

PREVENTION

1.1. PREVENTION: HOST RELATED, LOCAL FACTORS

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QUESTION 1: Does the presence of skin lesions (i.e., boils, grazes, folliculitis, etc.), either in the proximity or distant to the surgical site, predispose patients to surgical site infections/periprosthetic joint infections (SSIs/PJIs)? If so, is it necessary for patients with these skin lesions to undergo treatment prior to elective total joint arthroplasty (TJA)?

RECOMMENDATION: The presence of active skin infections, either in the proximity or distant to the surgical site, can potentially increase the risk of SSIs/PJIs in patients undergoing elective TJA. Therefore, surgery should be delayed until these lesions are treated and/or resolved. Placing surgical incisions through eczematous or psoriatic lesions should be avoided as well, whenever possible.

LEVEL OF EVIDENCE: Moderate

DELEGATE VOTE: Agree: 95%, Disagree: 3%, Abstain: 2% (Unanimous, Strongest Consensus)

RATIONALE

Optimization of the host is effective in minimizing the risk of PJIs/SSIs prior to elective total joint arthroplasty.

Presence of Active Infection

Bacterial Infection

For most SSIs after total hip and knee arthroplasties, the source of pathogens is the endogenous flora of the patient's skin [1,2]. The presence of bacterial infection of the skin, such as boils, folliculitis and erysipelas, is encountered in patients undergoing total hip and knee arthroplasty, although the incidence is not clear.

Folliculitis is most commonly caused by *Staphylococcus aureus* in all geographic regions, according to an international survey [3]. Nasal carriage of *S. aureus* was found in 58% of patients with folliculitis/furuncles overall and was associated with chronic furunculosis [4]. There is a concern that the prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) is increasing for these patients, with the overall MRSA rate in the skin and subcutaneous tissue infections reaching as high as 36% in North America [3].

Erysipelas affects predominantly adult patients in the sixth or seventh decade, a similar demographic to those considered for total joint arthroplasty, and occurs on the lower limb in more than 80% of cases. It is often caused by the disruption of the cutaneous barrier (e.g., leg ulcer, wound, fissured toe-web intertrigo, pressure ulcer), lymphedema, chronic edema or local surgical operations. The condition is most commonly caused by β -hemolytic streptococci of group A, less so by group B, C or G streptococci and rarely by staphylococci [5]. Impetigo consists of discrete purulent lesions that are nearly always caused by β -hemolytic streptococci and/or *S. aureus*. Resistance to fusidic acid in the European strains of *S. aureus* causing impetigo has increased in recent years [6]. MRSA is a major nosocomial pathogen that may also cause impetigo [7].

As the causative organisms for these bacterial skin infections are also common pathogens in SSIs/PJIs following TJAs [8–11], if such skin lesions are in the proximity of the surgical site, the risk of SSIs/PJIs could potentially increase.

These bacterial skin infections may also have some risk of bacteremia [12]. Although it is well-accepted that seeding of the operative site from a distant focus of infection can be a source of SSI pathogens [13], literature regarding the impact of remote skin infection on SSIs from a clean wound is scarce. In a retrospective study [14] on 2,349 patients with clean surgical wounds, the wound infection rate in the 53 patients with remote skin infections was 20.7% compared to the 6.9% in the 2,141 patients without remote infections ($p < 0.001$). It should be noted that most of the procedures in that study were not orthopaedic procedures. Theoretically, for patients who have a prosthesis or other implant placed during the operation, such a remote seeding could be particularly important because such devices provide a nidus for attachment of organisms [15].

Fungal Infection

Dermatophytosis (i.e., tinea) of the feet and inguinal area is not only contaminated by bacteria, but also can be a portal of entry for bacteria through rhagade [12,16]. If it is in the proximity of incisions, there might be the risk of contaminating the tissue in the surgical wound [17]. PJI with fungal pathogens is a rare but challenging clinical problem [18]. Therefore, elective TJA should not be performed until these infections are eradicated, no matter whether they are in proximity of or distant from the surgical site.

Special attention should be paid to *Cutibacterium acnes* (*C. acnes*) (formerly *Propionibacterium acnes*). This organism is not only found in facial acne lesions but also on the trunk. Skin areas rich in sebaceous glands are a particular risk for *C. acnes* surgical site infections [19]. In shoulder arthroplasty, a higher incidence of *C. acnes* inducing periprosthetic joint infections have been reported [20–22] and routine local preoperative treatments have been described as not being sufficient in reducing *C. acnes* loading [23]. New strategies like preoperative use of benzoyl peroxide (known from topical therapy for acne vulgaris) have proven to be effective in reducing the risk of infection by *C. acnes* [24,25].

Skin Disorders with the Potential for Enhanced Microbial Load

There are no existing studies evaluating the risk of SSIs when incisions are placed through eczematous or psoriatic lesions. Psoriatic plaques have been shown to harbor increased concentrations of bacteria compared with unaffected skin, causing concern for an increased risk of infection [26,27]. However, some studies have demonstrated that there is no such association [28,29].

Patients with atopic dermatitis have higher levels of bacterial colonization on both the affected and normal skin [30,31]. In non-affected normal skin, *S. aureus* colonization was found in 19 of 30 (63%) atopic dermatitis patients compared with 6 of 25 (24%) in nonatopic eczema patients and 1 of 30 (3%) in the healthy control group, respectively ($p < 0.05$) [32]. That means that even when the incision is made in the normal skin, the risk of implant infection remains high, as the normal skin of atopic dermatitis patients is more heavily colonized than the skin of healthy patients. Lim et al. reported two cases of PJI related to remote atopic dermatitis [33].

The degree of *S. aureus* colonization may also depend on the severity and duration of the eczematous lesions. The colonization rates in acute and chronic skin lesions of patients with atopic dermatitis are significantly different, with a colonization rate of more than 70% in acute lesions and about 30% in chronic lesions [34,35].

Therefore, patients with active skin disease should see their dermatologist preoperatively, and every attempt should be made to manage skin plaques before surgery to decrease bacterial burden. Placing surgical incisions through eczematous or psoriatic lesions should be avoided if possible.

Ulcerations

Venous leg ulcers and diabetic foot ulcers usually have bacterial contamination and might be a source of systemic bacterial spread [36,37]. In general, ulceration of the skin (including neoplasm) is a substantial risk factor for surgical site infections [38]. It was recommended that elective arthroplasty not be carried out in patients with active skin ulcerations (active ulcerations being defined as breaks in the skin barrier, excluding superficial scratches) [39].

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QUESTION 2: Does poor dental hygiene increase the risk of subsequent surgical site infection/periprosthetic joint infection (SSI/PJI)? If yes, is there a role for obtaining dental clearance in patients with poor dental hygiene to reduce the risk of SSI/PJI?

RECOMMENDATION: There is a small yet real risk of hematogenous spread of oral pathogens to patients undergoing arthroplasty. Patients with poor oral hygiene undergoing arthroplasty are at increased risk of subsequent SSI/PJI. Therefore, patients with oral disease and poor dentition should be identified and optimized prior to elective arthroplasty.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 92%, Disagree: 5%, Abstain: 3% (Super Majority, Strong Consensus)

RATIONALE

Transient bacteremia occurs following everyday activities such as tooth-brushing and flossing, as well as following dental procedures [1–4]. Associated with this transient bacteremia is the theoretical risk of hematologic spread, seeding of the prosthesis, and subsequent development of a PJI. Multiple small-scale studies have shown an association between bacteria isolated in PJI and oral flora [5–11].

With this in mind, in the past many joint arthroplasty surgeons have advocated for routine dental screening prior to total joint arthroplasty (TJA). In spite of this theoretical risk, controversy exists regarding the relationship of dental pathology and dental procedures and the development of PJIs. There have been several large-scale studies that have not identified an association between dental procedures and the development of PJI. One example is a prospective case-control study that showed that there was no increased risk of PJI in patients who underwent dental procedures following TJA [12]. Furthermore, antibiotic prophylaxis did not decrease the risk of PJIs [12]. In an additional case-control study by Skaar et al., using the Medicare Current Beneficiary Survey data, the group demonstrated that there were no associations between dental procedures and the subsequent development of PJIs. This was true for patients who underwent both high and low-risk procedures [13]. In a large retrospective review of a national health registry, Kao et al. identified 57,066 patients who underwent TJA and had dental procedures postoperatively. They matched these patients with those who had not undergone dental procedures. The authors found no significant difference in the rate of PJIs between the two groups [14]. In 2014, Lampley et al. compared the incidence of PJI between elective TJA patients who underwent dental screening prior to surgery to hip fracture patients treated with total hip arthroplasty (THA) or hemiarthroplasty who did not undergo dental screening. The authors found no significant difference in development PJI between the two groups [15].

In spite of the above evidence, a rare risk for hematogenous spread of PJI persists in a small subset of patients [7,11]. In a study by Bartzokas et al., the authors identified four cases of PJI where an oral pathogen was associated with poor dental hygiene [6]. This is supported by the fact that the incidence of bacteremia following dental procedures is higher in those patients who have dental pathology and poor dental hygiene [16,17]. Given this relatively small risk, several studies have sought to identify the prevalence of dental pathology in the TJA population. In a 2011 study by Barrington and Barrington, 23% of patients undergoing TJA were found to have dental pathology [18]. However, in a 2014 study, Takarski et al. identified 12% of patients having dental pathology at screening visits prior to TJA. Furthermore, the authors used multivariate analysis to identify six risk factors for failing dental clearance. Those risk factors were narcotic use, tobacco use, not having visited a dentist within 12 months, history of pulled teeth, older age and flossing less than once daily [19].

Given the lack of evidence linking dental pathology and procedures to hematogenous spread and subsequent development of PJI, it may be reasonable to require dental screening only for high-risks patients with specific risk factors for dental pathology. While recent studies have shed light on

the risk factors associated with discovering dental pathology, further studies are needed to identify which patients should undergo dental screening following TJA.

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QUESTION 3: Should routine dental clearance be obtained prior to total joint arthroplasty (hip/knee/shoulder/ankle)?

RECOMMENDATION: No. While dental pathology has been reported in a subset of patients undergoing joint arthroplasty, there are no prospective controlled studies supporting the role of pre-surgical dental clearance in reducing the rates of subsequent periprosthetic joint infections (PJIs).

LEVEL OF EVIDENCE: Consensus

DELEGATE VOTE: Agree: 76%, Disagree: 17%, Abstain: 7% (Super Majority, Strong Consensus)

RATIONALE

Evidence that demonstrates a relationship between dental disease and the risk for subsequent surgical site infections (SSIs) and PJIs is limited. It is known that the presence of bacteria in the bloodstream is common after any dental treatment [1–4], and this has also been associated with oral activities of daily life, such as chewing, teeth brushing or flossing [1,2]. Even so, the bacterial inoculum necessary to cause a clinically important bacterial infection in humans is unknown [2].

A few case reports in the literature have attempted to link PJI with a dental source [5–16]. Such case reports document PJI associated with a recent dental procedure and with an organism that is reasonably associated with oral flora. A logical extension of this association of PJI with an oral source has led to the practice of addressing dental concerns prior to arthroplasty surgery with the expectation that this could perhaps decrease the postoperative occurrence of dental-associated PJIs. While perhaps logical, there is little published literature to support this practice. Two studies have documented dental pathology in 12 to 23% of patients planning to undergo hip or knee arthroplasty [17,18]. Other reports show a prevalence of between 30 and 50% of dental pathology in elderly patients in the United States [2,17], with 23% of adults having untreated caries, with the incidence increasing in certain groups such as the institutionalized elderly, smokers, drinkers of carbonated beverages, patients with chronic conditions such as diabetes or rheumatic diseases and in those at a lower socioeconomic level [17].

It has been suggested that the need for dental clearance could perhaps be limited to this smaller percentage of patients who could potentially be identified by a preoperative questionnaire [18]. The American Academy of Orthopaedic Surgeons (AAOS) and the American Dental Association (ADA) have published numerous guidelines in the past [19–21] regarding antibiotic prophylaxis prior to dental procedures for prosthetic joint implant patients, but little has been said about preoperative dental clearance prior to joint arthroplasty. Only one study has compared the incidence of PJIs in a population of patients who underwent dental clearance prior to arthroplasty with a population of arthroplasty patients who had no such clearance [22]. This latter group of patients was not a prospective matched control cohort, but rather was composed of hip fracture patients treated with non-elective arthroplasty. This study was not only limited by the lack of a true control group, but also by the relatively small number of patients. Nevertheless, the conclusion of this study was that dental clearance prior to arthroplasty did not provide a significant decrease in PJIs.

In the absence of concrete data, we believe that routine dental clearance prior to joint arthroplasty is not mandated. We recognize that patients with active oral disease or infection may be at higher risk for subsequent SSI/PJIs, and every effort should be made to identify these patients. Elective arthroplasty should be postponed in patients who have active infections in the oral cavity until it has been cleared.

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QUESTION 4: Does the use of a urinary catheter during orthopaedic surgery increase the risk of subsequent surgical site infection/periprosthetic joint infection (SSI/PJI)?

RECOMMENDATION: The direct association between the use of a urinary catheter and a PJI remains controversial. However, as urinary tract infection (UTI) has been associated as a risk factor for PJIs in some studies, we recommend intermittent catheterization for postoperative urinary retention (POUR), or if an indwelling urinary catheter is utilized, removing it within 48 hours of insertion to minimize the risk of a UTI.

LEVEL OF EVIDENCE: Moderate

DELEGATE VOTE: Agree: 89%, Disagree: 6%, Abstain: 5% (Super Majority, Strong Consensus)

RATIONALE

The role of routine urinary catheter use and the subsequent development of a PJI is unclear. However, urinary catheterization with indwelling catheters or intermittent catheterizations are associated with the development of UTIs [1–4]. A UTI is one of the major causes of sepsis following total joint arthroplasty (TJA) [5]. The risk of UTI has been shown to be directly related to a duration of a urinary catheter for more than 48 hours [3,6]. This has been substantiated in the TJA literature [7,8].

The association between postoperative UTI and PJIs remains unclear. While several large scale studies have not found perioperative UTIs to be a risk factor for development of PJIs [9–11], in other studies postoperative UTIs have been associated with the subsequent development of PJIs [12–15]. This

risk is theoretically due to bacteremia and hematogenous spread of pathogens into the prosthetic joint resulting in a PJI [16–20]; however, this has not necessarily been found in the literature [21–24].

To date, there is no study that has identified a direct association between urinary catheters and SSIs and PJIs. However, given the relationship with urinary catheterization and UTIs, and the association between UTIs and PJIs in some studies, bladder catheterization should be minimized. In recent studies of patients undergoing TJA without insertion of an indwelling catheter, POUR has been reported at rates as low as between 6.4 to 9.7% when using general anesthesia or opioid-free regional anesthesia [2,25,26]. This leaves greater than 90% of patients not exposed to catheterization. Furthermore, in a recent prospective randomized study, Huang et al. found a higher rate of UTI in patients who received an indwelling urinary catheter versus those who did not [2], which has been supported in another study [4]. While there are also studies that report no difference in the rates of UTI between patients who received indwelling catheters versus those who did not [27–29], if possible, patients undergoing TJA who are at a low risk for POUR, should not routinely have an indwelling urinary catheter placed and should be treated with intermittent bladder catheterization for POUR. If patients require an indwelling urinary catheter, it should be removed within 48 hours.

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QUESTION 5: Is routine urinary screening indicated prior to elective total joint arthroplasty (TJA)? If so, how should asymptomatic bacteriuria be treated prior to undergoing elective joint arthroplasty?

RECOMMENDATION: No. Routine urinary screening in asymptomatic patients is not recommended prior to elective TJA. There is also no evidence to demonstrate that preoperative treatment of asymptomatic bacteriuria is of any benefit.

LEVEL OF EVIDENCE: Moderate

DELEGATE VOTE: Agree: 89%, Disagree: 9%, Abstain: 2% (Super Majority, Strong Consensus)

RATIONALE

Concern with the genitourinary tract as a possible source of hematogenous seeding of bacteria into the joint has been present from as far back as the 1970s, when a few case reports [1–3] and a retrospective study [4] found a correlation between patients with periprosthetic joint infections (PJIs) and perioperative urinary tract infections (UTIs).

Presently, there seems to be extensive evidence supporting a definitive relation between perioperative symptomatic UTI and an increased risk of PJIs [5–16]. Consequently, it is widely accepted not only that treatment should be instituted, but also that surgery should be postponed in such a clinical scenario. Nevertheless, even this claim is not without dispute, as some reports do not corroborate this finding [17–20]. This data should not, however, be blindly extrapolated into conditions such as asymptomatic bacteriuria (ASB), as they are clearly two very different clinical scenarios.

Urinalysis is frequently used as a screening test to diagnose UTI in asymptomatic patients and a positive urine abnormality is often misinterpreted as definitive proof that the patient has a UTI [21]. A few studies focusing on screening asymptomatic patients with urinalysis were analyzed. All of them suggest that there is no relation between urine abnormalities and an increased risk of developing a PJI [22–25].

Urine cultures, regardless of urinalysis, are still the gold standard test for identifying UTIs in symptomatic patients and are perhaps the most reliable way to identify bacteriuria in asymptomatic patients. A systematic review of the literature was performed, confirming that ASB is a common finding in elective total joint arthroplasty candidates ranging from 5 to 19% [23,25–29]. This prevalence is also in agreement with previous descriptions of the prevalence of asymptomatic bacteriuria in similar age groups of the general population [30,31].

Results regarding a possible association between ASB and PJIs are scarce and conflicting (see Table 1). A large (around 2,500 patients) multicenter study by Sousa et al. [29] has found a statistically significant higher risk of PJI in ASB patients [29]. A similar more recent study, conducted within the UK National Health System and using the same definition for asymptomatic bacteriuria, found the same statistical association [23]. Among the 5,542 patients included, 1,174 (21.2%) did not have a preoperative urine culture taken. A total of 4,368 (78.8%) had a preoperative urine culture taken within a year before the date of surgery, of which 140 (3.2%) had preoperative ASB. The infection rate in the ASB group was 5% (7/140), which was significantly higher than the 0.61% (26/4228) in the non-ASB group and the 1.96% (23/1174) in the group without a screening urine sample ($p < 0.001$). Although the difference was not statistically significant, they also found that the ASB group had a higher proportion of PJIs due to gram-negative bacteria despite all patients receiving preoperative treatment. Nevertheless, the ASB isolate was the same microorganism as the PJI isolate in only one of the seven cases.

Ollivere et al. [32] also studied the impact of asymptomatic urinary tract colonization in elective orthopaedic surgery, although they focused on outcomes other than PJI specifically. They found that 38% (15/39) of patients with preoperative ASB showed some form of postoperative delayed wound healing or confirmed superficial wound infection compared to 16% (83/511) of patients in the other subgroup, leading to a significantly increased relative risk of wound complications [32]. On the other hand, a recent study by Honkanen et al. [27] with over 20,000 patients [27] and several other smaller series [23,25,26,28,33] did not find an increased risk. One possible explanation for this potential statistical association is that ASB is not a risk factor in itself, but rather a marker for some kind of increased susceptibility [29,34].

What seems to be clear in interpreting all of the results of this systematic review is the lack of a clear causal relation. The overwhelming majority of PJI isolates are distinct from those previously found in the urine of asymptomatic total joint arthroplasty candidates [23,25–29,33]. This finding helps to understand the other clear result that ASB antibiotic therapy does not influence postoperative PJI risk [23, 25–29,33]. Treating ASB not only seems not to influence PJI risk, but it also does not seem to prevent symptomatic UTI [22,35] from occurring after surgery (which might be a secondary benefit).

Following the current trend to recommend against treatment of asymptomatic bacteriuria except in cases of proven benefit, [36] the authors of this review believe that there is no place for urinary screening and treatment of asymptomatic bacteriuria before total joint arthroplasty. In addition, urinary abnormalities in asymptomatic patients should not be regarded as an indication to delay surgery. In fact, recent evidence seems to corroborate the lack of clinical utility of routinely screening urine in asymptomatic patients prior to elective total joint arthroplasty. Bailin et al. [37] performed a before-and-after study to analyze the impact of a new protocol for managing asymptomatic urinalysis abnormalities that aimed to reduce antibiotic prescriptions. After the new protocol was implemented, there was a significant decrease in antimicrobial prescriptions based on urine abnormalities both preoperatively and postoperatively. Notwithstanding, PJI rates after total joint arthroplasty neither increased in the immediate post intervention period nor in the ensuing years [37]. Lamb et al. [38] implemented an institutional policy to no longer routinely process urine specimens submitted from orthopaedic preoperative clinics. They performed a time-series analysis to evaluate the impact of this change on the incidence of PJIs. In the study period before policy change, 3,069 patients were screened of whom 352 (11.5%) had positive urine cultures and 43 of 352 (12.2%) received perioperative antibiotic treatment. Following the intervention, there were no further perioperative antibiotic courses for preoperative ASB. The periprosthetic joint infection rate was 0.03% (1 of 3,523) during the baseline period and did not change significantly during the intervention period 0.2% (3 of 1,891). None of the PJIs during the intervention period were caused by urinary pathogens [38]. Nevertheless, it is recommended that if a patient has irritating symptoms, screening tests such as urine dip sticks, white blood cell counts, and urine cultures should be considered.

TABLE 1. Summary of asymptomatic bacteriuria and prosthetic joint infection rates major reports

Author, Year	Number of Joint Arthroplasties	Definition of Asymptomatic Bacteriuria	Patients without ASB		Patients with ASB		Follow-up	Major Finding(s)
			Number	Infection (%)	Number	Infection (%)		
Glynn 1984 [26]	299	Midstream urine specimens with significant bacterial growth (> 100,000)	242	0 (0.0)	57	2 (3.5)	3 months	- In all, 39 of 57 patients were operated on without antibiotic therapy; - Both surgical wound infections grew <i>Staphylococcus pyogenes</i> with previous <i>Escherichia coli</i> in urine isolate
Ritter 1987 [28]	364	Clean catch urine specimens with colony counts > 100,000	329	2 (0.6)	35	1 (2.9)	Up to 5 years	- All infected cases grew staphylococci including the patient that grew <i>Escherichia coli</i> in preoperative urine culture
Cordero-Ampuero 2013 [23]	471	> 100,000 colony-forming units (<i>only 181/471 patients with abnormal urinalysis proceeded with cultures</i>)	425	12 (2.8)	46	1 (2.2)		- 26 of the 46 ASB patients received specific antibiotic treatment for 7 days that began the operation day - in no case were the bacteria found in the joint the same as those in corresponding preoperative urine cultures
Sousa 2014 [29]	2, 497	Isolation $\geq 10^5$ colony-forming units/mL in the absence of signs or symptoms of UTI	2,193	30 (1.4)	303	13 (4.3)	12 months	- PJI rate was significantly higher in the ASB group (OR: 3.23) although surgical isolates did not correlate to urine isolates; - Preoperative ASB treatment did not influence PJI rate – 3.9% (6/154) among treated vs. 4.7% (7/149) among untreated patients
Martínez-Vélez 2016 [25]	215	> 100,000 colony-forming units (<i>only 89/215 patients with abnormal urinalysis proceeded with cultures</i>)	204	0 (0.0)	11	1 (9.1)	>48 months	- Four of the 11 ASB patients received specific antibiotic treatment for 7 days that began the operation day - Infected case grew <i>Staphylococcus epidermidis</i> which differed from corresponding preoperative urine culture
García-Nuño 2017 [33]	148	Isolation $\geq 10^5$ colony-forming units/mL in the absence of signs or symptoms of UTI	121	2 (1.6)	27	2 (7.4)	N/R	- ASB was significantly more common in patients with dementia - There was one case in which the microorganism isolated intraoperatively coincided with the urine isolate (<i>P. aeruginosa</i>)

Author, Year	Number of Joint Arthroplasties	Definition of Asymptomatic Bacteriuria	Patients without ASB		Patients with ASB		Follow-up	Major Finding(s)
			Number	Infection (%)	Number	Infection (%)		
Honkanen 2018 [27]	20,226	All bacterial growth in the urine was considered significant	18,848	133 (0.71)	1,378	7 (0.51)	12 months	- No statistically significant association was found between positive preoperative urine culture and PJI
Weale 2018 [39]	4,368	Isolation $\geq 10^5$ colony-forming units/mL in the absence of signs or symptoms of UTI	4,228	26 (0.61)	140	7 (5.0)	< 0.001	Up to 24 months
TOTAL	28,588		26,591	205 (0.8)	1,997	34 (1.7)	< 0.0001	

ASB, asymptomatic bacteriuria; UTI, urinary tract infection; OR, odds ratio

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QUESTION 6: How should a patient with a symptomatic preoperative urinary tract infection (UTI) be managed prior to undergoing elective joint arthroplasty?

RECOMMENDATION: Preoperative symptomatic UTIs should be treated/eradicated with appropriate antibiotics prior to elective total joint arthroplasty (TJA).

LEVEL OF EVIDENCE: Limited

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

RATIONALE

The potential link between asymptomatic bacteriuria, asymptomatic UTI, and symptomatic UTI with surgical site infection/periprosthetic joint infection (SSI/PJI) is an area of controversy in the arthroplasty literature. Given the low incidence of SSI/PJIs and the relatively low incidence of preoperative symptomatic UTI, the evidence for optimal management is limited. However, in light of the dire consequences of SSI/PJIs, every effort should be made to eliminate the sources and nidus of any infection, including UTIs, prior to elective orthopaedic procedures.

Perioperative symptomatic UTI has been shown to be a risk factor for SSI/PJI [1–3]. Pulido et al. [1] reviewed a prospective database of 9,245 primary TJA patients and found that postoperative UTI was a predisposing factor for PJIs (odds ratio (OR): 5.45, $p = 0.04$). The authors advocated for treatment and eradication of preoperative UTIs before proceeding with TJA [1]. Yassa et al. [2] reviewed 460 femoral neck fracture patients, 192 of which underwent hip arthroplasty. Ninety-nine patients (21.5%) had a preoperative UTI with 13 being chronic. All patients with UTI began treatment immediately with trimethoprim. Postoperatively, 57 of 460 patients (12.4%) had SSI, with a significantly higher proportion of those having had a preoperative UTI (rate ratio (RR): 2.47). The authors concluded that UTIs have a high prevalence in patients with femoral neck fractures and that it is an important risk factor for SSI [2]. Pokrzywa et al. [3] reviewed the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) database of 434,802 general surgery patients and found that the preoperative UTI group had a higher incidence of infectious complications (OR: 1.515; 95% confidence interval (CI) 1.000 to 2.296) and non-infectious complications (OR: 1.683, 95% CI 1.012 to 2.799). The authors recommended treating UTIs prior to surgery and delaying elective procedures until resolution of the preoperative UTI [3].

The evidence available seems to indicate equivalent SSI/PJI rates between patients with appropriately-treated preoperative UTI and patients without UTI, though these studies are underpowered. Garg et al. [4] reviewed 150 primary TJA patients and found that those treated for preoperative UTIs had similar outcomes to patients without UTIs. Koulouvaris et al. [5] retrospectively reviewed 19,735 TJA patient records with 58 postoperative wound infections and matched those patients to 58 control patients. Of the 58 with SSI/PJIs, 3 had a preoperative UTI and 4 had a postoperative UTI, though only 1 SSI/PJI was the same organism as the urinary culture. In the matched control group, eight had a preoperative UTI and one had a postoperative UTI. The authors concluded that treated UTI (five to eight-day treatment course) had no greater likelihood of a postoperative infection than a patient without UTI. However, given the low infection rate of 0.29%, the power of the study was only 25%. Park et al. [6] reviewed 544 patients who underwent primary THA, 13 of which had a symptomatic UTI. The UTI patients were treated starting the day of surgery. Surgery was delayed in cases of fever or leukocytosis. There were no instances of SSI/PJI in either the case or control group, and with only 13 patients with UTIs, with the study being underpowered [6].

To our knowledge, there are no studies reporting on symptomatic preoperative UTIs that are untreated prior to elective TJA. In light of the limited evidence, the best practice in management of symptomatic preoperative UTIs prior to elective TJAs is to treat and eradicate the infection before proceeding to surgery.

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QUESTION 7: Does preoperative urinary tract infection (UTI) (symptomatic and asymptomatic) increase the risk for subsequent surgical site infection/periprosthetic joint infection (SSI/PJI)?

RECOMMENDATION: Symptomatic UTI must be treated with appropriate antibiotics before proceeding with the surgery. In asymptomatic bacteriuria (ASB), treatment should be discontinued as it does not increase the risk of a subsequent SSI/PJI.

LEVEL OF EVIDENCE: Strong

DELEGATE VOTE: Agree: 96%, Disagree: 2%, Abstain: 2% (Unanimous, Strongest Consensus)

RATIONALE

Urinary tract infections (UTIs) can present as symptomatic with fever, pain, raised leucocytes and large amount of pus cells in the urine or as asymptomatic bacteremia without any symptoms but $> 10^5$ CFU/ml in urine culture (two consecutive samples with the same organism in women and one sample in men) [1]. A correlation between UTI and PJI was first described in several case reports in the 1970s. However, there is a lack of evidence to support that correlation.

Reportedly, the prevalence of preoperative UTI ranged from 5.1 to 36% in female patients undergoing arthroplasties [2–10]. Most of these studies reported that patients with or without a positive urine culture had comparable PJI rates following arthroplasties [2–7,9,10]. On the other hand, one study reported that UTIs by gram-negative bacteria are a risk factor for PJI. However, that report could be biased because the insertion of urinary catheters, which is an important risk factor for PJI, was not stratified and the microorganisms in the PJI wounds were not the same as the isolates from the urine cultures [8].

The incidence of PJI ranges from 0.3 to 1% [11,12]. Distant seeding accounts for 10 to 20% of PJIs, and UTIs are estimated to be responsible for 13% of PJIs due to distant seeding [13]. By calculation, UTI accounts for only 0.01 to 0.05% of total PJIs. The frequency of ABU varies widely according to age, sex and population characteristics. Assuming that the prevalence of ABU is 5%, approximately 200,000 PJI patients are required to determine the causality of UTI for PJI. Such a study is barely feasible.

Urine culture is the most common diagnostic tool for UTI. However, the diagnostic accuracy of a urine culture is reduced in cases of inadequate preparation, sampling error and contamination during the collection of urine. Moreover, there is an inconsistency in the cutoff for diagnostic bacterial counts ($> 10^5$ colony-forming units of a microorganism or $> 10^3$ colony-forming units of a microorganism) [4,5]. Due to heterogeneity of diagnostic tests and different diagnostic criteria of UTIs, it was difficult to collect the overall data, to compare the results across the studies and to draw a convincing conclusion.

Evidence for Preoperative UTI as a Potential Risk Factor

In 2003, the American Urology Association (AUA) and the American Academy of Orthopaedic Surgeons (AAOS) conducted a case control study of 47 cases and 200 controls and jointly identified urinary tract infections as an important risk factor for PJIs among other risk factors [14]. Luis et al. conducted a prospective review of 9,245 patients with joint arthroplasties and identified preoperative UTI as an important modifiable risk factor for PJIs and instituted preoperative screening and treatment for UTI before proceeding for surgery [11]. Yassa et al. conducted a retrospective cohort analysis of patients who underwent an emergency surgery within 24 hours for femoral neck fractures and examined the prevalence of urinary tract associated PJIs in these patients. Out of the 367 patients enrolled, 57 (12.4%) had a surgical site infection with 23 (40%) having a preoperative UTI. They concluded that a preoperative UTI is an important risk factor for PJI and requires treatment [15].

However, a study by Kuolovaris et al. reviewed medical records of 19,735 patients and did not find any relationship between preoperative UTIs and PJIs. Only one of their 58 patients had a PJI due to the same organism causing a UTI. However, this was an underpowered study ($\beta = 25\%$). Another study by Garg et al. showed that preoperative UTIs, when adequately treated with appropriate antibiotics, have similar outcomes as non-UTI patients [16]. Thus, symptomatic preoperative UTIs must be treated before proceeding with surgery.

Evidence for Preoperative Asymptomatic Bacteriuria (ASB)

A cohort study conducted by Glynn et al. in 1984 showed that ASB predisposes to superficial wound infections, though the organisms were different from that of the urine culture [3]. In another retrospective cohort study, Ritter et al. enrolled 277 patients who underwent arthroplasty, and 35 cases of preoperative ASB were identified. During the follow-up period, varying from one to 16 years, they identified three cases of PJI, but none were related to the preoperative ASB [17]. Ollivier et al., in their prospective study of 600 patients, showed that 36% of their patients with ASB had some form of delayed wound infections vs. 16% in the non-ASB group. They concluded that patients with ASB should be recognized as a high-risk subgroup for wound infections postoperatively irrespective of their treatment [18].

A randomized controlled trial of 441 patients undergoing arthroplasty found 42 patients with asymptomatic bacteriuria. Patients were randomized to specific urinary treatment (Group A) and no specific treatment (Group B) if the urine culture was positive. Six patients each in group A and B had wound infections after three months of follow-up. None of the organisms were similar to that of the urine culture. Thus, no urinary origin of PJI was identified in patients with asymptomatic bacteriuria irrespective of whether treatment was given or not [2]. A multicentric cohort study conducted by Sousa et al. found an ASB prevalence of 12.1% among 2,497 patients. They observed that the PJI rate was significantly higher in the ASB group than in the non-ASB group (4.3 vs. 1.4%; odds ratio (OR) 3.23, 95% confidence interval (CI), 1.67 to 6.27, $p = .001$). However, in the ASB group, there was no significant difference in PJI rate between treated (3.9%) and untreated (4.7%) patients. They concluded that preoperative treatment of ASB did not show any benefit and could not be recommended [8]. Other studies by Martinez et al., Gou et al. and Bouvet et al. also suggest similar findings [5,19,20]. Systematic reviews and a meta-analysis conducted by the European Association of Urology, Mayne et al. and Zhang et al. also concluded that detection and treatment of ASB has no benefit for patients undergoing joint arthroplasty [21–23].

All of these studies have cautioned against the adverse effects of antibiotics such as drug resistance, economic burden and potential allergies. A study conducted with the help of a multidisciplinary team comprised of orthopaedic surgeons, hospitalists, preoperative clinic nurses, infection control professionals, infectious diseases physicians and microbiologists decided to change their policy regarding preoperative urine culture screening, and no screening cultures were to be sent before an elective primary joint arthroplasty (EJA). A total of 5,414 primary EJAs were enrolled over a three-year period. Of these, 3,523 were in the baseline period, and 1,893 were during the intervention period. They did not find a significant increase in PJI in the intervention phase. Also, discontinuation of urine screening led to cost savings by eliminating urine cultures and also the cost of antibiotics prescribed for ASB; thus, there is good evidence to stop screening and treatment of patients for asymptomatic bacteriuria as it does not increase the risk of PJIs [24].

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QUESTION 8: Does a patient with a colostomy have an increased risk for surgical site infection/periprosthetic joint infection (SSI/PJI)?

RECOMMENDATION: There is currently no evidence in the literature to determine if a patient with a colostomy is at an increased risk for SSI/PJIs following an arthroplasty procedure. However, it is our recommendation to ensure that the patient has a leak-free and clean colostomy in place to prevent soiling.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 94%, Disagree: 4%, Abstain: 2% (Super Majority, Strong Consensus)

RATIONALE

There are several risk factors associated with SSIs or PJIs such as body mass index (BMI), diabetes mellitus (DM), rheumatoid arthritis (RA), depression, chronic corticosteroid use, hypoalbuminemia and previous joint surgery [1–4]. Furthermore, other risk factors are reported to be correlated but not significantly associated with PJIs. These include cirrhosis, hypothyroidism, urinary tract infection, illicit drug and alcohol abuse, dementia, hypercholesterolemia, hypertension, ischemic heart disease, peptic ulcer disease as well as hemiplegia or paraplegia [4].

Colostomy is a surgical procedure diverting a part of the colon to an artificial opening in the anterior abdominal wall. It may be performed for emergency or elective surgical conditions for the management of a wide range of congenital and acquired conditions, as well as for benign or malignant gastrointestinal conditions for two main purposes: diversion or decompression of the colon [5,6]. Although it is a lifesaving procedure, both its construction and reversal have high morbidity and mortality [7,8]. Surgical site infection after colostomy is reported to be one of its major complications [5].

Correlation between bowel diseases and procedures and infection in the hip joint has been reported. Colon-articular fistulas involving the hip have been reported in patients with inflammatory bowel disease [9], diverticular disease [10] and bowel carcinoma [11]. In addition, solitary case reports have described fistula formation following total hip arthroplasty [12] or Girdlestone resection arthroplasty [13]. Coelho-Prabhu et al. [14], in a prospective, single-center, case-control study, demonstrated that esophagogastroduodenoscopy with biopsy was correlated with increased risk (odds ratio (OR) = 3, 95% confidence interval (CI) 1.1 to 7) of PJI in arthroplasty patients.

There is no publication on the subject of colostomy and the potential risk for SSI/PJI following arthroplasty. The data available suggest that SSI around the abdomen are risk factors associated with colostomy. By way of speculation, we feel that a patient with a colostomy, who has developed a SSI, would be at risk for developing a PJI after elective arthroplasty. Thus, it is justified to propose that elective arthroplasty should be delayed in patients with an active infection around the colostomy. Furthermore, it must be ensured that patients have a clean, leak-free and properly functioning colostomy in place prior to elective arthroplasty. Consideration may be given to waiting until a temporary colostomy is reversed before proceeding with an elective arthroplasty.

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