studies should aim to further investigate these potential differences in the organism and resistance profiles in hips and knees diagnosed with SSI and PJI.

Groff *et al.* recently examined 1,214 PJI cases (501 hips and 713 knees) over a 17-year timeframe and found significant differences in pathogens causing PJI in the hip and the knee. A higher incidence of *Streptococcal* species (odds ratio (OR) 1.82, 95% confidence interval (CI), 1.23-2.67) and culture-negative PJI (OR 1.53, 95% CI, 1.12-2.09) were identified in TKA compared to THA. In contrast, *Pseudomonas* (OR 2.123, 95% CI, 1.04-4.34), *Enterococcus* (OR 1.72, 95% CI, 1.03-2.86), resistant species (OR 1.64, 95% CI, 1.19-2.25), *Staphylococcus aureus* (OR 1.40, 95% CI, 1.11-1.77) and gram-positive (OR1.37, 95% CI, 1.05-1.78) organisms were more prevalent in hips. The authors suggested that the higher rates of urogenital-associated pathogens causing PJI in hips may have been related to the close proximity of the incision to the flexural creases and the groin region.

Although most studies have not demonstrated a definitive difference in organism profile between hips and knees, some have identified differences in virulence patterns, culture-negative rates, urogenital and fecal bacteria, as well as the overall rates of PJI in bilateral compared to unilateral TKA [12–14,17]. It is important to further delineate the differences in organism profile at these anatomic sites in order to establish adequate protocols and select antimicrobials accordingly, that may account for potential differences in the pathogenic flora and mitigate the risk of SSI/PJI.

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QUESTION 4: Is there a difference in the organism profile that causes periprosthetic joint infections (PJIs) in different countries?

RECOMMENDATION: Yes, there is a difference in the organism profile causing PJIs in different countries and regions of this world. There seems to be a higher incidence of PJI caused by methicillin-resistant *Staphylococcus aureus* (MRSA) in the United States and Australia compared to Europe.

LEVEL OF EVIDENCE: Moderate

DELEGATE VOTE: Agree: 97%, Disagree: 1%, Abstain: 2% (Unanimous, Strongest Consensus)

RATIONALE

General strategies to prevent occurrence of PJIs have become more relevant over the last few years. As one recommendation of the International Consensus Meeting on Periprosthetic Joint Infection in 2013, surgical antibiotic prophylaxis with either single or 24-hour dose of cephalosporin should be performed. However, antibiotics (prophylactic and therapeutic) should be selected to cover the most frequently encountered pathogens, which might vary regionally, nationally and internationally (and could be affected as well by other factors) and not simply be administered empirically.

To date, several authors have described the bacterial incidence in isolated series of PJI with either single- or multicenter studies. However, the comparison of organism profiles causing PJI between countries or world regions has been evaluated by relatively few studies.

A study comparing organism profiles between PJI referral centers in the United States (US) (Rothman Institute) and Europe (HELIOS ENDO-Klinik) found that the percentage of MRSA pathogens was significantly higher in the US than in Europe [1]. In addi-

tion, a higher incidence of more virulent organisms was found in the US patient cohort in this study. Stefansdottir et al. and Phillips et al. in their study also found a higher incidence of coagulase-negative *Staphylococcus* (CoNS) and *Streptococcus* pathogens compared with *Staphylococcus. aureus* (*S. aureus*) within various European registries (United Kingdom (UK) and Sweden) [2,3].

Peel *et al.* [4] showed that causative pathogens in PJI differ significantly in Australia compared to other reported studies and geographic regions such as the US, Sweden and the UK. In particular, the rates of polymicrobial infections showed high differences (36 vs. 14 %), as did the isolation of MRSA (over 40 % of all cases), as compared to previous European and US reports.

Pakroo *et al.* [5] reported similar geographic variation in organisms causing spinal infections in patients presenting to a tertiary referral center in the UK. The epidemiology and antibiotic susceptibility of bacteria causing skin and soft tissue infections do show geographic variation (e.g., between US, Germany, Italy and Spain) differentiating between MRSA, methicillin-sensitive *Staphylococcus aureus* (MSSA) and CoNS pathogens [6]. Although these data which relate predominantly to general skin infections cannot be easily transferred to PJI, it has been well accepted that such local infections (at the time of surgery or after) subsequently might lead to PJI.

Furthermore, it has been shown that community-acquired soft tissue MRSA infections have a much higher incidence in the US compared to Europe [7]. While a large percentage of soft-tissue infections are caused by community-acquired MRSA in the US, the community-acquired MRSA cutaneous infection rate in Europe only accounts for between 1 and 3% of presenting wound infections [8].

Along with this geographic variability, Anthony *et al.* [9] found a seasonal variability of surgical site infection (SSI) in total knee arthroplasty (TKA) and total hip arthroplasty (THA), with seasonal increase of SSI between 30 and 19% in patients with TKA or THA procedures respectively in the summer months, suggesting the possibility that geographic temperature conditions might influence the incidence and etiology of PJI. This data was extracted from a US National Database.

Data from several multicenter, retrospective studies has demonstrated that the organisms causing PJI vary by country or region of the world. An increasing number of PJIs are being caused by more virulent and resistant organisms such as MRSA in the US and Australia. With the literature lacking large prospective studies, we assign a moderate recommendation.

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