Ludovico.lucenti@unipa.it

Luigi Meccariello : drlordmec@gmail.com

Andrea Perna : perna.andrea90@gmail.com

Michele Mercurio : michele.mercurio@unicz.it

Andrea Fidanza : fidanza.and@gmail.com

Lara Cristiano: laracristiano2811@gmail.com

Giuseppe Marongiu: Giuseppe.marongiu@unica.it

Amarildo Smakaj : amarildo.smakaj@gmail.com

Domenico De Mauro : demaurodomenico@gmail.com

Pasquale Farsetti : farsetti@uniroma2.it

Fenando De Maio : demaio@med.uniroma2.it

Lawrence Camarda camarda@unipa.it

Contributions

Giuseppe Rovere, Francesco Bosco, Claudia Cuttaia and Ludovico Lucenti, conceptualization; Luigi Meccariello, Andrea Perna, Giuseppe Rovere, and Francesco Bosco, methodology, software, formal analysis, data curation;Andrea Perna, Michele Mercurio, Giuseppe Marongiu, Andrea Fidanza, Amarildo Smakaj, and Domenico De Mauro, validation, writing – original draft preparation; Lara Cristiano, Francesco Bosco, Claudia Cuttaia and Ludovico Lucenti, investigation; Pasquale Farsetti, Fernando De Maio and Lawrence Camarda, resources; writing – Giuseppe Rovere, Francesco Bosco, Claudia Cuttai and Ludovico Lucenti review and editing; Luigi Meccariello, Lawrence Camarda , Andrea Perna , Giuseppe Rovere, visualization; Giuseppe Rovere, supervision; Giuseppe Rovere and Lawrence Camarda project administra- tion; all authors have read and agreed to the published ver sion of the manuscript

Funding

The study received no external funding.

Conflict of Interest

The authors declare no conflicts of interest.

Ethics approval

Not applicable

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Infection prevention in total knee arthroplasty

References

1. Guo J, Jin Z, Xia M. Evaluating surgical outcomes: robotic-assisted vs. conventional total knee arthroplasty. J Orthop Surg Res 2025;20:166.
2. Kayani B, Konan S, Tahmassebi J, et al. Robotic-arm assisted total knee arthroplasty is associated with improved early functional recovery and reduced time to hospital discharge compared with conventional jig-based total knee arthroplasty: a prospective cohort study. Bone Joint J 2018;100-B:930–7.
3. Li J, Liu Z, Wang Z, et al. Risk factors for periprosthetic joint infection following primary total knee arthroplasty: a systematic review and meta-analysis. Front Surg 2026;12:1715571.
4. McElroy MJ, Pivec R, Issa K, et al. The effects of obesity and morbid obesity on outcomes in TKA. J Knee Surg 2013;26:83–8.
5. Marchant MH Jr, Viens NA, Cook C, et al. The impact of glycemic control and diabetes mellitus on perioperative outcomes after total joint arthroplasty. J Bone Joint Surg Am 2009;91:1621–9.
6. Berkovich Y, Nissan EC, Maman D, et al. Diabetes and total knee arthroplasty: a nationwide analysis of complications, hospitalization outcomes and revision burden. Knee Surg Sports Traumatol Arthrosc 2025;33:3250–60.
7. Sowden J. The influence of diabetes on wound healing. Diabet Foot J 2010;13:22–6.
8. Patel AV, Stevens AJ, White R, et al. Hip, knee, and shoulder arthroplasty in patients with a history of solid organ transplant: A review. J Orthop 2024;51:116–21.
9. Akkaya M, Buday Z, Akcaalan S, et al. In-hospital complications following total knee and hip arthroplasty in patients with HIV. Jt Dis Relat Surg 2022;33:3–8.
10. Gu A, Malahias MA, Strigelli V, et al. Preoperative malnutrition negatively correlates with postoperative wound complications and infection after total joint arthroplasty: a systematic review and meta-analysis. J Arthroplasty 2019;34:1013–24.
11. Shin KH, Kim JH, Han SB. Greater risk of periprosthetic joint infection associated with prolonged operative time in primary total knee arthroplasty: meta-analysis of 427,361 patients. J Clin Med 2024;13:3046.
12. Rodríguez-Merchán EC, Davidson DJ, Liddle AD. Recent strategies to combat infections from biofilm-forming bacteria on orthopaedic implants. Int J Mol Sci 2021;22:10243.
13. Lei YT, Xie JW, Huang Q, et al. Benefits of early ambulation within 24 h after total knee arthroplasty. Mil Med Res 2021;8:17.

14. Aftab S, Ali HN, Saeed B, et al. Early physiotherapy for post-total knee arthroplasty recovery: a systematic review. Musculoskeletal Care 2025;23:e70158.
15. Izakovicova P, Borens O, Trampuz A. Periprosthetic joint infection: current concepts and outlook. EFORT Open Rev 2019;4:482–94.
16. Durst C, Rajaee L, Chang K, et al. Psoriasis is a risk factor for surgical site infection after primary TKA. Clin Orthop Relat Res 2024;482:1196–200.
17. Gordon AM, Ng MK, Erez O, et al. Dental procedures and risk of PJI. J Arthroplasty 2023;38:476–83.
18. Wang C, Huang W, Gu Y, et al. Effect of urinary tract infection on PJI risk: a systematic review. Surgeon 2020;19.
19. Tande AJ, Patel R. Prosthetic joint infection. Clin Microbiol Rev 2014;27:302–45.
20. Sørensen LT. Smoking and wound healing. Arch Surg 2012;147:373–83.
21. Zhu X, Sun X, Zeng Y, et al. Nasal screening and decolonization for S. aureus. J Orthop Surg Res 2020;15:60.
22. Schweizer ML, Chiang H, Septimus E, et al. Bundled intervention and SSI reduction. JAMA 2015;313:2162–71.
23. Ontario Health (Quality). Pre-surgical nasal decolonization of staphylococcus aureus: a health technology assessment. Ont Health Technol Assess Ser 2022;22:1-165.
24. Bode LG, Kluytmans JA, Wertheim HF, et al. Preventing surgical-site infections in nasal carriers. N Engl J Med 2010;362:9–17.
25. Ghanem E, Antoci V Jr, Pulido L, et al. ESR and CRP in diagnosing periprosthetic infection. Int J Infect Dis 2009;13:e444–49.
26. Enz A, Klinder A, Bisping L, et al. Surgical gloves and infection risk. Knee Surg Sports Traumatol Arthrosc 2023;31:1824–32.
27. Mastrocola M, Matziolis G, Böhle S, et al. Chlorhexidine vs povidone iodine. Sci Rep 2021;11:18634.
28. Chen S, Chen JW, Guo B, Xu CC. Antisepsis meta-analysis. World J Surg 2020;44:1412–24.
29. Lepelletier D, Maillard JY, Pozzetto B, Simon A. Povidone iodine role. Antimicrob Agents Chemother 2020;64:e00682-20.
30. Clayman E, Beauchamp Z, Troy J. Hypochlorous acid in infection control. Eplasty 2023;23:e1.
31. Gastmeier P, Breier AC, Brandt C. Laminar airflow and PJI. J Hosp Infect 2012;81:73–8.

32. Kirschbaum S, Hommel H, Strache P, et al. LAF effectiveness. Knee Surg Sports Traumatol Arthrosc 2021;29:3641–7.
33. Spagnolo AM, Ottria G, Amicizia D, et al. Operating theatre quality. J Prev Med Hyg 2013;54:131–7.
34. Voigt J, Mosier M, Darouiche R. Antibiotics in arthroplasty. Antimicrob Agents Chemother 2015;59:6696–707.
35. American Academy of Orthopaedic Surgeons. Perioperative antibiotics guidelines. 2019.
36. Martínez-Moreno J, Merino V, Nácher A, et al. Antibiotic-loaded bone cement. Orthop Surg 2017;9:331–41.
37. Leong JW, Cook MJ, O'Neill TW, Board TN. ALBC and revision risk. Bone Joint J 2020;102-B:997–1002.
38. Cooper HJ, Santos WM, Neuwirth AL, et al. Randomized controlled trial of incisional negative pressure following high-risk direct anterior total hip arthroplasty. J Arthroplasty 2022;37:S931-S936.
39. Kim JH, Kim HJ, Lee DH. NPWT meta-analysis. J Arthroplasty 2019;34:2804–14.
40. Liu T, Tao Y, Zhao R, et al. Skin closure methods in TKA. Arthroplasty 2024;6:51.
41. Kulkarni S, Goodbun M, Chowdhury M, Stather PW. Dermabond Prineo. J Wound Care 2025;34:220–26.
42. Velázquez-Velázquez JL, Santos-Flores A, et al. Silver dressings. Mater Sci Eng C 2015;49:604–611.
43. Liang Z, Ding Z, Wang D, et al. Cryotherapy meta-analysis. Orthop Surg 2024;16:2897–915.
44. Quesnot A, Mouchel S, Salah SB, et al. Cryotherapy RCT. BMC Musculoskelet Disord 2024;25:182.
45. Thijs E, Schotanus MGM, Bemelmans YFL, Kort NP. Cryotherapy and opioid reduction. Knee Surg Sports Traumatol Arthrosc 2019;27:1204–12.
46. Brouwers HFG, de Vries AJ, et al. Cryotherapy benefits. Knee Surg Sports Traumatol Arthrosc 2022;30:2698–706.
47. Coviello M, Abate A, Ippolito F, et al. Cold flow device. Medicina 2022;58:1537.
48. Galat DD, McGovern SC, Hanssen AD, et al. Hematoma complications. J Bone Joint Surg Am 2008;90:2331–6.
49. Christensen LMR, Arnesen CE, Möller S, Hyldig N. Compression therapy. Int J Orthop Trauma Nurs 2021;41:100815.

50. Wu D, Fu K, Jiang G, et al. Compression stockings. BMC Musculoskelet Disord 2025;26:733.
51. Holt BT, Parks NL, Engh GA, Lawrence JM. Drain vs no drain. Orthopedics. 1997;20:1121–4.
52. Liu J, Cao JG, Wang L, Ma XL. Fibrin sealant meta-analysis. Int J Surg 2014;12:95–102.
53. Rahayu U, Ibrahim K, Herman H. Patient education in orthopaedics. Patient Prefer Adherence 2025;19:1881–91.
54. Rovere G, De Mauro D, D'Orio M, et al. Use of muscular flaps for the treatment of hip prosthetic joint infection: a systematic review. BMC Musculoskelet Disord 2021;22:1059.
55. De Marco D, Messina F, Meschini C, et al. Periprosthetic knee fractures in an elderly population: open reduction and internal fixation vs distal femur megaprostheses. Orthop Rev (Pavia) 2022;14:33772.
56. Oliva MS, Muratori F, Vitiello R, et al. Cemented vs uncemented megaprostheses in proximal femur metastases: a multicentric comparative study. BMC Musculoskelet Disord 2022;22:1068.
57. Bosco F, Rovere G, Burgio C, et al. Accuracy and learning curve of imageless robotic-assisted total knee arthroplasty. J Orthop 2025;66:77-83.
58. Rovere G, Meschini C, Piazza P, et al. Proximal humerus fractures treatment in adult patients with bone metastasis. Eur Rev Med Pharmacol Sci 2022;26:100-5.
59. Mocini F, Rovere G, De Mauro D, et al. Newer generation straight humeral nails allow faster bone healing and better functional outcome at mid-term. J Orthop Surg Res 2021;16:631.
60. Romeo M, Rovere G, Stramazzo L, et al Single use instruments for total knee arthroplasty. Med Glas (Zenica) 2021;18:247-251.
61. Farsetti P, De Maio F, Potenza V, et al. Lower limb lengthening over an intramedullary nail: a long-term follow-up study of 28 cases. J Orthop Traumatol 2019;20:30.
62. Ippolito E, Valentini MB, Lala R, et al. Changing pattern of femoral deformity during growth in polyostotic fibrous dysplasia of the bone: an analysis of 46 cases. J Pediatr Orthop 2016;36:488-93.
63. De Maio F, Corsi A, Roggini M, et al. Congenital unilateral posteromedial bowing of the tibia and fibula: insights regarding pathogenesis from prenatal pathology. A case report. J Bone Joint Surg Am 2005;87:1601-5.
64. Meschini C, Cauteruccio M, Oliva MS, et al. Hip and knee replacement in patients with ochronosis: Clinical experience and literature review. Orthop Rev (Pavia) 2020;12:8687.

65. Rovere G, Bosco F, Miceli A, et al. Adoption of blockchain as a step forward in orthopedic practice. Eur J Transl Myol 2024;34:12197.
66. Vitiello R, Bocchi MB, Gessi M, Greco T, Cianni L, de Maio F, Pesce V, Maccauro G, Perisano C. Induced membrane by silver-coated knee megaprosthesis: keep or toss? J Biol Regul Homeost Agents 2020;34:101-106.

Infection prevention in total knee arthroplasty

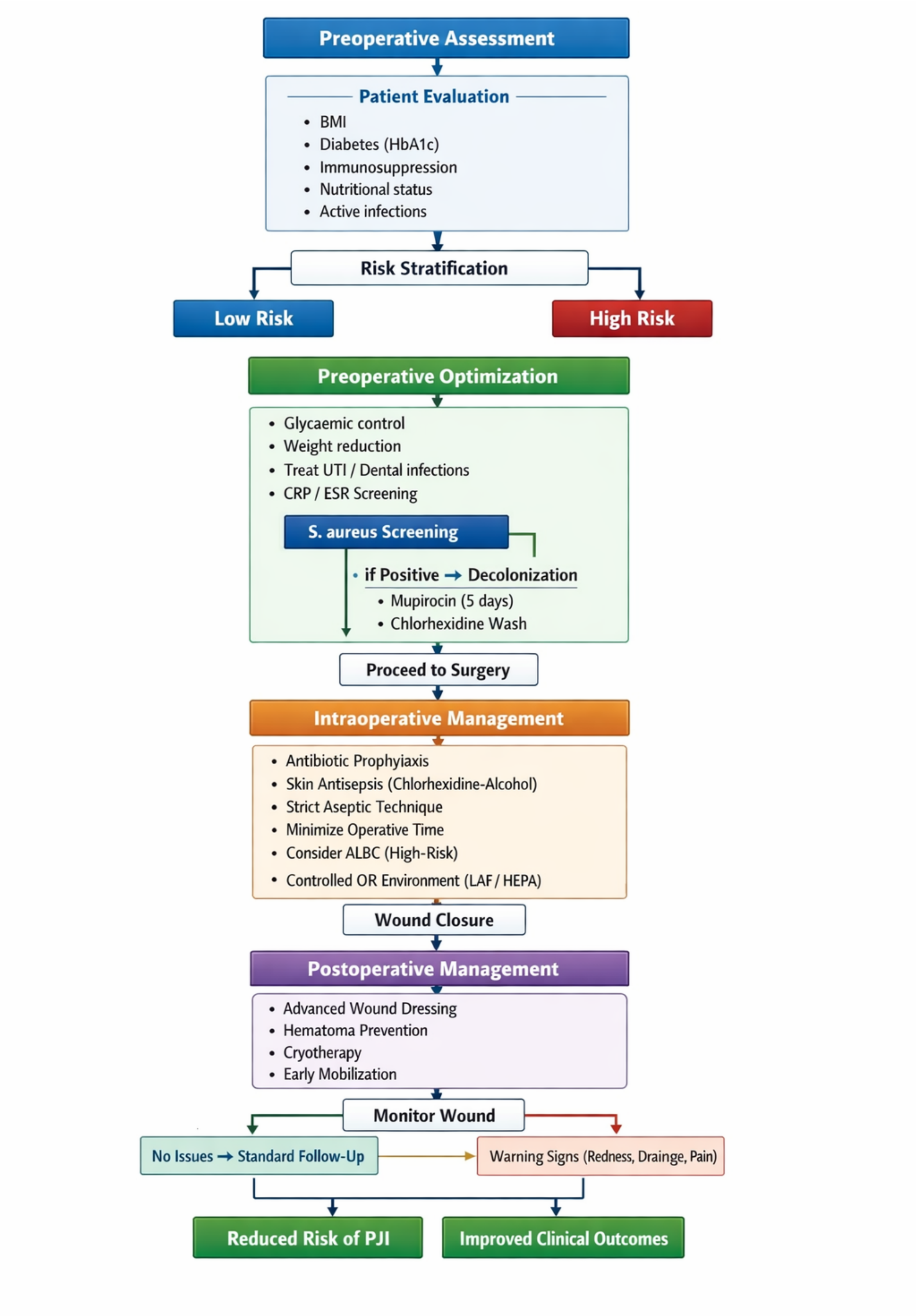


Figure 1. Clinical algorithm for infection prevention in total knee arthroplasty.

Infection prevention in total knee arthroplasty

Table 1. Risk stratification for periprosthetic joint infection in total knee arthroplasty (TKA). This table summarizes the principal risk factors associated with periprosthetic joint infection (PJI), categorized into patient-related, surgical, and postoperative domains. Each factor is classified according to its relative impact on infection risk and modifiability, providing a practical framework to guide preoperative optimization, intraoperative decision-making, and postoperative management.

Domain	Risk Factor	Level of Risk	Modifiable	Clinical Action
Patient-related	BMI 30–40 kg/m²	Moderate	Yes	Weight optimization, preoperative counseling
	BMI ≥40 kg/m²	High	Yes	Consider delaying surgery, structured weight loss program
	Poorly controlled diabetes (HbA1c >7–8%)	High	Yes	Optimize glycemic control before surgery
	Malnutrition (low albumin)	High	Yes	Nutritional assessment and supplementation
	Smoking	Moderate–High	Yes	Smoking cessation ≥4 weeks preoperatively
	Immunosuppression (HIV, transplant, steroids)	High	Partially	Multidisciplinary evaluation, risk–benefit assessment
	Advanced age (>75 years)	Moderate	No	Optimize comorbidities and perioperative care
	Active remote infection (UTI, dental, skin)	High	Yes	Treat infection before surgery
	Psoriasis / skin disease	Moderate	Partially	Dermatological optimization preoperatively
Surgical-related	Operative time >120 min	High	Yes	Optimize surgical workflow, experienced team

	Poor implant positioning / instability	Moderate–High	Yes	Accurate technique, alignment control
	Suboptimal aseptic technique	High	Yes	Strict adherence to sterile protocols
	High operating room traffic	Moderate	Yes	Limit personnel and door openings
Postoperative-related	Wound drainage (>48h)	High	Yes	Early intervention, wound management
	Hematoma / seroma	High	Yes	Hemostasis, compression, drainage if needed
	Delayed wound healing	Moderate–High	Yes	Optimize wound care and monitoring
	Early excessive mobilization	Moderate	Yes	Controlled rehabilitation protocols
	Poor patient compliance	Moderate	Yes	Patient education and follow-up
	Hematogenous infection (dental, UTI, etc.)	High	Yes	Early diagnosis and treatment

Table 2. Multimodal infection prevention strategies in total knee arthroplasty (TKA).

This table summarizes the main evidence-based preventive interventions across the entire perioperative pathway, including preoperative optimization, intraoperative measures, and postoperative management. Strategies are organized according to their phase of care, level of evidence, and clinical relevance, providing a practical framework to support risk-based decision-making and standardized infection prevention protocols in TKA.

Phase	**Intervention**	**Level of Evidence**	**Recommendation Strength**	**Clinical Notes**

Infection prevention in total knee arthroplasty

Preoperative	Glycemic control	High	Strong	Maintain HbA1c <7–8%
	Weight optimization	Moderate	Strong	Consider delay if BMI ≥40
	Smoking cessation	High	Strong	≥4 weeks before surgery
	Nutritional optimization	Moderate	Strong	Albumin assessment recommended
	S. aureus screening & decolonization	High	Strong	Mupirocin + chlorhexidine
	Treatment of remote infections	High	Strong	Dental, UTI, skin
Intraoperative	Antibiotic prophylaxis	High	Strong	Cefazolin 30–60 min pre-incision
	Skin antisepsis (chlorhexidine-alcohol)	High	Strong	Superior to povidone-iodine
	Aseptic technique	High	Strong	Fundamental
	Operative time minimization	Moderate	Strong	Efficiency critical
	Glove change	Moderate	Moderate	Especially before implant handling
	Laminar airflow	Low–Moderate	Controversial	Unclear clinical benefit
	Antibiotic-loaded cement	Moderate	Selective	High-risk patients
Postoperative	Advanced wound dressings	Moderate	Moderate	NPWT in high-risk
	Hematoma prevention	High	Strong	Hemostasis + compression
	Cryotherapy	Moderate	Moderate	Reduces inflammation

	Early infection detection	High	Strong	Patient education essential
	Follow-up protocols	Moderate	Strong	Early intervention critical

Table 3. High-risk patient protocol for infection prevention in total knee arthroplasty (TKA). This table outlines a structured, phase-based protocol for patients at increased risk of periprosthetic joint infection. Targeted interventions are organized across preoperative, intraoperative, and postoperative phases, with the aim of optimizing modifiable risk factors, enhancing perioperative management, and improving early detection of complications.

Phase	**Target Condition**	**Intervention**	**Timing**	**Clinical Objective**
Preoperative	Obesity (BMI ≥40)	Structured weight loss program	≥4–8 weeks before surgery	Reduce wound complications and infection risk
	Poor glycemic control (HbA1c >7–8%)	Intensive glycemic optimization	Preoperative	Improve immune response and healing
	Malnutrition (low albumin)	Nutritional supplementation	≥2–4 weeks before surgery	Enhance tissue repair capacity
	Smoking	Smoking cessation program	≥4 weeks before surgery	Improve perfusion and reduce SSI risk
	S. aureus colonization	Mupirocin + chlorhexidine protocol	5 days preoperative	Reduce bacterial load

Infection prevention in total knee arthroplasty

	Remote infections (UTI, dental, skin)	Targeted antibiotic therapy	Before surgery	Prevent hematogenous spread
Intraoperative	High-risk patient	Antibiotic prophylaxis (cefazolin ± alternatives)	30–60 min pre-incision	Ensure adequate tissue concentration
	High-risk patient	Consider antibiotic-loaded bone cement	Intraoperative	Provide local antibiotic release
	All high-risk cases	Strict aseptic protocol + glove change	During surgery	Reduce contamination
	Prolonged surgery risk	Surgical time optimization	Intraoperative	Limit exposure to contaminants
Postoperative	Wound complications risk	Advanced wound dressing (NPWT / silver dressings)	Immediate postoperative	Improve healing and reduce infection
	Hematoma risk	Compression + hemostasis protocols	Early postoperative	Prevent bacterial growth environment
	Inflammation	Cryotherapy	Early postoperative	Reduce edema and complications
	High-risk patient	Close clinical monitoring	First 2–4 weeks	Early detection of infection
	All high-risk cases	Patient education	Discharge phase	Prompt recognition of warning signs