Review

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Review

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Abstract

Introduction: Surgical site infections (SSIs) and prosthetic joint infections (PJIs) remain among the most serious complications in orthopedic surgery, and chemical debridement is recommended for all septic revisions. The combination of polyhexanide (PHMB) and poloxamer (PLX), with in vitro antimicrobial and antibiofilm activity, represents a promising antiseptic solution. A Delphi consensus to define the indications and clinical applications of PHMB/PLX as an antiseptic solution was carried out. **Materials and methods**: A steering committee convened a panel of orthopedic surgeons, infectious disease specialists, and wound care specialists with expertise in musculoskeletal infections. A three-phase Delphi process was conducted. Twelve clinical questions and four outcome measures were developed through literature review and iterative discussion. Two Delphi rounds were conducted using a 9-point Likert scale, and statements were rated according to the GRADE method. **Results**: All 12 final statements achieved strong agreement. The panel identified key patient-related risk factors (smoking, diabetes, obesity, immunosuppression) and procedure-related risks (open fractures, primary/revision arthroplasty, prolonged operative time). Antiseptic irrigation was considered superior to saline, and PHMB-PLX was seen as a helpful addition to mechanical debridement given its antibiofilm activity and good cytocompatibility. Low-pressure irrigation and short exposure times are the preferred application methods, while avoiding use on cartilage or neural tissues. **Conclusions**: The Delphi panel reached a strong consensus supporting the intraoperative use of PHMB-PLX as a safe and effective antiseptic adjunct for preventing and treating SSIs in orthopedic surgery. The panel recommended conducting high-quality clinical research to verify these findings and improve standardized irrigation protocols.

Keywords: periprosthetic joint infections; PJI; debridement; polyhexanide; poloxamer; irrigation; SSI; surgical site infection; antiseptic solution; DAIR; DAPRI

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1. Introduction

Surgical site infections (SSIs) and periprosthetic joint infections (PJIs) remain the most feared adverse events in modern orthopedic surgery, causing significant morbidity and mortality along with a substantial increase in healthcare costs. For example, in a recent French study [1], PJI affected 1% of procedures, with an overall incidence of 11.6 events per 1000 patient-years, and led to a significant extension of hospital stays. In the same study, the in-hospital mortality hazard ratio was 12.01 (95% CI 10.63 to 13.57) for patients with SSI after orthopedic surgery compared to those without SSI. This increase in mortality was the most significant among the various types of surgeries analyzed (cardiac, digestive, etc.). The number of fracture-related infections (FRI) is also rising exponentially. Therefore, preventing and managing musculoskeletal infections remains a primary focus for both clinicians and researchers.

Since bacterial biofilms are among the most critical factors in promoting the onset of clinically relevant infections [2], interventions aimed at preventing and removing them are attracting significant interest from the medical community. In addition to mechanical debridement, irrigating the surgical wound with saline or antiseptic solutions is now standard practice in treating PJIs [3].

Besides commonly used antiseptics such as povidone-iodine, new solutions with improved biofilm activity have recently been introduced [4–6]. In particular, a combination of polyhexanide (PHMB), an effective and well-established antiseptic for treating chronic wounds, and poloxamer (PLX) (Preventia™, a brand of Paul Hartmann AG, Germany), a surfactant intensely active against bacterial biofilm, has recently been proposed as a promising new agent for wound irrigation, including in orthopedic surgery [5–8]. Unfortunately, randomized clinical outcome trials supporting the use of PHMB/PLM-based antiseptic solutions are lacking.

Due to this limitation, the authors decided to conduct a Delphi expert consensus involving a multidisciplinary panel of professionals with the goal of: (1) identifying the indications and methods of use that are most likely to yield the greatest benefit from the PHMB/PLX combination; and (2) establishing the initial conditions for designing reliable and informative clinical studies on this topic.

2. Materials and Methods

This project was initiated and developed by a multidisciplinary Organizing Committee (OC) composed of specialists in infectious diseases, microbiology, and orthopedic surgery.

In January 2025, the OC assembled an interdisciplinary panel consisting of five orthopedic surgeons, one plastic surgeon, and one infectious disease specialist, all with demonstrated experience in research and clinical care for musculoskeletal infections (SSIs, FRIs, PJIs) in at-risk patients.

One methodologist (GP) with specialized expertise in designing and conducting consensus initiatives was also enrolled for support.

For this project, a systematic approach primarily based on the Delphi technique was used, as recommended by the National Institutes of Health in 2009 (Consensus Development Program) and similar Italian National System for Guidelines, with adjustments to suit the topic of interest [9–11].

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Phase 1: definition of the problem, questions, literature search, and appraisal

The OC identified four key areas: 1. defining proper intraoperative management of the surgical wound (primary goal); 2. identifying the most significant risk factors for SSIs, FRIs, and PJIs to pinpoint high-risk patients and procedures; 3. selecting pre- and post-surgery interventions to reduce the risk of infectious complications; 4. determining which clinical and organizational outcomes are critical or at least necessary for assessing the impact of any preventive measures.

For each area, the OC specified particular clinical and organizational scenarios along with associated questions. This was accomplished through a structured face-to-face meeting, where the results of a preliminary literature search were compared with personal experience and values (EPICOT+ method) [11].

A final list of 12 questions and 4 outcomes was developed and approved. Afterwards, a comprehensive literature review was conducted to assess the current evidence on the topic. PubMed, Google Scholar, and Scopus were searched according to the strategies outlined in Figure 1, focusing on clinical trials and systematic reviews.

The search was limited to the past 10 years. The same searches were repeated without using 'Mesh' to overcome limitations from an ongoing, incomplete indexing process where needed. Additionally, a manual search was performed through references of the selected articles.

The last update was on June 30, 2025. The retrieved papers were evaluated for consistency and quality. The non-systematic nature of the review prevented assigning a formal level of evidence.

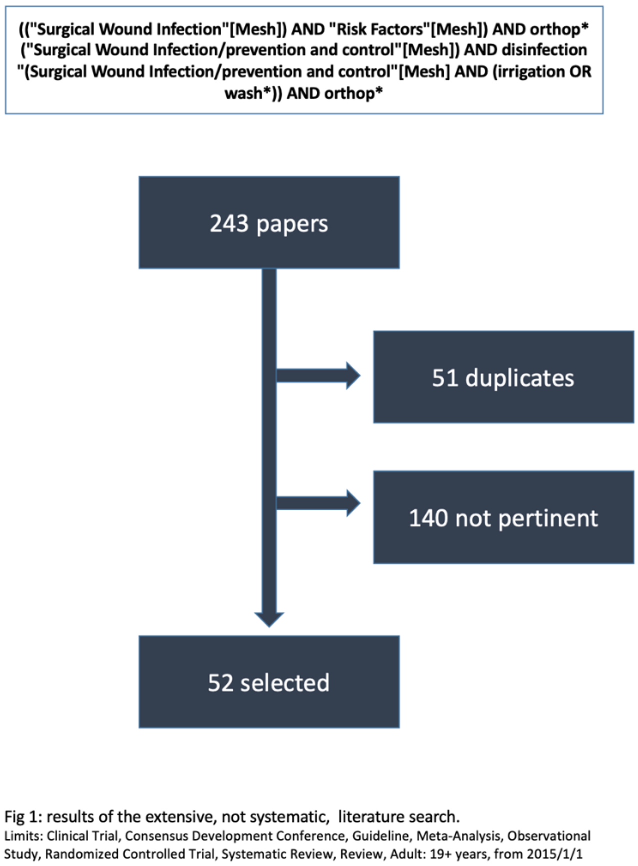

Figure 1.

Phase 2: statements, consensus development, and measurement

Evidence reports and the approved questions were submitted to the expert panel in February 2025 during a plenary meeting. After a structured and thorough discussion, 12 statements were proposed, along with notes and comments where appropriate.

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The statements were collected to form a preliminary list, which was then presented to an initial Delphi round to evaluate the level of agreement among the panel and gather additional suggestions. After several updates and revisions, the statements went through one final Delphi round. Voting took place on a dedicated web platform that guaranteed complete privacy. An 80% agreement threshold was established for approving statements. Agreement was defined as a vote of ≥7 on the Likert scale. Furthermore, the GRADE Method was employed to analyze expert votes and determine the strength of statements. Specifically, a scale from 1 (no agreement) to 9 (strong agreement) was used. Interquartile ranges (IQR) and medians (M) were calculated to assess the level of agreement. A statement was defined as characterized by:

- 'Strong agreement' if the median was ≥8 and the lower end of the IQR was >5
- 'Weak agreement' if the median was 6 or 7 and the lower boundary of the IQR was ≥5
- 'Disagreement' if the median was less than 5 and the upper boundary of the IQR was less than or equal to 5
- 'Uncertain' in the remaining situations (median=5; median >5 but lower quartile <5; median <5 but upper quartile >5)

The percentage of "Strong Agreement" was also calculated. A similar parallel process was followed for the four outcomes selected by OC and discussed in the plenary meeting with the panel.

Phase 3: general discussion and statement approval

The list of the 12 statements was discussed in a plenary meeting (July 2025) through a structured discussion to verify and refine the wording and gather additional comments.

3. Results

The thorough literature search, followed by careful manual screening of the 243 retrieved articles, identified 52 papers relevant to the 12 questions drafted (Figure 1).

Most statements received strong agreement from the expert panel (Table 1). For each topic and related groups of statements, the background evidence is summarized, followed by relevant comments and notes.

Table 1. Statements and results of voting (SA= % of votes >7; SA= Strong Agreement; WA= Weak Agreement).

#	Statement	Median	IQ25%	% Strong agreement	GRADE
Risk stratification					
1	Current smoking and non-compensated diabetes are the major risk factors for SSI. Other relevant risk factors are: BMI >35 kg/m^2, malnutrition, immunosuppression, previous irradiation of the surgical site, previous infection involving the site of intervention, history of relapsing soft tissues infections and intra-articular therapy in the three months prior the surgery	8	8	100	SA
2	Should be considered at high-risk for SSI the procedures performed on: a. osteomyelitis b. infected prostheses (DAIR, one-step and two-steps procedures) c. grade 2 or 3 open fractures d. oncological surgery Should be considered at intermediate risk for SSI the procedures performed on: a. closed fractures with implant of foreign material b. first prosthetic implant c. non-infected prostheses (i.e. prostheses revision)	9	8	100	SA

	Should be considered at baseline risk level the procedures on a. closed fractures without the implant of foreign material b. other elective interventions involving sterile territories				
3	Need to perform surgery under urgent or emergency conditions, large surgical wound site, prolonged duration of surgery further increase the risk of SSI	8	8	87.5	SA
4	In patients who underwent orthopedic surgery the definition of surgical site infection can be derived from the criteria provided by CDC	9	8	100	SA
Management of surgical wound					
5	In all patients, regardless of intrinsic risk level associated to patient-related of intervention-related factors, preoperative skin antisepsis using alcoholic CHX solution is recommended	8.5	8	100	SA
6	Surgical wound irrigation with antiseptic solution is preferable to irrigation with saline or no-irrigation in all the interventions at increased risk of infection	8	7	62.5	SA
7	The use of antibiotic solutions for surgical wound irrigation should be discouraged due to the increased risk of inducing antibiotic resistance	9	8	100	SA
8	In all patients, especially in cases where at least one risk factor related to the patient or the type of surgery is present, the use of polyhexanide-poloxamer for surgical wound irrigation should be considered	8	7	62.5	SA
9	In high-risk orthopedic surgery, especially in cases where the surgery is conducted on infected territories, the use of Polyhexanide-poloxamer for surgical wound irrigation is recommended	8	7.75	75	SA
10	When polyhexanide-poloxamer is used to irrigate surgical wounds: -it is recommended to use a solution volume sufficient to completely fill the surgical site - to use a low pressure is preferable, particularly in traumatic surgery - the minimum suggested contact time is 1 minute when the intervention is performed on sterile territories and 3 minutes when the intervention is performed on infected territories	8	7	62.5	SA
Pre-operative procedures					
11	Panel recommendations for pre-operative procedures in all patients: 1. Avoid razors for hair removal if not necessary. Clippers or depilatory cream can be used if hairs interfere with the site of incision 2. Perform *Staph. aureus* nasal screening in all patients and decolonize whether positive 3. Recommend a pre-surgery bath with antiseptic soap or solutions 4. Check blood glucose levels in the hours before the intervention and maintain	8	8	87.5	SA

	glycemia<150 mg/dl and maintain HbA1C <8% 5. Provide antimicrobial prophylaxis with weight-based antimicrobial agents selected based on most common pathogens for specific procedure. The infusion of antibiotics must be completed not before 30-60 min from the intervention. Administer an additional dose whether the surgery procedure lasts more than 3 hours.				
Post-operative procedures					
12	Panel recommendations for post-operative procedures in all patients: 1. -Early SSI and/or PJI should be assessed at 90 days (first clinical evaluation after 48 h) 2. Avoid antibiotic powder application to the patient's skin or in the site of incision 3. Use negative pressure wound therapy after open fracture treatment when immediate surgical wound closure is not appropriate 4. Use negative pressure wound therapy as prevention in difficult to heal wounds and/or in presence of comorbidities as diabetes, BMI >30 kg/m^2	8	7.75	87.5	SA
Outcomes, primary					
A	Appearance of clinical signs of infection at the intervention site within 90 days (early infection) or 2 years (prosthetic joints late infections) from the surgery	8	8	87.5	Critical
Other Outcomes					
B	Appearance of systemic signs of infection* within 90 days from the intervention *(Fever, C-reactive protein elevation)	8	7.25	75	SA
C	Prolongation of hospital stay and/or need of systemic antibiotic therapy	8	8.75	87.5	SA
D	Need of re-intervention within 90 days	8	7.75	97.5	SA

3.1. Risk Stratification

Statements 1-4: defining patients and procedures at higher risk of infection.

- Evidence Background

Multiple systematic reviews and recommendations from international scientific societies [12] highlight the significant role of current smoking and diabetes in increasing the risk of SSI. The relative risk for active smokers following orthopedic surgery related to trauma or joint replacement is consistently estimated between 2.6 and 2.8 in recent systematic reviews [12–14], while the risk increase seems to be lower in the context of spinal surgery [15]. Diabetes is another significant factor that can increase the incidence of infections by more than two percentage points [16]: maintaining pre-operative blood glucose levels below 150 mg/dL reduces the risk of SSI by about half (OR 0.59, p<0,001) [17,18].

Obesity is another well-studied risk factor [19,20], with an OR ranging from 1.9 to 2.7. However, the thresholds used to define it vary across studies, likely due to differences in reference populations (e.g., body mass index [BMI] >24 kg/m^2 in studies conducted in Asia versus BMI >30-35 kg/m^2 in

Western countries). Nonetheless, very high BMI (>40 kg/m²) appears to be associated with an increased risk of deep-site or prosthetic joint infections [19]. A recent consensus report listed a BMI >50 kg/m² as a contraindication to arthroplasty [21]. Malnutrition is a less explored risk factor. However, evidence of its significance in increasing SSI risk has been thoroughly evaluated in other consensus initiatives [20] and confirmed in recent reviews [22,23].

In oncological surgery, prior irradiation also appears to increase the risk of infection [24,25], although some reports are inconsistent [26]. Fewer, but more controversial, data support other patient-related risk factors, as endorsed by the experts' opinion, due to the scarcity of dedicated studies and flaws in experimental design (mostly post hoc or secondary analyses).

Regarding procedure-related risk factors, the cited systematic reviews and other studies emphasize the increased risk linked to open fracture surgery and the implantation of prosthetic material. Surgery on already infected areas, including oncological procedures—especially when near colonized tissues like the pelvis—is also universally considered high risk for infectious complications. The risk of SSI when revising infected surgical wounds or implants is also higher, with a tendency for lower risk in one-step procedures compared to two-step or DAIR [27–30]. The risk increase seems considerably lower when repeated procedures are done on non-infected areas [31].

Another relevant procedure-related risk factor is the prolonged duration (>60 min) of the surgical intervention [32], which often correlates with longer procedures, usually in complex cases, and may involve extensive exposure and significant tissue damage [33].

- Comments

Although some inconsistencies exist in the literature, mainly due to the retrospective design and heterogeneity across various aspects of the available studies, there was little doubt among the panel of experts about the importance of the patient-related risk factors listed in statement #1.

Biological plausibility and clinical experience strongly support this. Current smoking, poorly controlled diabetes, and obesity are the most significant factors. Notably, a BMI over 50 kg/m² should be regarded as a strong contraindication for elective joint replacement surgery. There was also strong agreement on the importance of immunosuppression [34], as well as on the potential impact of superficial skin fragility, such as that seen in patients on chronic steroid therapy, recurrent soft tissue infections, or changes in skin vascularization. Although it is not listed in the statement because establishing it as an independent risk factor is difficult, significantly advanced age should also be considered an additional negative prognostic factor.

A spirited debate emerged about how much importance to assign to different procedures. Specifically, the discussion centered on procedures used during the revision of infected areas. Ultimately, all experts agreed that choosing the proper surgical technique in infected arthroplasty cases (DAIR vs. one-step vs. two-step) [35–37] was more crucial than assigning a specific risk level to each procedure. One of the key factors influencing SSI and PJI risk is the extent of tissue damage caused by trauma or surgical procedures, especially when tissue mobilization disrupts normal blood flow to the area. For these reasons and because of their effect on operative duration, large surgical wounds should be considered at higher risk of infection.

Regarding open reduction internal fixation (ORIF) procedures performed to treat closed fractures, listed as #2 among low-risk procedures, the panel noted an exception for patients with polytrauma or fractures caused by high-energy trauma. The delay between fracture and surgery, especially in specific types of interventions such as femoral fractures, was identified by all the experts as an additional risk factor. Moreover, there was a strong consensus about the potential impact of the need for transfusions [38] and of patients passing through an intensive care unit, due to the increased risk of colonization with multidrug-resistant bacteria. Finally, the experts chose to adopt the CDC definition for superficial and deep surgical site infection [39], even though it is quite broad and not easily applicable to orthopedic surgery. The definition of PJI is more debated, and the panel chose to reference the findings of the international Consensus Meeting on PJI held in Istanbul in spring 2025.

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3.2. Management of Surgical Wounds

Statements 5-7: generalities on surgical wound irrigation

- Evidence background

Several recent systematic reviews [40–42] confirmed that alcoholic chlorhexidine (CHX) was more effective than iodine-based preoperative skin antiseptics in reducing the risk of SSI across various surgical procedures, especially in orthopedic surgery. In the latest meta-analysis [42], the CHX group had a lower overall incidence of postoperative surgical site infections than the iodine group (RR=0.30, 95% CI=0.20–0.46, I2=95%, P<0.00001). It showed similar effectiveness across different surgical procedures, as indicated by RR of 0.25 [95% CI 0.15–0.41], I2=51%, and P <0.0001 for general surgery; for cesarean section, RR=0.47 [95% CI 0.32–0.67], I2=82%, P=0.0002; and for additional surgical procedures, including orthopedic surgery and others, RR of 0.47 [95% CI 0.34–0.65], I2=76%, with P <0.00001. These findings are consistent with other similar systematic reviews and network meta-analyses [42,43]. In 2020, a randomized clinical trial (RCT) [43] was conducted to examine the preoperative use of CHX or PVP-I in lower limb trauma surgery: logistic regression analysis showed that the odds of wound healing complications were 3.5 times higher with PVP-I than with CHX (odds ratio = 3.5; 95% confidence interval, 1.1-11.2; P = 0.032). However, less robust retrospective studies do not always confirm these results [44].

Multiple systematic reviews have examined the effectiveness of surgical wound irrigation in preventing SSI and PJI, comparing various aqueous antiseptic solutions with antibiotic solutions, saline, or no-irrigation strategies. Antiseptic solutions are more effective than saline or no irrigation in preventing SSI across general surgery and various surgical subtypes. A recent meta-analysis of 41 RCTs shows an OR of 0.72 (CI 0.57-0.93) for SSI compared to saline [45]. The findings align with evidence from systematic reviews conducted on both general [46] and orthopedic [47] surgery. Some recent studies have challenged the superiority of antiseptic irrigation over saline[48,49]. However, these findings should be interpreted with caution, as they are based on post hoc analyses of observational data, even when derived from registry sources. The majority of RCTs and meta-analyses show that antibiotic-based solutions have effects similar to those of antiseptics [48]. Nevertheless, concerns about their possible role in promoting colonization by antibiotic-resistant organisms have led most authors to advise against their routine clinical use [48].

- Comments

The discussion among the experts revealed strong agreement between their experiences and evidence in the literature. This convergence allowed for quickly forming statements that led to a solid consensus.

3.3. Polyhexanide-Poloxamer in Orthopedic Surgery

Statements 8-10: rationale, indications, and technical advice on surgical wound irrigation with polyhexanide-poloxamer

- Evidence Background

PHMB-PLX irrigation provides a dual-mechanism approach: quick membrane-targeted killing (PHMB) and surfactant-driven EPS disruption (PLX). This combination decreases planktonic load and improves penetration into sessile biofilm bacterial niches found in orthopedic implant surgery.

Robust in vitro and translational models demonstrate multi-log reductions in both planktonic and biofilm populations. Furthermore, evidence from ex vivo and murine translational models supports their application on implant surfaces such as titanium and hydroxyapatite coatings [50,51]. Few authors [52] have reported rapid planktonic killing of orthopedic-relevant bacteria by PHMB–PLX, with a 3–5 log10 reduction in CFU within 30–120 seconds at the experimental challenge concentrations used in bench studies (0.05–0.1% PHMB). Several studies [50–52] report MBEC (minimum biofilm eradication concentration) or MBEC-like endpoints for PHMB, which are slightly higher than planktonic MICs, as expected. In practical irrigation use, high local concentrations and repeated mechanical action (pulsatile lavage) help achieve these effective local exposures without systemic toxicity. Cytotoxicity studies [53] also showed that short exposures (seconds to a few minutes) at concentrations that are effective against bacteria maintain cell viability of 60–80% in many assays, resulting in a favorable therapeutic index (ratio of antimicrobial effect to host-cell toxicity).

Nonetheless, it is recommended to avoid prolonged pooling on cartilage, exposed nerve tissue, or sensitive intracapsular structures. Additionally, it is recommended to prevent ad hoc increases in concentration or unvalidated dilution changes. While translational data are compelling, animal and ex vivo human tissue models are approximations: human surgical sites involve complex host immune and perfusion factors that may influence antiseptic kinetics and outcomes.

- Comments

Many of the experts have effectively used PHMB-PLX in clinical practice [8]. Its key benefit is its promising ability to prevent and remove biofilm from foreign materials and tissues.

In fact, evidence from wound care studies shows that removing biofilm is crucial for achieving a favorable prognosis, whether in late or early (<4 weeks) surgical site or periprosthetic joint infections [54]. Additionally, using a ‘chemical debridement’ as an adjunct to mechanical debridement provides benefits for treating surgical wounds with limited space and hard-to-reach recesses [3]. Additionally, an important factor to consider is PHMB-PLX's proven effectiveness at low pressure. In fact, PHMB-PLX (Preventia™) has been approved by regulatory agencies for use with low-pressure techniques. Of note, low pressure should be preferred in traumatic surgery, especially for open fractures [55].

Furthermore, the scientific and clinical community is increasingly moving toward establishing a contraindication for high-pressure intraoperative lavage in prosthetic surgery due to the risk of transferring pathogens from superficial tissues into the wound. The strength of the biological data on the effectiveness of combining a disinfectant and surfactant in reducing the need for extended contact times with surgical wounds and foreign materials led the authors to a strong consensus on practical application methods, detailed in recommendation #10. The use of multiple antiseptics, including PHMB-PLX, has also been recently recommended by experts at the 2025 ICM on PJIs [3] for DAIR scenarios. Finally, the demonstrated low tissue toxicity, particularly concerning the cells involved in repair processes, is, in the panel's unanimous opinion, another major strength of this disinfection strategy.

However, all experts agree that the main barrier to the broader use of PHMB-PLX in orthopedic surgery is the lack of clinical studies. Developing high-quality randomized controlled trials to evaluate their effectiveness in preventing and treating surgical site infections in orthopedics should be a top priority for researchers.

3.4. Pre-and Post-Operative Procedures and Outcomes

Statements 11-12: patient preparation, surgical wound closure, and post-surgery management

- Evidence background

Although providing recommendations on pre- and post-operative procedures was not the primary focus of this project, the expert panel chose to draft statements to help guide the future development of reliable and informative clinical trials on the use of PHMB-PLM in orthopedic surgery. The review by Siedelman et al. on surgical site infection prevention [56] and the 2021 clinical guidelines by the Italian Society for Orthopedics and Traumatology [57] served as the primary sources of evidence. After thorough discussion, a strong consensus was achieved on the 5 pre-operative procedure recommendations summarized in statement #11, as well as on the 4 post-operative recommendations listed in statement #12. Surprising results from a recent umbrella review [58] showed that intrawound vancomycin significantly reduces infection rates in primary joint arthroplasty, including periprosthetic joint and superficial infections, without increasing wound complications. This finding sparked a lively debate among the panel members because the ICM 2025 recommendations took a different direction [59]: ultimately, the prevailing consensus was to continue recommending against the use of vancomycin powder, in line with the findings of an international consensus.

During the discussion, a strong consensus emerged on the primary outcome to be tested in future trials focused on assessing the effectiveness of preventive or therapeutic interventions for infected surgical wounds in orthopedics. The presence of clinical signs and symptoms was unanimously considered the primary method to evaluate the outcome of interest, and a 90-day time point was selected in accordance with the 2024 National Healthcare Safety Network (NHSN) recommendations [60]; the 2-year minimum follow-up as a time to define the outcome of the intervention, specific to arthroplasty, was selected based on surveillance data from Sweden's extensive national infection control program [61], which reported on the incidence of periprosthetic joint infection after primary total hip arthroplasty.

4. Discussion

This Italian Delphi Consensus is a structured effort by experts to develop evidence-based recommendations for intraoperative wound irrigation in orthopedic surgery and to clarify the role of PHMB–PLX in this context. Despite ongoing advancements in perioperative infection control, SSIs and PJIs continue to be significant clinical challenges. The consensus reaffirmed the important role of intraoperative wound irrigation as both a preventive and therapeutic measure and reached strong agreement on its technical aspects, especially the preference for antiseptic solutions over saline or antibiotics, and for low-pressure techniques to reduce tissue damage and bacterial spread. A key outcome of this initiative was establishing clear guidelines for use of PHMB–PLX and its proper application methods. The experts agreed that PHMB–PLX is especially effective in high-risk procedures—such as open fractures and primary and revision arthroplasty—where biofilm presence is most critical. Its application should include brief exposure times and gentle, low-pressure irrigation, avoiding prolonged pooling or contact with cartilage and nerve tissue. These recommendations align with the current understanding of PHMB–PLX's dual mechanism of action, combining rapid antiseptic effects with surfactant-mediated biofilm disruption while maintaining favorable cytocompatibility. Another significant contribution of this consensus is the methodological foundation it offers for future research. By identifying key clinical questions, critical outcomes, and standardized application methods, the panel set the foundation for designing strong, informative randomized controlled trials to evaluate the clinical effectiveness, tolerability, and effect size of PHMB–PLX irrigation.

The main strength of this work is its rigorous and systematic approach: a clear decomposition of the problem, transparent negotiation among evidence, experience, and expert values, and a measurable assessment of agreement.

The main limitation is the lack of a formal systematic review, which might have caused the omission of minor studies. However, the project's goal was not to create a formal guideline, and it is unlikely that additional small or diverse publications would have significantly changed the experts' consensus.

5. Conclusions

This Delphi Consensus establishes a scientifically grounded framework for the safe and rational intraoperative use of PHMB–PLX and provides a methodological template for future clinical research to measure its true clinical benefit.

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