

REVIEW ARTICLE

**[Translated article] PREVENCOT project: Do we follow international guidelines to prevent surgical site infection in orthopaedic elective surgery?**



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**KEYWORDS**

Periprosthetic  
infection;  
Prevention;  
Orthopaedic surgery;  
Arthroplasty;  
Hip;  
Knee

**Abstract**

**Background and objective:** Prevention of postoperative surgical site infections is indeed feasible. The aim of this work is to analyse adherence to international guidelines for the prevention of infections in elective orthopaedic prosthetic surgery by means of a survey of a representative sample of Spanish orthopaedic surgeons, with the purpose to establish general recommendations.

**Material and method:** A population survey was conducted in online format consisting of 78 questions to analyse the usual clinical practice of Spanish orthopaedic surgeons in the face of periprosthetic infections of the hip and knee, and their adherence to international guidelines.

**Results:** The results of the survey ( $n = 138$ ) show in clinical practice of Spanish orthopaedic surgeons a high adherence to most of the international recommendations.

**Conclusions:** The integration high adherence of individual clinical practice with the best available scientific evidence based on the recommendations of international guidelines is the best way to adequately manage the prevention of periprosthetic infection in elective surgery.

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**PALABRAS CLAVE**

Infección  
periprotésica;  
Prevención;  
Cirugía ortopédica;  
Artroplastia;  
Cadera;  
Rodilla

## Proyecto PREVENOT: ¿Seguimos las recomendaciones internacionales para la prevención de la infección del sitio quirúrgico en cirugía ortopédica programada?

**Resumen**

**Antecedentes y objetivo:** La prevención de las infecciones postoperatorias en el sitio quirúrgico es realmente factible. El objetivo de este trabajo es analizar la adhesividad a las guías internacionales para la prevención de las infecciones en cirugía ortopédica protésica electiva a través de una encuesta sobre una muestra representativa de cirujanos ortopédicos españoles, con el fin de establecer unas recomendaciones generales.

**Material y método:** Se realiza una encuesta poblacional en formato *online* compuesta por 78 preguntas para analizar la práctica clínica habitual de los cirujanos ortopédicos españoles ante las infecciones periprotésicas de cadera y rodilla, y la adhesividad de los mismos a las guías internacionales.

**Resultados:** Los resultados de la encuesta (n = 138) muestran que en práctica clínica existe una alta adhesividad de los cirujanos ortopédicos españoles a la mayoría de las recomendaciones internacionales.

**Conclusiones:** La integración de la práctica clínica individual con la mejor evidencia científica disponible a partir de las recomendaciones de las guías internacionales es la mejor vía para el manejo adecuado de la prevención de infección periprotésica en cirugía electiva.

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**Introduction**

Despite the many advances in the field of surgery over the last decade,<sup>1</sup> inadvertent contamination by microorganisms during surgery can lead to postoperative surgical site infections (SSIs).<sup>2</sup> SSIs are the second most frequent cause of hospital acquired infection in Europe,<sup>3</sup> increasing hospital stays from 3 to 20 days.<sup>4</sup> SSIs are also the most prevalent nosocomial infection (NI) in hospitalised patients. Their incidence in Spain is 5.9% according to the INCLIMECC study.<sup>5</sup> They are also associated with high morbidity and mortality and high costs for the healthcare system, 77% of deaths of surgical patients are related to them, and they increase the risk of death 2- to 11-fold.<sup>6</sup> It is essential to prevent SSIs. The current published literature indicates that it is possible to reduce the incidence of SSIs by up to 60%.<sup>6</sup> It was in this context that the PREVENOT project was born, with the main objective of analysing adherence to the international guidelines for the prevention of SSI in elective orthopaedic surgery in daily clinical practice by means of a survey of a representative sample in Spain. Our secondary objective was to establish general recommendations for routine clinical practice in Spain.

**Methods**

The PREVENOT project is a project led by the Spanish Society of Orthopaedic Surgery and Traumatology (SECOT) and developed by a scientific committee of specialists in Orthopaedic Surgery and Traumatology.

As a starting point for the initiative, the scientific committee established a series of questions based on an analysis of the current evidence on each of the sections asked about and then analysed the answers, and based on this, evaluated the usual clinical practice for these aspects through a survey

aimed at specialists in Orthopaedic Surgery and Traumatology (population-based survey in online format consisting of a total of 78 questions). The survey was sent to 280 hospitals registered in the SECOT database. It was disseminated through a letter of invitation sent by SECOT and addressed to hospitals throughout Spain, to be processed by the physician specialising in the area of knowledge analysed. A total of 138 responses were obtained.

The survey questions were divided into blocks: general prevention in the preparation of the surgical site, surgical personnel and clothing, surgical environment and surgical field, surgical wound technique, and management; and infection prevention in the hip and knee regarding surgery, technique, implants, and postoperative problems.

The statistical representativeness of the sample was estimated with a 95% confidence interval,  $\pm 5\%$  precision, and 10% necessary replacements as the maximum uncertainty assumption in each of the responses obtained. We used IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp. released 2011, for the statistical treatment of the data; the results are shown as absolute frequencies (number of cases) and percentages (%).

**Results**

A total of 138 orthopaedic surgeons answered the survey from a total of 124 hospitals, public, private, and subsidised, which is very close to the figure required to achieve statistical representativeness at national level. At this point, it should be noted that this representativeness was not achieved due to the interruption in survey collection forced by the health crisis caused by the COVID-19 global pandemic. Most of the specialists who responded to the survey were heads of departments and section heads (65%), and the autonomous communities of Catalonia (28%) and the Com-

munity of Madrid (19%) were the most represented at the national level. Thirty-four percent of the respondents were from hospitals of between 200 and 500 beds. Furthermore, 77% of the participants indicated that they belonged to hospitals in which more than 200 elective orthopaedic surgeries are performed per year.

Annex 1 shows the list of survey respondents.

Annex 2 shows the complete survey.

Annex 3 shows the survey results.

## Discussion

The fundamental finding of our work is the high adherence in routine clinical practice of Spanish orthopaedic surgeons to international guidelines. These results represent the daily clinical practice of 124 hospitals in our country in 78 aspects related to infection prevention, and is one of the largest studies in this field.

The prevention of SSIs is a key challenge that requires the implementation of a variety of measures before, during, and after surgery.<sup>7</sup> The risk of developing a SSI in orthopaedic surgery is likely to be influenced by patient characteristics, multiple factors during surgery and perioperative care.<sup>8</sup> Guidelines for the prevention of SSIs have been developed by various international bodies such as the World Health Organization (WHO),<sup>3</sup> the US Centers for Disease Control and Prevention (CDC),<sup>9</sup> and the National Institute for Health and Care Excellence (NICE).<sup>10</sup> However, despite the usual precautions taken in clinical practice based on the available scientific evidence for many crucial issues in this field, some remain unresolved.

## Preparation for surgery

It is well known that preoperative cleansing of the skin with an antiseptic agent (at home or in the hospital) can substantially decrease microbial counts on the skin and can be performed using a wide variety of agents.<sup>11</sup> Of the respondents, 91% consider preoperative skin cleansing at home before elective surgery important to reduce the risk of SSIs. However, the heterogeneity of skin cleansing protocols and variable compliance rates (up to 78% non-compliance<sup>12</sup>), make it difficult to isolate preoperative preparation as a determinant of infection prevention in patients undergoing orthopaedic surgery. Traditionally, preparation for surgery has included removing hair from the incision site. In the survey, 60% indicated that this was mandatory and indicated that it should be done with electric clippers on the day of surgery in the preoperative area. Only 40% of the respondents do not consider hair removal around a surgical incision to be mandatory. However, international recommendations suggest that if the hair around the surgical incision site does not interfere with the operation, it should not be removed as there is a potential risk of skin and wound contamination.<sup>11</sup> If hair must be removed, the available evidence suggests it should be removed with electric clippers, avoiding the use of razors. It is important that this is done shortly before the operation and outside the operating theatre.

Antibiotic prophylaxis is another aspect of preparing patients for surgery. Much research has focused on reducing the rate of infection using prophylactic antibiotics.<sup>13-16</sup>

The respondents follow the international recommendations in using it 30 min before surgery and/or cuff inflation, if used.

## Surrounding the surgical procedure

When the patient arrives in the operating theatre, certain standards must be met to control the extrinsic risk factors associated with the surgical environment, minimising the microbiological risk as much as possible. Surgical gowning plays an essential role as a barrier to prevent infection during surgery. It is presumed, despite the lack of strong clinical evidence in the literature, that the use of surgical masks and surgical caps by operating theatre staff reduces the frequency of SSIs<sup>11</sup> (67% of participants believe that the use of disposable surgical caps and surgical masks reduces the risk of SSIs). Operating theatre staff are also recommended not to wear scrubs and clogs during surgery that have been in contact with areas outside the restricted environment of the operating theatre.<sup>11</sup> Most of the respondents restrict the use of this clothing to the surgical area and indicate that, to reduce the risk of SSI, shoes, or clogs exclusively for surgical use should be worn. Standard clinical practice, as reflected in the survey, shows clear adherence (92%) to European recommendations on limiting the number of individuals in the operating room and opening doors correlating with the number of airborne particles predisposing to periprosthetic joint infections. Therefore, foot traffic in and out of the operating theatre should be kept to a minimum.

Operating room temperature may affect core body temperature, which could influence subsequent SSI/PJI rates. Therefore, an optimal operating room temperature (between 18 and 24 °C)<sup>11</sup> should be maintained. It is known that forced warm air systems (FWA) around the patient help maintain normothermia during surgery. There is no evidence of their use being associated with an increased risk of SSI/PJI.<sup>11</sup> The survey results show high concordance with international recommendations in these areas.

The use of laminar airflow systems in the operating theatre (LAF) does not now appear to be as important as in the past and their routine use is not recommended. This should not be interpreted to mean that operating theatre air quality is not important.<sup>11</sup> Of the survey respondents, 54% say they do not use this system in their hospital, yet 64% believe that its use can reduce the risk of SSI.

## During the surgical procedure

Many reviews have been conducted to study whether the technique, duration or agent used by the surgeon and surgical staff for hand washing affects the patient's risk of SSI/PJI.<sup>11</sup> There is evidence that hand scrubbing with alcohol-based products, as opposed to traditional hand washing with soap solutions and brush, is more effective as it causes less damage to the skin.<sup>17-22</sup> Most of the survey respondents consider washing with alcohol-based chlorhexidine gluconate for at least 3 min is the most appropriate method.

In relation to painting the skin before placing the surgical drapes, the ideal solution for skin preparation in the surgical field has not been identified,<sup>23,24</sup> but it should con-

tain alcohol according to recommendations made by the CDC, ICM, and previously published studies, ensuring rapid drying, to improve patient safety, and preferably using a single-dose system with applicator.<sup>25–27</sup> Of the respondents, 83% stated that they use 2% chlorhexidine-alcohol as the antiseptic agent for preoperative skin preparation.

Regarding painting the skin again after placing the surgical drapes, the recommendations and the survey results show that this may reduce the microbiological load on the skin and result in lower rates of superficial SSIs, but further evidence is needed in this regard.<sup>28</sup> Most of the respondents highlight that the entire limb should be painted to reduce SSI/PJI rates, rather than part of the limb, applying the antiseptic using back-and-forth strokes. International recommendations point in the same direction, despite limited evidence, as surgical skin preparation of the entire limb can potentially reduce the risk of SSI/PJI by reducing the risk of contamination associated with partial limb preparation.<sup>11</sup>

In relation to the surgical drape of choice (reusable vs. non-reusable), the current literature is inconclusive but does suggest using impermeable barriers, regardless of the type of drape used. In this regard, 88% of the respondents would opt for disposable drapes, although more research is needed to confirm this trend.

Finally, it would be interesting to conduct studies to better assess the effect of iodine-impregnated adhesive surgical incision drapes on infection in total hip and knee arthroplasty, as there is no solid evidence.<sup>11</sup> In this respect, our survey shows that half the respondents agree on the use of adhesive surgical drapes. A recent study shows that alcoholic chlorhexidine solutions act synergistically, *in vitro*, with iodine-releasing antimicrobial incision drapes. These antimicrobial incision drapes help reduce underlying skin colonisation achieved by surgical antisepsis, but their actual impact on SSI rates needs to be verified by controlled studies.<sup>29</sup>

Most of the respondents believe it beneficial to change gloves during prolonged operations and before handling implants (91%), to change surgical gowns every 180 min, as well as electroscalpel tips and suction cannulas. Electro-surgical scalpel tips are vulnerable to contamination during surgery. However, the significance of this contamination is questionable. Larger and sufficiently powered studies are needed to determine whether this contamination causes subsequent SSI/PJI,<sup>11</sup> but it should be noted that the survey results, especially during prolonged surgeries, indicate that electric scalpel tips are often changed to reduce rates of SSI/PJI. The same trend is observed in relation to changing suction/catheter tips or turning off suction when not in use.

The recommendations are that surgeons should minimise contact with light handles as they are a potential source of contamination and when possible circulating staff should be responsible for moving the lights.<sup>11</sup> If contact with lights is necessary, the recommendations and clinical practice are consistent: gloves should be changed to limit contamination of the surgical field.

Instrument trays should be kept in sterile packaging and opened as soon as possible before they are to be used.<sup>11</sup> In

addition, it is recommended not to use liquid-filled trays that remain open during the surgery (if used, a diluted antiseptic solution such as chlorhexidine gluconate or diluted betadine, rather than sterile water would be better).<sup>30,31</sup> These recommendations are consistent with the survey results.

Considering the low cost of changing scalpel blades, it is difficult to recommend that they should not be changed after skin incision, although there is insufficient evidence to support this. The skin blade should be changed to continue to deeper planes using a new blade.<sup>11</sup> Most of the respondents perform this procedure in this way (87%).

Regarding the association between prolonged operative times and SSIs/PJIs, there is considerable evidence to suggest a correlation,<sup>11</sup> which the respondents also believe. In addition, recent technological developments in surgical instrumentation have improved the operative process of the surgery, but perhaps because computer-assisted surgery is used operative time may be longer and therefore there is an increased risk of subsequent SSI/PJI.<sup>11</sup> It would be interesting to investigate these aspects further. However, 54% of the respondents do not use these technologies in their centre.

Several techniques are now available for wound closure after total arthroplasty including staples, sutures, adhesives, and transdermal systems.<sup>32</sup> Although several randomised clinical trials are available, surgeons usually select wound closure systems based on personal preference (the respondents often use staples for skin closure), as no specific closure system has been shown to reduce the risk of SSI/PAI.<sup>11</sup> Risk factors for SSI are multifactorial. The presence of suture material, considered a prosthetic implant, logarithmically reduces the number of organisms required for SSI from 105 to 102 colony-forming units, and thus increases SSI rates.<sup>33,34</sup>

As for surgical drains, many studies show that they do not seem to increase the risk of PJI/SSI when used for a short period of time (less than 48 h). However, the recommendation is to avoid their use in elective primary hip and knee prosthetic surgery.

## Measures in managing periprosthetic infections

There is no evidence on the impact and effectiveness of changing surgical drapes and instrumentation during implant retention surgery for a prosthetic infection; it is, therefore, at the surgeon's discretion.<sup>35</sup> Of the respondents, 73% considered it appropriate to do so. Specifically in hip and knee surgery, the recommendations indicate that the risk of PJI may be higher when elective arthroplasty follows a contaminated case. The risk is reduced by thorough cleaning of the operating theatre after the contaminated case.<sup>35</sup> The respondents state that they routinely do this. However, further studies are needed to clarify this connection.

## Approach and implants

There appears to be no difference in SSI/PJI rates after total hip arthroplasty or total knee arthroplasty according to the surgical approach and the type of implant fixation,<sup>35</sup> as also

indicated by 60% of the respondents. It is logically necessary to prevent SSIs by providing surgical instruments and implants that are free of contamination at the time of use.<sup>36</sup> Reuse of an implant that accidentally comes into contact with a contaminated surface is not recommended, and this is the opinion of the respondents.<sup>35</sup> If the implants are cemented, it is recommended that the cement be antibiotic-impregnated.<sup>37</sup> Eighty percent of the respondents agree with this statement. It has also not been shown that the bearing surface in total hip arthroplasty has no influence on SSI rates; however, some work suggests that ceramic-on-ceramic bearings would have lower infection rates.<sup>38</sup> This was supported by 62% of the respondents.

### Postoperative care

During postoperative surgical wound care, it should be noted that the dressing placed over the surgical wound under sterile conditions in the operating theatre should be changed depending on the saturation of the dressing. If the dressing remains dry, wound coverage for a minimum of 48 h is recommended.<sup>11</sup> The survey results show the same trend in this respect. Again, 58% of the respondents believe that negative pressure dressings decrease the risk of SSI, although they caution that they should be restricted to high-risk patients. This statement needs further research to be corroborated.

When to allow the wound to get wet after surgery remains a controversial issue. The benefits of early showering (no earlier than 48 h) would be improved quality of life and better rehabilitation outcomes.<sup>39</sup> In clinical practice, as reflected through the survey, it is considered appropriate to wet or soak the incision after suture removal. If earlier, it should be no earlier than 48 h after surgery.

There is no validated definition of "persistent wound drainage", although it is a common issue of concern to all orthopaedic surgeons. In the absence of data, the recommendations define it as any continued fluid extrusion from the surgical wound occurring beyond 72 h from the previous surgery. Postoperative (under 72 h) wound drainage is not uncommon in patients undergoing hip or knee arthroplasty, and observed up to 10% of patients.<sup>40–42</sup> Of the respondents, 35% consider the most appropriate time frame for defining the term "persistent wound drainage" would be continuous drainage beyond the fourth postoperative day.

Cellulitis is a serious event in patients with a joint prosthesis and requires treatment. The recommendations are that any patient presenting with suspected cellulitis or suspected superficial infection should be carefully assessed, which may include joint aspiration.<sup>35</sup> In clinical practice, joint aspiration is also considered appropriate to rule out joint infection if suspected.

Finally, procedures such as colonoscopy or upper endoscopy can produce transient bacteraemia, although the evidence is limited to confirming some associated risk of SSI/PJI. However, there is no evidence that administering antibiotics prior to procedures decreases this risk, and therefore this practice should be avoided.<sup>35</sup> In this regard it should be noted that most of the respondents consider that

performing these procedures after total joint arthroplasty may influence the incidence of SSI/PJI.

### Conclusions

In clinical practice in Spain, there is high adherence to most of the international recommendations regarding the prevention of infection after elective hip or knee arthroplasty. SSI is a very costly complication with high morbidity and mortality. Its management should be multidisciplinary and preventive measures require further research to understand its pathogenesis and determining factors, and thus reduce its incidence.

### Level of evidence

Level of evidence IV.

### Conflict of interests

The authors have no conflict of interests to declare.

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### Annex 1. Respondents in the SSI/PJI survey in orthopaedic surgery:

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## Appendix B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at [doi:10.1016/j.recot.2021.10.006](https://doi.org/10.1016/j.recot.2021.10.006).

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