Welcome to ICM 2018
General Section
Red is my favorite color?

A. Agree
B. Disagree
C. Abstain
We need oxygen to survive?

A. Agree
B. Disagree
C. Abstain
Today is Thursday?

A. Agree
B. Disagree
C. Abstain
Prevention
G-1 (Former G-158) What modifiable and non-modifiable host related factors contribute to an increased risk of SSI/PJI?

RESEARCHED BY:

Setor Kunutsor
Literature:

• In pooled analysis of 14 studies, Kerkhoffs and colleagues reported an increased risk of infection following total knee arthroplasty (TKA) when obese were compared to non-obese patients.

• In pooled analysis of eight studies, age (as a continuous exposure) was not associated with the risk of PJI. However, findings from two studies suggested that patients aged 75 years and above had an increased risk of SSI following primary THA.

• In pooled analysis of eight studies, Chen and colleagues demonstrated that males had a higher risk of infection after TKA than females. Recent pooled multivariate analysis of 28 studies confirms the emerging evidence.

• Pooled analysis shows that black populations (compared with the white race) have an increased risk of PJI/SSI.
**Recommendation:** Modifiable host related factors such as BMI, smoking, alcohol consumption, diabetes, malnutrition and other and certain medical co-morbidities have been shown to increase the risk of SSI/PJI. Non-modifiable factors such as increasing age, male gender, and low-socioeconomic status have also been shown to increase the risk if SSI/PJI.

**Level of Evidence:** Strong

A. Agree 98%
B. Disagree 0%
C. Abstain 1%
G-2 (Former G-4) Are there any genetic factors that predispose patients to SSI/PJI or predict the success of the treatment for SSI/PJI?

RESEARCHED BY:

Christopher E. Pelt
Li Cao
Lidong Wu
Literature:

• Meta-analysis 2, Prospective/Randomized 0, Retrospective 26

• Many retrospective studies have demonstrated a genetic linkage.

• However, these are primarily of small sample sizes and analyzing a specific gene.
**Recommendation:** The evidence suggests a potential heritable predisposition is possible, but there is a lack of definitive evidence supporting specific genetic risk factors for SSI/PJI.

**Level of Evidence:** Limited

A. Agree 93%
B. Disagree 2%
C. Abstain 5%
G-3 (Former G-54) Does the presence of skin lesions (i.e. boils, grazes, folliculitis, etc) in the proximity of the surgical site or distant from the surgical site predispose patients to SSI/PJI? If so, is it necessary for patients with these skin lesions to undergo treatment prior to elective total joint arthroplasty?

RESEARCHED BY:

Hao Shen  Peter Thomas  Qiojie Wang
Literature:

- In a retrospective study on 2349 patients with clean surgical wounds (of different surgical specialties), the wound infection rate in the 53 patients with remote skin infections was 20.7% compared with 6.9% in the 2141 patients without remote infections ($p < 0.001$).

- There are no existing studies evaluating the risk of SSI when incisions are placed through eczematous or psoriatic lesions.

- Ulceration of the skin (including neoplasm) is a significant risk factor for surgical site infection.
**Recommendation:** The presence of active skin infection, either in the proximity or distant to the surgical site, can potentially increase the risk of SSI/PJI in patients undergoing elective TJA. Surgery should be delayed until these lesions are treated and/or resolved. Placing surgical incisions through eczematous or psoriatic lesions should be avoided, whenever possible.

**Level of Evidence: Moderate**

A. Agree
B. Disagree
C. Abstain
G-4 (Former G-29) Does current tobacco use increase the risk of SSI/PJI?
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 30

• Univariate statistical analysis evaluating the association between tobacco use and recurrence of PJI was performed in 19 of the 20 studies found on systematic review. Smoking was associated with a significantly increased risk for PJI recurrence in 3 of these studies.

• Hoell et al. retrospectively evaluated 59 patients who underwent two-stage revision for PJI and identified smoking as an independent risk factor for failure to cure infection (odds ratio [OR]: 21.5, 95% confidence interval 2.6-178).

• Pooled analysis demonstrated tobacco users were significantly more likely to experience recurrence of PJI after surgical treatment than non-tobacco users, with an OR of 1.53 [1.06-2.21]
Recommendation: Yes. Current tobacco use appears to increase the risk of SSI/PJI in patients undergoing orthopedic procedures.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
G-5 (Former G-125) a) What upper body mass index threshold is associated with an increased risk of SSI/PJI?
b) Does implementation of these cut-offs reduce the incidence of SSI/PJI?

RESEARCHED BY:

Stuart Goodman
Ruben Limas Telles
Literature:

• Two recent studies of approximately 20,000 patients in each institution showed a 10% increased risk for PJI for each BMI unit above normal (25 Kg/m$^2$).

• In both studies, the risk became progressively more pronounced for the group of patients with BMI values above 40 Kg/m$^2$, with a 3 times higher risk for SSI/PJI.
**Recommendation:** Obesity increases the risk of SSI/PJI after total joint arthroplasty (TJA). The risk increases gradually after normal body mass index (18.5 Kg/m²), rather than surging at a certain cut point. A substantially increased risk is noticed in patients with a BMI > 40 Kg/m² and the risks of surgery must be carefully weighed against its benefit in these patients.

**Level of Evidence:** Strong
G-6 (Former G-25) Does bariatric surgery reduce the risk of SSI/PJI in patients with obesity?

RESEARCHED BY:

Mitchell Klement  Ngai Nung  Neil Sheth
Literature:

- Meta-analysis 2, Prospective/Randomized 0, Retrospective 22

- 7 largest studies have demonstrated that undergoing bariatric surgery either prior to or after undergoing TJA does not influence the incidence of subsequent SSI/PJI.

- A meta-analysis published in 2015 demonstrated a reduction in postoperative infection in the bariatric group (OR 0.36, 95% CI 0.15-0.90, p=0.03). However, no differences in infection when results stratified by superficial or deep infection.
Recommendation: The evidence is inconclusive at present. Thus, preoperative bariatric surgery cannot be routinely recommended.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
G-7 (Former G-30) Does human immunodeficiency virus (HIV) predispose patients to SSI/PJI? If so, what optimization should be undertaken prior to operating on patients with HIV?

RESEARCHED BY:

Mohammad Ali Enayatollahi
Lipalo Mokete
Marisa Sanchez
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 53

• Modern studies on HIV-infected patients without hemophilia had better outcomes and lower rates of periprosthetic joint infection (PJI), even equal to healthy population

• HIV viral loads of >500 copies/mL were associated with minimal complications

• A CD4 count of >400 cell/ml and a viral load of <500 copies/ml could be ideal thresholds for elective TJA
Recommendation: Human immunodeficiency virus (HIV) infection is known to be a risk factor for surgical site infection (SSI) and periprosthetic joint infection (PJI). However, in patients who are medically optimized, with antiretroviral therapy (ART), the magnitude of the risk is small and comparable to HIV-negative patients. Patients must be optimized for underlying conditions including malnutrition, renal and liver disease, CD4 count and viral load.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
G-8 (Former G-31) Does liver disease (hepatitis C, cirrhosis) predispose patients to SSI/PJI? If so, what optimization should be undertaken prior to operating on patients with liver disease?

RESEARCHED BY:

Chi Xu  Yuhan Chang  Wadih Y Matar
Literature:

• PJI can occur at a higher frequency among patients with liver cirrhosis compared to those without liver cirrhosis undergoing elective knee replacement (2.7% vs 0.8%), elective hip replacement (3.66% vs 0.69%) and hip fracture patients (6.30% vs 1.10%).

• Large database studies with matching control group with age, gender, and Charlson comorbidity index (CCI), patients with HCV has higher rated of complications in a 30-day, 90-day, or 2-year period after TJA

• Among cirrhosis patients, alcohol-related cirrhosis carried the highest rate of perioperative complications
**Recommendation:** Yes. Patients with liver disease (hepatitis or cirrhosis) have a higher risk of infection. Patients with liver disease undergoing total joint arthroplasty should be evaluated by a hepatologist to ensure the liver function is optimized as much as possible. These patients, especially Child-Turcotte-Pugh are class B and C, are at increased risk of intraoperative and postoperative bleeding and perioperative complications. All efforts should be made to ensure such complications are minimized.

**Level of Evidence:** Strong

A. Agree  
B. Disagree  
C. Abstain
G-9 (Former G-108) Should routine dental clearance be obtained prior to total joint arthroplasty (hip/knee/shoulder/ankle)?

RESEARCHED BY:

William V Arnold
Emad Mustapha Al-Bushra
Juan Ottolenghi
Literature:

• Only one retrospective study has compared the incidence of PJI in a population of patients who underwent dental clearance prior to arthroplasty with a population of arthroplasty patients who had no such clearance.

• 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. The conclusion of this study was that dental clearance prior to arthroplasty did not provide a significant decrease in PJI.
**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 rate of subsequent PJIs.

**Level of Evidence:** Consensus
G-10 (Former G-36) Does poor dental hygiene increase the risk of subsequent 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?

RESEARCHED BY:

Martin Clauss
Oscar Ares
Max Greenky
Literature:

• In a large study, 57,066 patients who underwent TJA and had dental procedures post-operatively. They matched these patients with those who had not undergone dental procedures. The authors found no significant difference in the rate of PJI between the two groups.

• Using the Medicare Current Beneficiary Survey data, there was no association between dental procedures and subsequent development of PJI.

• However, the incidence of bacteremia following dental procedures is higher in those patients with dental pathology and poor dental hygiene.
Recommendation: There is a small, yet real, risk of hematogenous spread of oral pathogens to joints receiving arthroplasty. Patients with poor oral hygiene undergoing arthroplasty are at increased risk of subsequent SSI/PJI. Patients with oral disease and poor dentition should be identified and optimized prior to elective arthroplasty.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
G-11 (Former G-94) Is routine urinary screening indicated prior to elective TJA? If so, how should asymptomatic bacteriuria be treated prior to undergoing elective joint arthroplasty?

RESEARCHED BY:

Ricardo Sousa

Young-Kyun Lee
Literature:

- Meta-analysis 4, Prospective/Randomized 0, Retrospective 34

- The literature is moderately consistent that while screening in asymptomatic patients can identify UTIs, the subsequent treatment does not mitigate the risk of infection compared to non-treated patients
**Recommendation:** No. Routine urinary screening in asymptomatic patients is not recommended prior to elective total joint arthroplasty. There is also no evidence to demonstrate that preoperative treatment of asymptomatic bacteriuria is of any benefit.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain
G-12 (Former G-69) Does the use of a urinary catheter during orthopedic surgery increase the risk of subsequent SSI/PJI?

RESEARCHED BY:

Filipenko Volodymyr  Max Greenky  Martinez Leibnitz
The risk of UTI has been shown to be directly related to a duration of a urinary catheter for more than 48 hours.

To date, there is no study that has identified a direct association between urinary catheters and subsequent surgical site infection (SSI) and PJI.

While several large scale studies have not found peri-operative UTI to be a risk factor development of PJI, in other studies post-operative UTI has been associated with the subsequent development of PJI.
Recommendation: The direct association between the use of a urinary catheter and periprosthetic joint infection (PJI) remains controversial. However, as urinary tract infection (UTI) has been associated as a risk factor for PJI in some studies, we recommend intermittent catheterization for post-operative urinary retention (POUR) or if an indwelling urinary catheter is utilized, removing it within 48 hours of insertion to minimize the risk of UTI.

Level of Evidence: Moderate

A. Agree (89%)
B. Disagree (6%)
C. Abstain (5%)
How should a patient with a pre-operative urinary tract infection (UTI) be managed prior to undergoing elective joint arthroplasty?
Literature:

• To date, there are no studies reporting on symptomatic pre-operative UTI that goes untreated prior to elective TJA, making comparison difficult

• Current data is limited to large institutional and publicly available databases; 3 demonstrated preoperative UTI as a risk while smaller retrospective studies fail to find a difference (3).
Recommendation: Pre-operative UTI should be treated with appropriate antibiotics prior to elective total joint arthroplasty (TJA).

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
G-14A (Former G-112) Should patients with a penicillin or cephalosporin allergies routinely undergo allergy testing, desensitization, or a test dose before administering alternative antibiotic prophylaxis?

RESEARCHED BY:

Michael Kheir

Gábor Skaliczki
Literature:

• Multiple studies estimate that up to 90% of patients reporting an allergy are actually able to tolerate penicillin and its derivatives.

• Recent literature: cross-reactivity between penicillin and cephalosporins is much lower than the alleged 10%, and closer to 0.1%.

• Most (99%) patients with a positive penicillin skin test will still be able to tolerate a cephalosporin
Recommendation:
A majority of patients with a penicillin allergy can tolerate cephalosporins and do not need routine skin testing. Patients with a non-anaphylactic reaction to penicillins or cephalosporins can be given a test dose of a cephalosporin in the operating room.

Level of Evidence: Moderate

A. Agree 90%
B. Disagree 8%
C. Abstain 2%
G-14B (Former G-112) What is the alternative choice of prophylactic antibiotic when the patient has anaphylactic allergy to penicillin/cephalosporins?

RESEARCHED BY:

Michael Kheir  Gábor Skaliczki
Literature:

• Multiple studies estimate that up to 90% of patients reporting an allergy are actually able to tolerate penicillin and its derivatives.

• Recent literature: cross-reactivity between penicillin and cephalosporins is much lower than the alleged 10%, and closer to 0.1%.

• Most (99%) patients with a positive penicillin skin test will still be able to tolerate a cephalosporin.
**Recommendation:** The choice of prophylactic antibiotic for patients with a known anaphylactic penicillin or cephalosporin allergy includes vancomycin, teicoplanin, or clindamycin. Cephalosporins for patients with anaphylactic penicillin allergy may be given following skin testing.

**Level of Evidence:** Moderate

- A. Agree
- B. Disagree
- C. Abstain
G-15 (Former HK-16) Do immunomodulatory disease-modifying medications (e.g. methotrexate, anti-TNF agents) need to be withheld pre-operatively to reduce the risk for subsequent SSI/PJI?

RESEARCHED BY:

Susan Goodman

Bryan D Springer
Literature:

• For synthetic non-biologic DMARDs, there is evidence from randomized controlled trials revealing no increase in infection when these medications are continued through the perioperative period.

• Recent 2017 American College of Rheumatology (ACR) and American Association of Hip and Knee Surgeons (AAHKS) consensus guidelines regarding perioperative management of antirheumatic drugs
**Recommendation:**

1. For adults with inflammatory arthritis (RA, psoriatic arthritis (PsA), adults with juvenile arthritis (JA), Ankylosing Spondylitis (AS) or systemic lupus erythematosus (SLE), all biologic anti-rheumatic medications including TNF inhibitors and IL-6 blockers (complete list see Table 1) should be withheld for a full dosing cycle prior to total hip (THA) and total knee arthroplasty (TKA), and the surgery should be timed to the week following the withheld dose. These medications can be restarted no less than 2 weeks after surgery if the wound is healing well, all sutures are out, and there are no non-surgical site infections.

2. For adults with inflammatory arthritis or SLE, synthetic disease modifying anti-rheumatic drugs (DMARDs; Table 1) including methotrexate can be continued through the perioperative period.

3. For adults with severe SLE, immunomodulatory medications can be continued through the perioperative period.

4. For adults with mild SLE, immunomodulating medications (with the exception of tacrolimus) should be withheld prior to surgery and restarted at a minimum of 14 days after surgery if the wound is healing well and all sutures are out, and there is no surgical site or non-surgical site infection.

5. For adults with RA, SLE, AS, PSA, and JIA receiving glucocorticoids (GCs) for treatment of their rheumatic disease, who did not receive GCs during development and are not receiving replacement therapy, we recommend the usual daily GC dose be given on the day of surgery rather than supra-physiologic (“stress dose”) GCs.

**Level of Evidence: Limited**

A. Agree

B. Disagree

C. Abstain
Is there a link between opioid consumption and an increased risk for SSI/PJI?

RESEARCHED BY:

Efrain Diaz-Borion

Navin Fernando

Kerri Bell
Literature:

- Current literature is limited to retrospective, large insurance databases
- Further high quality prospective or large institutional data will be needed to confirm these findings
**Recommendation:** Yes. The utilization of opioids prior to surgery has been associated with an increased risk of developing surgical site infection (SSI) and periprosthetic joint infection (PJI).

**Level of Evidence:** Limited

A. Agree  
B. Disagree  
C. Abstain
G-17 (Former G-66) Does the type of venous thromboembolic (VTE) prophylaxis influence the risk of SSI/PJI in patients undergoing orthopedic procedures?

RESEARCHED BY:

Ronald Huang  James J Purtill  I. Remzi Tozun
Literature:

• Meta-analysis 2, Prospective/Randomized 2, Retrospective 30

• A prospective cohort study showed a significantly higher rate of surgical site infections in patients receiving LMWH prophylaxis dosing compared with patients receiving therapeutic warfarin with or without bridging therapy.

• Two recent meta-analyses of RCTs found no difference in SSI/PJI rates in TJA patients receiving rivaroxaban versus enoxaparin

• Randomized trial demonstrated that in patients receiving enoxaparin, there was nearly eight times the number of wound complications compared to other modalities
**Recommendation:** Yes. In a majority of studies evaluating venous thromboembolic (VTE) prophylaxis in patients undergoing total joint arthroplasty (TJA), aspirin appears to result in a lower risk of SSI/PJI than anticoagulants (vitamin K antagonists, heparin-based products, factor Xa inhibitors, and direct thrombin inhibitors).

**Level of Evidence:** Moderate

A. Agree 80%
B. Disagree 10%
C. Abstain 10%
G-18 (Former G-83) For patients awaiting organ transplant who need elective arthroplasty, should the arthroplasty be done before or after the organ transplant?

RESEARCHED BY:

Mitchell Klement   Joris Ploegmakers   Aydin Gahramanov
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 22

• Retrospective reviews of large publically available databases agreed that patients receiving arthroplasty in end-organ failure had more infection complications than those receiving arthroplasty after organ transplantation
**Recommendation:** We recommend performing arthroplasty after solid organ transplant, as long as transplantation can be done on a timely manner. Recent studies utilizing publicly available databases compare patients undergoing total joint arthroplasty (TJA) during organ replacement therapy (i.e. hemodialysis) versus after organ transplantation (i.e. kidney transplant) and consistently report less infections in the post-transplant cohort.

**Level of Evidence:** Moderate

A. Agree  
B. Disagree  
C. Abstain
What immune system enhancing strategies can be employed to reduce the risk of SSI/PJI?

RESEARCHED BY: Edward Schwarz  Ibrahim Azboy
Literature:

• A meta-analysis containing 13 randomized controlled trials and 1,269 patients revealed that the addition of immunonutrients to routine preoperative diets reduced subsequent SSI and shortened the hospital stay

• Retrospective studies agree that low serum vitamin-D level (25-OH) in patients undergoing joint arthroplasty was associated with an increased risk of 90-day complications as well as PJI

• Large publically available database studies have demonstrated that hypoalbuminemia is a risk factor for PJI following joint arthroplasty
**Recommendation:** Besides medical optimization of patients to enhance their immunity, there is some evidence demonstrating that immunonutrients (amino acids), vitamin-D supplementation, and passive/active immunization against *Staphylococcus aureus* may enhance immune system function, and potentially reduce the incidence of SSI/PJI.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain
What methods for MRSA/MSSA decolonization exist? What are the benefits and risks associated with the use of each?

RESEARCHED BY:

Gregory K Deirmengian

María S Quevedo
Literature:

• Meta-analysis 2, Prospective(Randomized 2, Retrospective 24

• Multiple studies prove the efficacy and cost-effectiveness of Mupirocin

• Concern persists regarding emerging resistance (3.3%, increasing 9x with prior use) of resistant organisms

• Newer methods (i.e. alcohol-based nasal sanitizer) show promise
**Recommendation:** Methods of nasal decolonization include 2% mupirocin ointment, 5% povidone-iodine solution, alcohol-based products, and chlorhexidine-based products. Each method has its own advantages and disadvantages related to proven effectiveness, potential for emergence of bacterial resistance, and patient compliance. However, no consensus has been reached on the preferred method for decolonization for MRSA with all products having a potential role.

**Level of Evidence:** Moderate

- A. Agree
- B. Disagree
- C. Abstain
G-22 (Former G-140) What is the optimal antibiotic for perioperative prophylaxis in patients who are MRSA carriers and undergoing orthopedic procedures?

RESEARCHED BY:

Chong Bum Chang
Literature:

• Meta-analysis 0, Prospective/Randomized 2, Retrospective 20

• Two low quality studies did not demonstrate a significant risk reduction of SSI when either teicoplanin or vancomycin was used in MRSA carriers

• Meta-analysis demonstrates a significant risk reduction of MRSA SSI following teicoplanin and vancomycin
**Recommendation:** Vancomycin or teicoplanin is recommended as a perioperative prophylactic antibiotic agent for the current MRSA colonizer undergoing total joint arthroplasty (TJA).

**Level of Evidence:** Moderate

A. Agree  
B. Disagree  
C. Abstain
G-23 (Former G-1) After a patient undergoes MRSA decolonization, is there a need to re-screen the patient?
Literature:

• Meta-analysis 1, Prospective/Randomized 1, Retrospective 14

• Decolonisation protocols have been proven to be highly successful in reducing the percentage of MRSA carriage

• Multiple meta-analyses show that MRSA prophylaxis reduces MRSA SSI, though a number of studies were underpowered.

• Recolonization rates have been reported to be as high as 38%
**Recommendation:** We recognize that a subset of MRSA carriers remains colonized despite preoperative decolonization protocols. Currently, there is no evidence to suggest that re-screening has any benefit in minimizing subsequent SSI/PJI.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-24 (Former G-93) Is pre-operative MRSA decolonization effective at reducing SSI/PJI in patients undergoing orthopedic procedures? If so, is pre-operative MRSA decolonization cost-effective?

RESEARCHED BY:

Ricardo Sousa  Antonia Chen
Literature:

• Moderate evidence exists that universal screening and treatment of carriers, or universal treatment may reduce overall SSI.

• Adopting a universal screening programme seems to be the most cost-effective approach, however, this may contribute to emerging antibiotic resistance.
Recommendation: No definitive recommendation can be made regarding the routine implementation of preoperative S. aureus screening and decolonization protocols due to conflicting literature. Additionally, no definitive recommendation can be made about selective or universal treatment, although the universal treatment strategy seems to be the most cost-effective strategy and easiest to implement. Alternatives to mupirocin such as povidone-iodine nasal ointment may obviate the concern for antibiotic resistance raised by universal treatment protocols.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
PREVENTION

Host-related factors
G-25 (Former G-40) Does prior SSI/PJI of a joint increase the risk of subsequent infection in another joint? If so, should elective arthroplasty of the joint be withheld in patients with active or treated PJI of another joint?

RESEARCHED BY:

Edmundo Ford Jr  Hany Bedair
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 14

• Risk of haematogenous spread to subsequent joints has been reported at 18%, rising to 29% following *S. aureus* bacteraemia.

• Previous successfully-treated PJI in another joint gives a reported risk of subsequent PJI of 11% in one study or a RR of 21 in another.
**Recommendation:** Yes. Prior surgical site infection (SSI) and periprosthetic joint infection (PJI) of a joint increases the risk of subsequent infection in another joint. Elective arthroplasty of the other joint should be withheld in patients with active infection or undergoing treatment for PJI.

**Level of Evidence:** Limited

A. Agree 95%
B. Disagree 4%
C. Abstain 1%
G-26 (Former G-16) Does a patient with a colostomy have an increased risk for SSI/PJI?

RESEARCHED BY:

Marcelo Lizarraga Ferrand

Georgios Komnos
Literature:

• Meta-analysis 2, Prospective/Randomized 0, Retrospective 12

• There is minimal evidence to suggest that a prior arthroscopy of the hip increases the risk of subsequent surgical site/prosthetic joint infection.

• Majority of studies underpowered
Recommendation: There is currently no evidence in the literature to determine if a patient with colostomy is at an increased risk for SSI/PJI following an arthroplasty procedure. It is however our recommendation to ensure that the patient has a leak free and clean colostomy in place to prevent soiling.

Level of Evidence: Limited

A. Agree 94%
B. Disagree 4%
C. Abstain 2%
G-27 (Former G-50) Does the presence of anxiety/depression and mood disorders increase the risk of SSI/PJI? If so, what are the considerations that should be implemented to reduce the risk of SSI/PJI?

RESEARCHED BY:

Alexander Rondon  Kevin Bozic  Samuel Wellman  Camila Novaes de Santana
Literature:

- Meta-analysis 1, Prospective/Randomized 0, Retrospective 21

- Multiple national registry studies report depression to be an independent risk factor for SSI/PJI.

- Multiple case-control studies and a meta-analysis have found depression, bipolar disorder and schizophrenia an independent risk factor for infection.

- There is limited evidence that treating depression reduces the PJI risk.
Recommendation: There is emerging evidence to suggest that affective disorders, such as depression and anxiety, increase the risk for PJI. Although both physiological and psychological explanations for this association have been offered, it is not clear whether modulating or treating these disorders prior to surgery results in a reduction in the risk of PJI.

Level of Evidence: Strong

A. Agree
B. Disagree
C. Abstain
G-28 (Former G-39) Does pre-operative urinary tract infection (symptomatic and asymptomatic) increase the risk for subsequent SSI/PJI?

RESEARCHED BY:

Kyung-Hoi Koo
Aruna Poojary
Literature:

• Meta-analysis 2, Prospective/Randomized 0, Retrospective 22

• Multiple studies have reported UTI as an important modifiable risk factor for PJI.

• One study reported that adequate antibiotic treatment of a preoperative UTI returns the PJI risk to non-UTI patients.

• Multiple meta-analyses concluded that detection and treatment of ASB has no benefit for patients undergoing joint replacement.
**Recommendation:** Symptomatic urinary tract infection (UTI) must be treated with appropriate antibiotics before proceeding with the surgery. Diagnosis of asymptomatic bacteriuria and treatment should be discontinued as it does not increase the risk of a subsequent SSI/PJI.

**Level of Evidence:** Strong

A. Agree
B. Disagree
C. Abstain
G-29 (Former G-5) Do underweight patients (low BMI) have a higher risk of SSI/PJI following orthopedic procedures? If yes, does increasing the body mass index in underweight patients reduce the risk of SSI/PJI?

RESEARCHED BY:

Jorge Manrique
Andrew Battenberg
Joao Mauricio Barretto
Literature:

- Meta-analysis 0, Prospective/Randomized 0, Retrospective 29

- Several retrospective studies have demonstrated that low BMI increases the PJI rate

- There are no studies that regarding medical optimization of these patients.
**Recommendation:** Yes. Underweight patients (low BMI) have a higher risk of SSI/PJI following orthopedic procedures. However, there is no current evidence indicating an increase in the BMI of an underweight individual has an effect on reducing the risk of SSI/PJI.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain
G-30 (Former G-82) Does vitamin D deficiency increase the risk of subsequent SSI/PJI in patients undergoing orthopedic procedures?

RESEARCHED BY:

Andrew Battenberg

Kier Belvins
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 14

• One prospective study report that Vit D deficiency was found in 86% patients presenting with PJI, significantly more than primary TJA and aseptic loosening.

• Vit D replacement has been shown to reduce bacterial burden in animal models, but no clinical studies exist
Recommendation: Unknown. Vitamin D Deficiency (VDD) may increase the risk of subsequent surgical site infection (SSI) and/or periprosthetic joint infection (PJI) in patients undergoing orthopedic procedures by diminishing vitamin D-mediated innate and adaptive immune responses.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
G-31 (Former G-9) Can immunotherapy and immunoprophylaxis be used to prevent biofilm formation and implant-associated infections?

RESEARCHED BY:

Edward Schwarz  
James W.M. Kigera  
Claus Moser
Literature:

• Meta-analysis 0, Prospective/Randomized 4, Retrospective 28

• There are several retrospective studies with few in orthopaedics. None of these are FDA approved.

• There are no high-level studies supporting this trend with evidence and further study is needed.
**Recommendation:** Yes. Although no vaccine or passive immunization has been Food and Drug Administration (FDA) approved for an orthopaedic indication, a four-antigen vaccine (SA4Ag) with established safety and immunogenicity in healthy volunteers is currently being tested for efficacy in a phase II clinical trial of spine fusion patients. This is also supported by evidence from literature regarding cochlear implants for children, showing that a decreased incidence of pneumococcal meningitis. However, there are no high-level studies supporting this trend with evidence and further study is needed.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain
PREVENTION

Risk Assessment
G-32 (Former G-42) Does routine screening for diabetes and glycemic control reduce the risk of SSI/PJI? 

RESEARCHED BY: 

Noam Shoat 

Javad Parvizi
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 19

• The prevalence of diabetes in patients undergoing TJA has been shown to be 20.7% (40.9% of these were undiagnosed)

• Inadequately controlled diabetes is associated with greater risk of PJI, though no studies exist that show tight control reduces this risk
**Recommendation:** The routine screening for diabetes and glycemic control has the potential to reduce the incidence of surgical site infection (SSI) and/or periprosthetic joint infection (PJI) following total joint arthroplasty (TJA).

**Level of Evidence: Consensus**

A. Agree

B. Disagree

C. Abstain
G-33 (Former G-137) What is the most accurate marker for assessing glycemic control that best predicts SSI/PJI?

RESEARCHED BY:

Noam Shoat

Kevin Mulhall
Literature:

• Meta-analysis 1, Prospective/Randomized 2, Retrospective 23

• One meta-analysis that took a threshold of 7% for HbA1c did not demonstrate a significant association between elevated HbA1c and subsequent PJI, though emerging evidence supports the utility of HbA1c levels of 7.5-8% as a predictor of PJI.

• Fructosamine has a shorter half-life than HbA1c and has been shown to have a better association with SSI and PJI compared to a HbA1c of 7%.
Recommendation: While there is evidence showing an association between elevated HbA1c and fasting blood glucose and increased risk for subsequent SSI/PJI, this association is not strong. Recent findings suggest that fructosamine in the preoperative period and glucose variability in the immediate postoperative period may provide greater prediction of surgical site infection (SSI) or periprosthetic joint infection (PJI).

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
G-34 (Former G-153) What is the threshold for HbA1C that is predictive of subsequent SSI/PJI in patients undergoing orthopedic procedures?

RESEARCHED BY:

Hasan Nahouli  William Jiranek  Brian A Klatt  Majd Tarabichi
Literature:

• Meta-analysis 2, Prospective/Randomized 2, Retrospective 18

• Multiple studies have found that a HbA1c greater than either 7.5% or 8% to be significantly associated with wound complications and SSI, though its poor specificity limits it clinical applicability.
**Recommendation:** The upper threshold for HbA1c that may be predictive of subsequent SSI/PJI is most likely to be within the range of 7.5–8%.

**Level of Evidence:** Moderate

- **A. Agree** (88%)
- **B. Disagree** (3%)
- **C. Abstain** (9%)
PREVENTION

Operating room environment – Personnel matters
G-35 (Former G-48) Does the number of individuals in the operating room affect the rate of SSI/PJI? If so, what strategies should be implemented to reduce traffic in the operating room?

RESEARCHED BY:

Eleftherios Tsiridis

Daniel Del Gaizo
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 29

• Multiple studies show an increased trend in PJI associated with high OR traffic and increased rate of door opening.

• Systemic and behavioural measures in the OR have been shown to significantly reduce the incidence of superficial PJI and a non-significant decrease in the deep PJI.
**Recommendation:** Yes. The number of individuals in the operating room (OR) and door openings (DO) during total joint arthroplasty (TJA) are correlated to the number of airborne particles in the OR. Elevated airborne particles in the OR can predispose to subsequent periprosthetic joint infection (PJI). Therefore, operating room traffic should be kept to a minimum. Multiple strategies, outlined below, should be implemented to reduce traffic in the OR during orthopaedic procedures.

**Level of Evidence: Moderate**

A. Agree
B. Disagree
C. Abstain
G-36 (Former G-47) Does the MRSA/MRSE colonization status of OR personnel affect the hospital's rate of SSI/PJI?

RESEARCHED BY:

T. David Tarity

Rami Sorial
Literature:

- Meta-analysis 2, Prospective/Randomized 0, Retrospective 18

- Multiple studies have shown that decolonisation of both hospital staff and patients results in a statistically significant reduction in SSI and PJI.

- However, their inherent heterogeneity prevents pooled statistical analysis. Often, multiple other interventions are included with a decolonization protocol.

- No studies evaluated the rates of persistent colonisation or recurrence in hospital staff.
**Recommendation:** Unknown. While operating room personnel have previously been reported to contribute to environmental contamination, the literature provides insufficient data to establish a strong correlation between operating room staff colonization with MRSA/MRSE and potential for increased infection in patients after orthopedic procedures.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-37 (Former G-119) Should surgeons and personnel in the OR wear a mask and a cap in the operating room?

RESEARCHED BY:

Kevin Tetsworth
Rajendra Shetty
Literature:

• Meta-analysis/Systematic review 2, Prospective/Randomized 0, Retrospective 12

• Multiple systematic reviews found that the evidence regarding the efficacy of surgical facemasks in preventing postoperative wound infection is inconclusive
Recommendation: Yes. The use of surgical facemasks and caps by staff in the operating room is presumed to reduce the frequency of surgical site infections. There is a paucity of data with few studies addressing this topic. The long-standing established standard of surgical facemasks and caps in the operating room should continue despite the lack of strong evidence demonstrating clinical efficacy and a lack of persuasive evidence for altering current clinical practice. Evidence for the potential role for surgical facemasks in protecting staff from infectious material encountered in the operating room is also controversial. In the absence of convincing clinical evidence either for or against wearing masks and caps in the OR, it is advisable at this time to continue to follow local or national health and safety regulations.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
G-38 (Former G-62) Does the type of cap worn by the OR personnel matter?

RESEARCHED BY:

Rajeev Sharma  Naasha Talati  Paul Manner  Kier Blevins
Literature:

• Meta-analysis 0, Prospective(Randomized) 0, Retrospective 9

• Significantly higher number of airborne particulates are seen when disposable bouffant hats were used compared to cloth surgical caps (p<0.05) and a greater amount of microbial shedding at the sterile field compared to disposable skull caps (p<0.05).

• A more recent study revealed that surgical site infection (SSI) rates were not significantly different (p=0.016) in surgical cases where attending surgeon’s wore bouffant hats (8%) versus those who wore surgical skull caps (5%).
**Recommendation:** Unknown. The evidence would suggest that, since normal hygiene such as daily shampooing and showering does not result in bacterial decontamination of operating room (OR) personnel, some form of disposable head covering is prudent. Whether this takes the form of a bonnet, bouffant, or helmet is unknown. We recommend that the cap should cover the entire scalp, ears, and facial hair.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-39 (Former G-111) Should patients wear a mask and a surgical cap in the operating room to reduce the risk of subsequent SSI/PJI?

RESEARCHED BY:

Carlos Autorino  Fabio Catani  Andrew Battenberg
Literature:

• Meta-analysis 0, Prospective/Randomized 1, Retrospective 12

• No study investigating the impact of *patients* wearing surgical masks or caps during surgery has been performed.
**Recommendation:** Unknown. The use of face masks and surgical caps by inhabitants in the operating room (OR) has not been shown to impact SSI rates, but with the limited evidence available a recommendation for or against patient usage cannot be made. Surgical cap usage by patients in the OR may decrease the risk of SSI/PJI by decreasing microbial air contamination.

**Level of Evidence:** Limited

A. Agree  
B. Disagree  
C. Abstain
G-40 (Former G-51) Does the presence of exposed facial hair (beard and mustache) on any OR staff or surgeon influence the rate of SSI/PJI in patients undergoing orthopedic procedures?

RESEARCHED BY:

Kier Blevins
Robin Patel
Karan Goswami
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 7

• In general, mask decrease shedding compared to no mask. Clean shaven faces shed less contaminants than beards.

• However, the association of these relationships on SSI/PJI has not been clearly defined.
Recommendation: Although facial hair may increase the risk of bacterial contamination under certain circumstances, risk should ideally be assessed in the context of masking, with and without nonsterile hoods, where limited and contradictory data exists.

Level of Evidence: Consensus

A. Agree: 89%
B. Disagree: 5%
C. Abstain: 6%
G-41 (Former G-56) Does the risk of SSI/PJI increase when the surgeon performing the arthroplasty has an upper respiratory infection?

RESEARCHED BY:

Pier Francesco Indelli

Andrea Baldini
Literature:

• Meta-analysis 1, Prospective/Randomized 3, Retrospective 3

• Strong evidence to suggest that the use of PPE and sterile surgical technique are effective in preventing disease transmission from the surgeon to the patient
**Recommendation:** It is unlikely that the risk of SSI/PJI is increased in patients undergoing orthopedic procedures when the surgeon or surgical team has an upper respiratory infection.

**Level of Evidence:** Moderate

- A. Agree
- B. Disagree
- C. Abstain

85% Agree, 8% Disagree, 7% Abstain
G-42 (Former G-43) Does strict adherence to not wearing OR attire outside the hospital or outside the restricted OR area reduce the risk of SSI/PJI?

RESEARCHED BY:

Kier Blevins  Annette W-Dahl  Parag Sancheti
Literature:

• Meta-analysis 1, Prospective/Randomized 5, Retrospective 0

• Limited evidence to suggest that wearing of OR attire outside of hospital increases clothing contamination

• No studies evaluating if OR attire worn outside of OR or hospital has an impact of SSI/PJI
Recommendation: We recommend that OR personnel wearing attire that has come into contact with outside the restricted OR environment, do not wear the same attire during elective arthroplasty or complex orthopedic procedures.

Level of Evidence: Consensus

A. Agree 90%
B. Disagree 8%
C. Abstain 2%
G-43 (Former G-27) Does changing surgical gowns during prolonged operations reduce the risk of SSI/PJI? If so, how frequently should gowns be changed during the procedure?

RESEARCHED BY:

Wael Samir Osman
Vasili Karas
Literature:

• Meta-analysis 1, Prospective/Randomized 1, Retrospective 17

• Evidence suggests that longer operating times are associated with increased gown contamination and increased SSI

• No evidence exists to support changing of gowns during prolonged procedures
Recommendation: We cannot recommend for or against gown changes at specific time intervals as there is no studies evaluating the contamination rate of gowns with time. We do, however, recommend that the surgical gowns be changed if saturation or perforation of the gown occurs during surgery.

Level of Evidence: Consensus

A. Agree
B. Disagree
C. Abstain
G-44 (Former G-65) Does the type of surgical gown (disposable or reusable) used by the OR personnel affect the rate of subsequent SSI/PJI in patients undergoing orthopedic procedures?

RESEARCHED BY:

Ibrahim ElGanzoury  Eoin Sheehan
Literature:

• Meta-analysis 1, Prospective/Randomized 13, Retrospective 4

• Limited evidence to suggest disposable gowns are more effective in preventing bacterial dispersion in the OR

• As long as sterile and fluid resistant, no difference between sterile and reusable gowns in preventing SSI
**Recommendation:** Unknown. The available low level evidence suggests that disposable gowns may have a higher ability to prevent bacterial dispersion in the OR. Evidence to demonstrate that the use of gown type versus other results in a lower SSI/PJI is lacking.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-45 (Former G-75) Does the use of occlusive strips at the sleeves of the surgical gowns reduce the risk of SSI/PJI?

RESEARCHED BY:

Mark Spangehl  David Lewallen  Brian M Smith
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 12

• Evidence exists suggesting occlusion at the gown-glove interface prevents egress of potentially contaminating particles

• No evidence linking occlusion of gown-glove interface to reduction of SSI/PJI
**Recommendation:** There is no direct evidence that occlusive strips at the sleeves of surgical gowns reduce the risk of subsequent SSI / PJI. However, there is evidence that occlusive strips prevent the egress of particles from the gown-glove interface of certain gowning systems and thereby can reduce contamination of the surgical field and potentially reduce the risk of SSI/PJI.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-46 (Former G-59) Does the technique, duration, or agent used for a surgical hand scrub by surgeon and the OR personnel alter the patient's risk of SSI/PJI?

RESEARCHED BY:

Teija Puhto

William Griffin
Literature:

- Meta-analysis 1, Prospective/Randomized 0, Retrospective 6

- No evidence to suggest one type of surgical scrubbing technique is superior to any other in reducing SSIs
**Recommendation:** Unknown. Surgical hand preparation should be performed either by traditional scrubbing with a suitable antimicrobial soap and water or by using a suitable alcohol-based hand cleansing agents.

**Level of Evidence:** Moderate

- A. Agree
- B. Disagree
- C. Abstain
G-47 (Former G-26) Does changing gloves during prolonged operations reduce the risk of SSI/PJI? If so, how frequently should gloves be changed during the procedure?

RESEARCHED BY:

Simon Young
Literature:

• Meta-analysis 0, Prospective/Randomized 1, Retrospective 15

• No evidence exists directly linking intraoperative glove changes to a reduction in SSI/PJI rates in total joint arthroplasty

• Studies conducted in other surgical fields suggest a reduction in SSI with outer glove changes
**Recommendation:** Changing gloves intraoperatively may reduce the risk of SSI/PJI in arthroplasty surgery by reducing contamination. Based on prior studies, gloves should be changed after draping, before handling implants, and when macroscopic perforation in the glove occurs. Gloves should also be changed at least once every 60 to 90 minutes, as contamination and glove perforation rates increase with duration of surgery.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-48 (Former G-57) Does shoe wear (i.e. OR dedicated shoes, uncovered outside shoes, covered outside shoes) of the surgeon and operating room staff affect the rate of SSI/PJI in patients undergoing orthopedic procedures?

RESEARCHED BY:

Setor Kunutsor
Ashley Blom
Victor Hernandez
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 7

• No evidence exists linking type of shoe worn to a difference in rate of SSI/PJI in orthopaedic procedures
**Recommendation:** There is little or no evidence to suggest that the use of dedicated operating room (theatre) shoes influence the rate of SSI/PJI. However, in view of the fact that shoes worn outside may be grossly contaminated, we recommend that outside shoes are not worn in orthopedic operating rooms (theatres) or shoe coverings are worn to prevent the contact of outside shoes with the operating room floors.

**Level of Evidence:** Limited

A. Agree  
B. Disagree  
C. Abstain
PREVENTION

Operating room environment – Fomites
G-49 (Former G-74) Does the use of laminar flow in the operating room reduce the risk of subsequent SSI/PJI in patients undergoing orthopedic procedures?

RESEARCHED BY:

Arash Aalireazaie  Everth Merida  Kelly Vince  Greg Stocks
Literature:

- Meta-analysis 0, Prospective/Randomized 1, Retrospective 20
- Early studies suggested LAF was effective in reducing SSI/PJI
- 6 retrospective studies found no difference in rate of SSI/PJI with use of LAF
- 3 recent studies linked use of LAF to increase in rate of SSI/PJI
Recommendation: Recent orthopedic literature has not demonstrated that the use of laminar flow systems (LAF) reduces surgical site infection (SSI) or periprosthetic joint infection (PJI) in orthopedic surgery. At this time, it is not necessary to perform a clean orthopedic surgery procedure, including elective joint replacement surgery, in an operating theatre equipped with LAF systems.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
G-50 (Former G-72) Does the use of forced air warming during orthopedic procedures increase the risk of subsequent SSI/PJI?

RESEARCHED BY:

Joseph Karam

Mike Reed
Literature:

• Meta-analysis 2, Prospective/Randomized 12, Retrospective 2

• Numerous experimental studies to suggest increased theoretical risk of contamination with use of forced air warming

• No evidence exists directly linking the use of forced air warming to increased SSI/PJI in orthopaedic procedures
**Recommendation:** There is no evidence to definitively link forced air warming to an increased risk of SSI/PJI. Alternative methods of warming can be effective and may be used.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-51 (Former G-154) What method(s) is available to verify the microbiological cleanliness of the operating room?

RESEARCHED BY:

Wenming Zhang

Elie Ghanem
Literature:

- Meta-analysis 0, Prospective/Randomized 0, Retrospective 24

- Culture via swab is superior to visual inspection in monitoring OR cleanliness but has limitations including time required to obtain results and inability to culture certain bacteria

- ATP bioluminescence has been recently introduced to healthcare for monitoring bacterial burden but limited literature exists describing an acceptable contamination threshold
**Recommendation:** Multiple options are available to verify the microbiological cleanliness of the operating room, including visual inspection, swab and culture, contact culture plates and ATP bioluminescence.

**Level of Evidence: Limited**

A. Agree  
B. Disagree  
C. Abstain
Is there a relationship between levels of airborne microorganisms in the operating room and the risk of prosthesis-related infection (PRI)?

RESEARCHED BY:

Rabih O Darouiche
Literature:

- Meta-analysis 1, Prospective/Randomized 5, Retrospective 3
- Multiple Level 1 studies linking the levels of airborne microorganisms to the incidence of PJI
**Recommendation:** Yes. High quality evidence indicate that there is a proportional relationship between intraoperative levels of airborne microorganisms (colony-forming units or CFU) and the incidence of PJI.

**Level of Evidence:** Strong

A. Agree
B. Disagree
C. Abstain
G-53 (Former G-2) Are light handles a source of contamination during orthopedic procedures?

RESEARCHED BY:

Daniel Schweitzer  Peteris Studers  Darko Talevski  Elie Ghanem
Literature:

• Meta-analysis 1, Prospective/Randomized 7, Retrospective 0

• Strong evidence demonstrating that light handles are source of contamination

• No evidence linking contamination of light handles to increased incidence of PJI
Recommendation: Yes. Light handles are a possible source of contamination during orthopaedic procedures.

Level of Evidence: Moderate
G-54 (Former G-102) Is there a role for banning all handheld devices/mobile phones in the operating room?

RESEARCHED BY:

Piret Mitt  Charles Nelson
Literature:

• Meta-analysis 2, Prospective/Randomized 17, Retrospective 0

• Handheld devices are potential sources of distraction in the operating room and excessive noise which has been linked to increased SSI rates

• Handheld devices are potential sources of contamination but no evidence exists directly linking handheld devices in the OR to increased SSI rates
**Recommendation:** Given a lack of evidence correlating with increased infection rates/adverse outcomes with the use of handheld devices in the operating room, a recommendation to ban these devices in the OR cannot be made at this time. However, regular cleansing of cell phones is an easy and effective practice and should be performed routinely.

**Level of Evidence: Limited**

A. Agree  
B. Disagree  
C. Abstain
G-55 (Former G-49) Does the operating room temperature affect the rate of subsequent SSI/PJI?

RESEARCHED BY:

Nilo Paner

Christoph Lohmann
Literature:

• Meta-analysis 0, Prospective/Randomized 4, Retrospective 3

• Increased temperatures have been linked to increased bacterial burden and correlated with increased superficial SSI

• Increased temperatures in the OR lead to increased surgeon perspiration which may serve as source of contamination

• No Level 1 studies exist to evaluate the effect of OR temperature on SSI rates
**Recommendation:** The operating room temperature may affect core body temperature, which could potentially affect the rate of subsequent SSI/PJI. Thus, all efforts should be made to maintain an optimal operating room temperature.

**Level of Evidence:** Consensus
G-56 (Former G-34) Does perioperative normothermia affect the rate of subsequent SSI/PJI?

RESEARCHED BY:

Georgios Komnos
Koji Yamada
Literature:

• Meta-analysis 0, Prospective/Randomized 1, Retrospective 16

• Limited evidence linking hypothermia to increased incidence of SSI

• No RCTs evaluating the effect of maintenance of perioperative normothermia on SSI/PJI rates in orthopaedic procedures
**Recommendation:** Based on data from general surgery and other surgical disciplines, normothermia has been found to be important during perioperative period to minimize the risk of subsequent infection. Although evidence in orthopedic surgery is sparse, we recommend that normothermia is also provided to patients undergoing orthopedic procedures.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
PREVENTION

Operating room environment – Surgical field
G-57 (Former G-167) When should instrument trays be opened during surgery to minimize the risk of contamination?

RESEARCHED BY:

Justinas Stucinskas  David Jahoda  Timothy Brown
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 11

• Several studies show direct correlation between time since opening of sterile tray and contamination of instruments

• Covering of sterile equipment reduces rate of contamination
**Recommendation:** Instrument trays should be opened as close to the time of surgery as possible. Once opened, trays and instruments should be covered with a sterile towel or drape when not in use.

**Level of Evidence:** Moderate
G-58 (Former G-68) Does the use of a splash basin increase contamination of instruments and the rate of subsequent SSI/PJI in patients undergoing orthopedic procedures?

RESEARCHED BY:

Jon Goosen  Karan Goswami
Literature:

• Meta-analysis 0, Prospective/Randomized 5, Retrospective 0

• Several studies have shown the splash basin to be a potential source of contamination with positive bacterial growth

• No evidence exists directly linking the use of a splash basin to increased incidence of SSI/PJI
**Recommendation:** Unknown. We recommend against the use of fluid filled splash basins that sit open during surgery, based upon microbiological contamination data. However, the independent association between splash basin contamination and development of subsequent SSI/PJI remains unclear.

**Level of Evidence:** Moderate
G-59 (Former G-28) Does changing the electrocautery tip during surgery reduce the rate of subsequent SSI/PJI?

RESEARCHED BY:

Michael J Petrie
Rob Nelissen
Anil Gambhir
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 10

• No current evidence exists directly linking time of use of electrocautery tip to increased contamination levels or incidence of SSI/PJI

• Higher incidence of electrocautery tip contamination noted in setting of known infection
Recommendation: While it is clear that electrocautery tips may become contaminated during surgery, no study has been able to prove a relationship between the amount of time that an electrocautery tip is exposed and its contamination. However, in cases where there is known infection, such as a 1-stage or 2-stage exchange arthroplasty for PJI, we do recommend changing the electrocautery tip at the end of the “dirty” portion of the procedure and prior to reimplantation of components.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
G-60 (Former G-117) Should suction tips be regularly changed during surgery? If so, how frequently?

RESEARCHED BY:

Federico J Burgo

Alfredas Smailys
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 12

• Several studies show high contamination rate of suction tip (up to 65%) which is correlated with total usage time

• No studies exist comparing time of usage of suction tips or frequency of suction tip change to incidence if SSI/PJI
**Recommendation:** Yes. The suction tips should be regularly changed during surgery. Although no time threshold has been established for its exchange, we believe it should be changed every 60 minutes. Studies have shown that suction tips get contaminated during surgery and the contamination rate is higher with prolonged operative time.

**Level of Evidence:** Limited

A. Agree  
B. Disagree  
C. Abstain
G-61 (Former G-118) Should suction tips enter the intramedullary canal during orthopedic surgery?

RESEARCHED BY:

Nicholas Giori  Imran Ilyas  Yakub Saheed  Yale Fillingham
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 12

• Several studies have reported contamination of suction tips.

• One study has specifically looked at femoral canal and contamination rate was low
**Recommendation:** Suction tips can be introduced into the intramedullary canal during orthopedic surgery to remove fluid as needed, but should not be left in the canal where they draw in large volume of ambient air and particles that could potentially contaminate the intramedullary canal.

**Level of Evidence:** Consensus

- A. Agree (91%)
- B. Disagree (4%)
- C. Abstain (5%)
G-62 (Former G-70) Does the use of C-arm intraoperatively increase the risk for subsequent SSI/PJI in patients undergoing orthopedic procedures?

RESEARCHED BY:

Hamish Simpson  
Arjun Saxena
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 2

• Several studies have suggested that C-arm has high contamination rates

• No studies have demonstrated a higher rate of PJI with c-arm
**Recommendation:** There are no studies that link the use of intra-operative C-arm with a higher rate of subsequent surgical site infection (SSI) or periprosthetic joint infection (PJI) in orthopedic surgery. However, based on available studies, it appears that “sterile” cover of C-arm is often contaminated during the surgery. We recommend that all efforts are made to prevent the cover, or any other part, of C-arm come in contact with the operative field.

**Level of Evidence:** Limited
G-63 (Former G-76) Does the use of recent technologies (navigation, robots, etc.) influence the incidence of SSI/PJI after orthopedic procedures?

RESEARCHED BY:

Seng Jin Yeo  Robert Hube  Edward Vasarhelvi
Literature:

- Meta-analysis 2, Prospective/Randomized 0, Retrospective 16

- Many studies have demonstrated that navigation and robotics has similar rate of PJI to a standard TKA.

- Pin site infection rate is low in the literature

- Navigation and robotics have a longer operative time throughout the literature
**Recommendation:** The use of computer-navigation, patient-specific instrumentation and robot-assisted surgery during total joint arthroplasty has not been shown to increase the risk of subsequent SSI/PJI. However, an increase in operative time that may occur as a result of use of these technologies may increase the risk of subsequent SSI/PJI.

**Level of Evidence:** Limited
G-64 (Former G-81) Does the use of UV light decontamination in the operating room reduce the risk of subsequent SSI/PJI in patients undergoing orthopedic procedures?

RESEARCHED BY:

Murat Bozkurt

C. Lowry Barnes
Literature:

- Meta-analysis 0, Prospective/Randomized 2, Retrospective 14

- Several studies have demonstrated that UV light can reduce bacteria colonization but not PJI

- There are no studies that demonstrate that UV light reduces PJI in clinical studies
**Recommendation:** Yes, the use of UV light during surgery is effective against airborne bacteria. However, due to the potential risks for the operating room personnel, it is recommended that UV light is only used at unoccupied times for terminal cleaning of the room.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain
PREVENTION

Anesthesia related matters / Blood conservation
G-65 (Former G-61) Does the type of anesthesia (general vs. neuraxial) influence the risk of subsequent SSI/PJI?

RESEARCHED BY:

Andrew Fleischman

Stavros G Memtsoudis
Literature:

• Meta-analysis 2, Prospective/Randomized 0, Retrospective 16

• Several retrospective, and meta-analysis have demonstrated that general anesthesia has a higher rate of infection and wound complications than neuraxial anesthesia.

• Large database and registry studies also demonstrate increased infection with general anesthesia

• There are no high quality randomized studies available
Recommendation: Compared to general anesthesia (GA), neuraxial anesthesia (NA) appears to be associated with reduced risk of SSI/PJI after total hip arthroplasty (THA) and total knee arthroplasty (TKA).

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
Can regional anesthesia be administered to patients with orthopedic infections?

RESEARCHED BY:
Andrew Fleischman  Stavros Memtsoudis
Literature:

- Meta-analysis 0, Prospective/Randomized 1, Retrospective 13

- Majority of studies are retrospective and demonstrate that risk of CNS complications are rare in patients with orthopaedic infection.
**Recommendation:** Yes, central nervous system (CNS) infectious complications, such as meningitis, epidural abscesses, or vertebral osteomyelitis, are exceedingly rare when regional anesthesia is administered to patients with orthopedic infections. The potential benefits of neuraxial anesthesia likely outweigh any possible risk.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain
G-67 (Former G-91) Is it safe to perform a neuraxial anesthesia in patients with active musculoskeletal infection?

RESEARCHED BY:

Mustafa Citak  Yutaka Inaba  Ismet Gavrankapetanović
Literature:

- Meta-analysis 0, Prospective(Randomized 0, Retrospective 15

- Several studies demonstrate that the rate of hematogenous spread and CNS is infections is low in patients that receive neuraxial anesthesia with orthopaedic infections.

- Several studies demonstrate that bacteremia may be a risk factor for epidural abscess
Recommendation: Yes. The use of neuraxial anesthesia is safe in patients with PJI without septicemia. There is limited evidence regarding the use of neuraxial anesthesia in patients with septicemia or other active musculoskeletal infection.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
G-68 (Former G-92)

a) Is preoperative anemia a risk factor for SSI/PJI?
b) If so, what optimization can be done to increase the hemoglobin concentration?  
c) Does an increased preoperative hemoglobin concentration decrease postoperative SSI/PJI?

RESEARCHED BY:

Riaz Khan  
Vasili Karas
G-68A (Former G-92)

Is preoperative anemia a risk factor for SSI/PJI?

RESEARCHED BY:

Riaz Khan

Vasili Karas
Literature:

- Meta-analysis 4, Prospective/Randomized 4, Retrospective 29

- Many studies have consistently demonstrated that preoperative anemia (variable definitions) is a risk factor for PJI

- There is minimal literature on the role of preoperative optimization
Response/Recommendation: Based on available evidence, preoperative anemia as defined by a hemoglobin of less than 13.0 g/dl in men and 12.0 g/dl in women is an independent risk factor for postoperative SSI/PJI following total joint arthroplasty.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
G-68B (Former G-92)
What preoperative optimization for anemia can be done to increase the hemoglobin concentration?

RESEARCHED BY:
Riaz Khan
Vasili Karas
Literature:

• Meta-analysis 4, Prospective/Randomized 4, Retrospective 29

• Many studies have consistently demonstrated that preoperative anemia (variable definitions) is a risk factor for PJI

• There is minimal literature on the role of preoperative optimization
68B) **Response/Recommendation:** Literature suggests that administration of iron and/or erythropoietin (EPO) increases preoperative hemoglobin concentration and decreases the need for postoperative allogeneic blood transfusion. However, iron may only be effective for patients with pre-existing iron deficiency and is associated with many side effects. Given the high costs of EPO, preoperative administration to avoid transfusion alone has not been cost effective. Further research is required to assess the risks and benefits of preoperative allogeneic blood transfusion.  

**Level of Evidence: Limited**
G-68C (Former G-92)
Does an effort to increase preoperative hemoglobin concentration influence the rate of postoperative SSI/PJI?

RESEARCHED BY:
Riaz Khan
Vasili Karas
Literature:

• Meta-analysis 4, Prospective/Randomized 4, Retrospective 29

• Many studies have consistently demonstrated that preoperative anemia (variable definitions) is a risk factor for PJI

• There is minimal literature on the role of preoperative optimization
68C **Response/Recommendation:** Despite the absence of evidence demonstrating a reduction in SSI/PJI with optimization of preoperative hemoglobin, we recommend that all efforts be made to address and optimize anemia preoperatively.

**Level of Evidence: Consensus**

A. Agree
B. Disagree
C. Abstain
G-69 (Former G-101) Is there a role for administration of erythropoietin, hematinics, or other agents for patients with orthopedic infections?

RESEARCHED BY:

Seung-Beom Han

Martin Sarungi
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 7

• Several studies demonstrate that erythropoietin results in higher pre-operative hemoglobin levels and lower allogeneic transfusion rates without compromising eradication of infection.

• There is minimal literature on TXA.

• No literature regarding blood reduction agents for patients with orthopaedic infections
**Recommendation:** Yes – erythropoietin used pre-operatively in infected revision arthroplasty results in higher pre-operative hemoglobin levels and lower allogeneic transfusion rates without compromising eradication of infection.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain
G-70 (Former G-14) Do antiplatelet drugs need to be withheld pre-operatively to reduce the risk for subsequent SSI/PJI?

RESEARCHED BY:

David Beverland  
Sumon Nandi  
Andrew Battenberg
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 27

• The literature demonstrates no increased rate of PJI with aspirin.

• Several studies demonstrate increased blood loss, infection, and wound drainage with clopidogrel
Recommendation: Aspirin should not be withheld pre-operatively. There is no evidence that withholding aspirin affects SSI/PJI rates, and the cardiac and stroke risk associated with discontinuing aspirin outweighs any unproven, theoretical benefit with respect to SSI/PJI.

Clopidogrel should be withheld a minimum of 5 days preoperatively to reduce the risk for subsequent SSI/PJI.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
G-71 (Former G-79a) Does the use of tranexamic acid reduce blood loss and need for allogeneic blood transfusion during primary total joint arthroplasty?

RESEARCHED BY:

Henry Wynn-Jones  
Seng Jin Yeo  
Javad Parvizi  
Yale Fillingham
Literature:

• Meta-analysis 5, Prospective/Randomized 5, Retrospective 8

• The overwhelming literature supports the blood conservation properties of TXA

• Many studies demonstrate that TXA reduces the transfusion rate, a known risk factor of PJI
**Recommendation:** Yes. The administration of intravenous, topical, and oral tranexamic acid (TXA) is an effective strategy for reducing blood loss and the need for allogeneic transfusion during primary total joint arthroplasty.

**Level of Evidence:** Strong

A. Agree

B. Disagree

C. Abstain
G-72 (Former G-79b) Does the use of tranexamic acid reduce blood loss and need for allogeneic blood transfusion during revision total joint arthroplasty?

RESEARCHED BY:

Yale Fillingham  Javad Parvizi
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 9

• All retrospective studies in revisions demonstrate that TXA reduces blood loss and transfusion rate of revision cases.
**Recommendation:** Yes. The administration of tranexamic acid (TXA) during revision total joint arthroplasty reduces blood loss and the need for allogeneic blood transfusion.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain

97% Agree, 0% Disagree, 3% Abstain
G-73 (Former G-80) Does the use of tranexamic acid reduce the incidence of SSI/PJI following orthopedic procedures?

RESEARCHED BY:

Mandus Akonjom
Robert Molloy
Javad Parvizi
Yale Fillingham
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 9

• There are no studies that directly link TXA with a reduced infection rate
**Recommendation:** The administration of tranexamic acid (TXA) potentially reduces the incidence of surgical site infection (SSI) and/or periprosthetic joint infection (PJI) following total joint arthroplasty (TJA) by limiting post-operative anemia and the need for allogeneic blood transfusion.

**Level of Evidence:** Limited

A. Agree  
B. Disagree  
C. Abstain
G-74 (Former HK-10) Can intra-operative or postoperative blood salvage be utilized in patients undergoing reimplantation for treatment of PJI?

RESEARCHED BY:

Rafael Tibau Olivan  William Jiranek  Jorge Manrique
Literature:

• Meta-analysis 1, Prospective/Randomized 0, Retrospective 8

• Studies have found that contamination of processed and re-administered units obtained intraoperatively range from 9 to 30% without clinical implications

• There is minimal literature regarding blood salvage in potentially infected patients

• Blood salvage often used in non-orthopaedic contaminated procedures.
**Recommendation:** Unknown. The limited published data on this subject suggest that the use of intra-operative or postoperative blood salvage in patients undergoing reimplantation for treatment of PJI may be beneficial but also pose a potential risk of bacterial dissemination. Further studies are needed to evaluate the risk-benefit of this strategy.

**Level of Evidence:** Consensus

A. Agree 92%
B. Disagree 4%
C. Abstain 4%
G-75 (Former G-22) Does allogeneic blood transfusion increase the risk of SSI/PJI?
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 22

• Many studies consistently demonstrate that allogenic blood transfusion is a risk factor for PJI.

• Five studies demonstrate that allogenic transfusion increases infection rate compared to autologous transfusion
**Recommendation:** Yes. Allogenic blood transfusion is associated with an increased risk of SSI / PJI.

**Level of Evidence:** Strong
G-76 (Former G-107) Is thrombocytosis associated with an increased risk of SSI/PJI in patients undergoing orthopedic procedures?

RESEARCHED BY:

Fatih Kucukdurmaz
Jay Lieberman
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 0

• There is no evidence that thrombocytosis increases the risk of PJI.
Recommendation: It is unlikely that thrombocytosis is associated with an increased risk of post-surgical SSI/PJI. However, patients with severe thrombocytosis should undergo evaluation prior to orthopedic procedures.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
PREVENTION

Antimicrobials
What patient factors (allergy status, weight, etc) should be utilized to alter the choice of perioperative antibiotic prophylaxis?

RESEARCHED BY:

Stanislaw Bondarenko  Simon W Young
Literature:

• Meta-analysis 0, Prospective/Randomized 3, Retrospective 15

• There is minimal evidence to suggest that patients at high risk or with specific comorbidities should be administered alternative antibiotics.

• There are a few studies that suggest that giving a fixed dose rather than weight based dosing increases the PJI rate.

• There is little evidence regarding the improved efficacy of a preferred antibiotic in patients who are administered an alternative antibiotic.
Recommendation: A weight-adjusted dose of antibiotics should be administered to patients. A minimum of 2g cefazolin is recommended for patients with weight>70kg to achieve effective MIC (minimum inhibitory concentration). Patients with a non-anaphylactic reaction to penicillins or cephalosporins can be given a test dose of cephalosporins in the operating room. The choice of prophylactic antibiotic for patients with a known anaphylactic penicillin or cephalosporin allergy includes vancomycin, teicoplanin, or clindamycin. Cephalosporins for patients with anaphylactic penicillin allergy may be given following skin testing.

Level of Evidence: Moderate

A. Agree 95%
B. Disagree 4%
C. Abstain 2%
G-78 (Former G-124) What are the indications for dual perioperative antibiotic prophylaxis in patients undergoing orthopedic procedures? What are the optimal combination antibiotics?

RESEARCHED BY:

Rolando Suarez  Alex Soriano  Michael Kheir
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 24

• There is minimal literature that suggests that dual antibiotic prophylaxis should be used

• Several studies demonstrate that dual antibiotic prophylaxis increases the rate of acute renal injury
**Recommendation:** In the absence of high-level data, we recommend that dual antibiotic prophylaxis should be reserved only for patients being at high risk of infection, such as those undergoing revision surgery and patients at high risk of MRSA infection.

**Level of Evidence:** Limited

A. Agree 80%
B. Disagree 15%
C. Abstain 5%

A. Agree
B. Disagree
C. Abstain
G-79 (Former G-110) Should extended (beyond 24 hours) antibiotic prophylaxis be administered to patients with surgical drain in place?

RESEARCHED BY:

Werner Zimmerli

Ed McPherson
Literature:

- Meta-analysis 0, Prospective/Randomized 0, Retrospective 6

- There is minimal evidence that extended antibiotics demonstrates a reduced rate of infection

- There is minimal literature that antibiotics should be administered in patients with drains
**Recommendation:** No. There is no indication for prolonged antibiotic prophylaxis regardless of the presence of surgical drains. Prolonged prophylaxis is potentially dangerous, because it increases the fraction of resistant microorganism on the skin microbiome.

**Level of Evidence:** Strong
G-80 (Former G-52) Does the presence of other implants from prior surgery in the affected joint alter the perioperative antibiotic prophylaxis?

RESEARCHED BY:

Jose Cordero-Ampuero  
Stephen Kates  
Mitchell Klement
Literature:

• Meta-analysis 1, Prospective/Randomized 0, Retrospective 15

• Conversion THA and TKA have complication rates closer to revision TJA than primary TJA, including increased SSI and PJI

• It is unclear whether prior hardware, host factors or extended operative duration required for conversion are responsible for increased complications rate
**Recommendation:** There is currently no evidence to suggest the use of alternate or additional perioperative antibiotics in joint surgery when prior implants exist from previous surgery. There is an increasing body of literature to suggest that conversion hip and knee arthroplasty carries a risk of SSI/PJI similar to revision surgery rather than primary surgery and altering antibiotics may be one method to mitigate this risk. However, studies will need to be conducted to either confirm or refute this statement given the lack of evidence.

**Level of Evidence: Consensus**

A. Agree
B. Disagree
C. Abstain
Can ceftriaxone be utilized as an alternative to cefazolin in the treatment of orthopedic infections caused by methicillin sensitive Staphylococcus aureus (MSSA)? If so, what dosing is recommended?

RESEARCHED BY:

Jason Webb  Michael Kheir  Randi Silibovski
Literature:

• Meta-analysis 0, Prospective/Randomized 1, Retrospective 25

• There are few studies that have compared cefazolin with ceftriaxone.

• No studies demonstrate that ceftriaxone should be used preferentially.
**Recommendation:** There is minimal data in literature evaluating the use of ceftriaxone and its appropriate dosage to treat orthopedic infections caused by MSSA. International guidelines state there is no consensus on the use of ceftriaxone in the treatment of prosthetic joint infection.

**Level of Evidence:** Consensus
PREVENTION

Surgical Site Preparation
G-82 (Former G-37) Does preoperative skin cleansing at home prior to orthopedic surgery have a role in reduction of subsequent SSI/PJI?

RESEARCHED BY:

Rafael Tibau Olivan
Brett Levine
Michael Mont
Alexus Cooper
Literature:

• 2 level I studies, 9 level III studies

• 1 Cochrane review demonstrating chlorhexidine wash was better than placebo but showed no difference between individual

• The literature cannot affirm emphatically that skin cleansing at home prior to orthopedic surgery have a role in reduction of subsequent SSI or PJI. However, there has yet to be any reports on the negative effects of preoperative skin cleansing at home.
**Recommendation:** Yes. Preoperative skin cleansing at home prior to orthopedic surgery does have a role in the reduction of subsequent surgical site infection (SSI) and periprosthetic joint infection (PJI). Specifically, chlorhexidine gluconate (CHG) has been shown to have excellent results in preventing PJI/SSI.

**Level of Evidence:** Moderate

- A. Agree
- B. Disagree
- C. Abstain
G-83 (Former G-116) Should skin hair around a planned surgical incision be removed? If so, what is the best method and timing of removal?

RESEARCHED BY:

James Cashman  Vasileios Nikolaou  Alexus M Cooper
Literature:

• 1 network meta-analysis (2015) included 16 RCT, 6 of which compared shaving with no hair removal. No decreased risk was associated with hair removal and shaving actually increased risk.

• 1 Cochrane systematic-review (2011) reviewed 11 RCTs and found electric clippers and depilatory creams to be associated with lower rates of SSI in comparison to shaving with a razor blade.

• The optimal time to deplete hair was inconclusive in the literature, evidence to dictate hair depilation practices with greater statistical significance are desired.
**Recommendation:** Hair at the site of surgical incision may be removed immediately before incision using clippers or depilatory creams.

**Level of Evidence:** Consensus

- A. Agree: 84%
- B. Disagree: 13%
- C. Abstain: 3%
G-84 (Former G-161) What pre-surgical skin preparation is most effective in reducing the risk of SSI/PJI in patients undergoing orthopedic procedures?

RESEARCHED BY:

Ernesto Guerra
John Blaha
Hossain Shahcheraghi
Petri Virolainen
Alexus Cooper
Literature:

• 1 Cochrane meta-analysis (2015) demonstrating in preparations when alcohol is included

• Current literature lacks evidence to support the use of one solution over another in the prevention of SSI but there is an overall consensus that it should contain alcohol from recommendations made by the CDC, International Consensus Meeting Group (ICG) and previous studies
**Recommendation:** There appears to be no difference between various skin preparation agents (chlorhexidine gluconate versus povidone iodine) as long as isopropyl alcohol is part of the preparation.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-85 (Former G-44) Does surgical preparation of the skin on the whole limb instead of a partial limb reduce the rate of SSI/PJI?

RESEARCHED BY:

Gilberto Lara Cotacio

Joshua Bingham
Literature:

• 1 RCT addressing whether to prep the foot or not, not prepping the foot demonstrated greater contamination migration into the surgical field

• Three retrospective studies demonstrating concern for increased contamination when the foot is not prepped, however, they did not address covering the foot with non-sterile drapes or wraps.

• Despite our current knowledge about the antimicrobial activity of many antiseptic agents and application techniques, the best approach for surgical site preparation still remains unclear and further high-quality studies are warranted.
Recommendation: Surgical skin preparation of the whole limb may potentially reduce the risk of surgical site infections (SSI) and/or periprosthetic joint infections (PJI) by decreasing the risk of contamination associated with partial limb preparation. Despite the limited evidence we recommend surgical skin preparation of the whole limb as there is a potential for contamination with partial limb skin preparation and little downside to whole limb skin preparation.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
G-86 (Former G-45) Does surgical skin preparation starting from the surgical site, proximal portion of the extremity, or distal portion of the extremity affect the rate of SSI/PJI?

RESEARCHED BY:

Gilberto Lara Cotacio  Lucian Bogdan Solomon
Literature:

• No study has specifically evaluated prepping from incision to the periphery versus another method

• This recommendation appears to be based on conventional wisdom and historical teaching, further evidence is required to support this claim
Recommendation: Despite the absence of supportive evidence, we recommend starting the skin preparation from the site of surgical incision towards the periphery. In general, skin preparation should be performed from a less contaminated towards a more contaminated area. In case of draining sinus, the area around the sinus should be prepped at the end of the preparation process.

Level of Evidence: Consensus

A. Agree 95%
B. Disagree 4%
C. Abstain 2%
G-87 (Former G-21) Does additional skin cleansing after placement of surgical drapes have a role in reducing the rate of SSI/PJI?

RESEARCHED BY:

Majd Tarabichi  Antonia Chen  Javad Parvizi
Literature:

• 1 RCT demonstrating decreased SSI rates after second skin cleansing with iodine and isopropyl alcohol following the placement of surgical drapes. However, the overall rate of PJI was unaffected.

• No other studies have addressed this issue and should be performed to confirm or condemn this practice.
**Recommendation:** Repeat skin cleansing following placement of surgical drapes may reduce bacterial colonization and the incidence of subsequent superficial SSI.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-88 (Former G-73) Does the use of incise draping reduce the incidence of SSI/PJI? Is there a difference in efficacy between incise drapes?

RESEARCHED BY:

Timothy Tan  Kirill Gromov  Soeren Overgaard
Literature:

• 1 RCT in hip preservation surgery demonstrated decreased rate of bacterial colonization at incision and closure

• 2 retrospective studies reported mixed results

• Despite routine use, there is a need for studies evaluating the effect of iodine impregnated incise drapes on infection rate in THA and TKA as no clinical studies have been done.
**Recommendation:** There is evidence to indicate that antimicrobial impregnated incise drapes result in a reduction in bacterial colonization of the surgical site. While bacterial colonization of the incision may predispose to subsequent SSI/PJI, there is no literature to demonstrate that the use of incise drapes results in a clinical difference in the rate of subsequent PJI. Many surgeons prefer to utilize incise draping for physical isolation of sterile from non-sterile region and prevent migration of drapes during the procedure.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-89 (Former G-64) Does the type of surgical drape (disposable vs non-disposable) used affect the risk of subsequent SSI/PJI in patients undergoing orthopedic surgery?

RESEARCHED BY:

Gary Hooper  Arjun Saxena  Richard Kyte
Literature:

• Currently, no studies in orthopedics exist investigating this question.

• RCTs performed in cardiac and general surgery demonstrated no statistically significant difference in infection rate between the two types of drapes
**Recommendation:** Unknown. The data from non-orthopedic procedures suggest that disposable drapes resist bacterial passage and reduce the risk of subsequent SSI.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-90 (Former G-71) Does the use of cloth or impervious stockinettes around the ankle and extremity affect the rate of subsequent SSI/PJI in patients undergoing orthopedic procedures?

RESEARCHED BY:

Anil Gambhir
Arjun Saxena
Gustavo Sayago
Literature:

• No studies in orthopedics have compared impervious to non-impervious stockinette use

• This topic is further confounded by whether or not the foot is prepped, with a non-prepped foot demonstrating more proximal contamination in retrospective and cadaver studies

• Further research is required on this topic
**Recommendation:** In the absence of evidence, we propose that a stockinette is always used to cover the unprepared skin and prevent potential contamination of the surgical field. Impervious stockinettes may be more resistant to soak through during the surgery.

**Level of Evidence:** Consensus
G-91 (Former G-120) Should the knife blade be changed after skin incision for deep dissection?

RESEARCHED BY:

Francisco Rafael Grieco Silva
Snir Heller
Eric Smith
Literature:

• 1 Systematic review (2017) included 7 studies and no study demonstrated a direct relationship between knife change (or not) and infection

• However, given the low cost of changing the blade, the methodology of all the studies included, and the potentially devastating consequences of prosthetic joint infection, we find it hard to recommend against changing the knife after skin incision is made despite the limited evidence for this practice.
**Recommendation:** Yes, the scalpel should be changed after making the skin incision. There are studies demonstrating that bacteria from the superficial planes of the skin can contaminate the scalpel and potentially transfer this into deeper tissues.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
PREVENTION

Surgery related factors
G-92 (Former G-33) Does operative time affect the risk of SSI/PJI?

RESEARCHED BY:

Danielle Ponzio

Qiaojie Wang
Literature:

• 3 meta-analysis all demonstrated that longer operative time was associated with increased SSI

• 6 large national database or registry studies all found an association between increased operative time and SSI

• 5 retrospective studies, after controlling for cofounding variables did find an increase in SSI with increased operative time
Recommendation: Yes. There is an association between prolonged operative time and surgical site infection. Prolonged operative time may be a result of a considerable and inescapable level of complexity of the surgery. Coordinated efforts to reduce the operative time without technically compromising the procedure can provide additional benefits for infection prevention.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
G-93 (Former G-18) Does a prior surgical procedure (with or without retained hardware) in the same joint as the arthroplasty increase the risk of subsequent SSI/PJI?

RESEARCHED BY:

Ran Schwarzkopf  Jonathan Danoff  Arash Aalirezaie  David Choon
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 19

• Majority of studies demonstrate that there is an increased rate of infection in patients with prior open procedures.

• However, there is conflicting literature.
**Recommendation:** Open surgical procedures with or without the use of hardware increases the risk for subsequent SSI/PJI in the same joint receiving arthroplasty. We suggest that elective arthroplasty is delayed on the affected joint that has undergone a recent (within 6 months) major surgical procedure.

**Level of Evidence:** Limited
G-94 (Former G-17a) Does a prior arthroscopy of the hip joint increase the risk of a subsequent SSI/PJI in patients undergoing elective total hip arthroplasty?

RESEARCHED BY:

Arash Aalirezaie  Nirav K Patel  Zoran Bozinovski  Hamed Vahedi
Literature:

• Meta-analysis 1, Prospective/Randomized 0, Retrospective 11

• There are several retrospective studies on this topic.

• Almost all studies are underpowered to detect a difference.
**Recommendation:** There is no evidence to suggest that a prior arthroscopy of the hip increases the risk of subsequent surgical site/prosthetic joint infection.

**Level of Evidence:** Limited

A. Agree  
B. Disagree  
C. Abstain

[Bar chart showing 81% Agree, 11% Disagree, 8% Abstain]
G-95 (Former G-17b) Does a prior arthroscopy of the knee increase the risk of a subsequent SSI/PJI in patients undergoing elective arthroplasty?

RESEARCHED BY:

Arash Aalirezaie  Nirav K Patel  Zoran Bozinovski  Hamed Vahedi
Literature:

- Metanalysis 0, Prospective/Randomized 0, Retrospective 15

- There are several retrospective studies on this topic that are underpowered.

- There is conflicting evidence but large scale studies have showed differences.
**Recommendation:** There is no evidence to suggest that a prior arthroscopy of the knee increases the risk of subsequent surgical site infection (SSI)/prosthetic joint infection (PJI) in patients undergoing total knee arthroplasty.

**Level of Evidence:** Moderate

A. Agree (81%)
B. Disagree (12%)
C. Abstain (6%)
G-96 (Former G-88) In patients with prior septic arthritis what strategies should be undertaken to minimize the risk of subsequent SSI/PJI?

RESEARCHED BY:

James Cashman  
Dace Vigante  
Eoin Sheehan
Literature:

• No high-quality randomized trials have assessed the effectiveness of different treatment strategies to prevent subsequent PJI in a patient with a history of PJI.

• The majority of the published literature are case series without controls. Treatment strategies are based largely on opinion and experience with infected arthroplasty. However, the reported experience of the majority of reporting groups is similar.
Recommendation: Prior to elective arthroplasty, infection in the joint with prior septic arthritis needs to be ruled out using appropriate diagnostic tests. In the presence of an active infection two-stage joint replacement is recommended.

Single-stage joint replacement may be considered when all diagnostic tests are normal and there is no active soft tissue involvement (such as sinus tract or abscess).

Single-stage arthroplasty is a reasonable treatment strategy in patients with septic arthritis caused by Mycobacterium tuberculosis (TB), where anti-tuberculous medication has been commenced and in the absence of sinus tract or extensive soft tissue involvement.

Antibiotic (no more than 5% by weight), targeted towards the prior organism if known, should be added to cement during arthroplasty.

Level of Evidence: Consensus

A. Agree
B. Disagree
C. Abstain
G-97 (Former G-53) Does the presence of prior projectile missile/bullet fragments in a joint predispose the patient to a higher risk of subsequent SSI/PJI? If so, what should be done to reduce the risk of SSI/PJI?

RESEARCHED BY:

Ran Schwarzkopf

Matthew Dietz
Literature:

• There are very limited studies available describing the risk for subsequent SSI/PJI following a projectile missile/bullet injury to a lower extremity joint indicated for a TJA.

• Three case series exist with the largest reporting 10 arthroplasties.
**Recommendation:** The presence of a prior projectile missile/bullet fragments in a joint, unless the fragment was previously infected, does not increase the risk of subsequent SSI/PJI in patients undergoing elective arthroplasty in the same joint.

**Level of Evidence:** Consensus

<table>
<thead>
<tr>
<th>Option</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agree</td>
<td>71%</td>
</tr>
<tr>
<td>Disagree</td>
<td>18%</td>
</tr>
<tr>
<td>Abstain</td>
<td>11%</td>
</tr>
</tbody>
</table>
G-98 (Former G-13) Do antibiotic coatings on implants reduce the rate of SSI/PJI?

RESEARCHED BY:

Philip C Noble

Jennings Jason
Literature:

• Meta-analysis 1, Prospective/Randomized 0, Retrospective 3, Animal studies/in-vitro 9

• There are several basic science and in vitro studies that demonstrate effective results.

• High powered studies *in vivo* are very limited.
**Recommendation:** The use of antibacterial coatings on implants has been shown to reduce surgical site and/or prosthetic joint infection based *in vitro* and in pre-clinical animal model studies. The use of antibiotic coated implants in small series of patients appears to be encouraging. Larger scale studies to prove the value of these technologies are needed.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-99 (Former G-58) Does the size of an implant (volume) used during orthopedic procedures influence the incidence of subsequent SSI/PJI?

RESEARCHED BY:
P. Maxwell Courtney Thomas Bradbury
Literature:

• An organized literature search failed to investigate any literature investigating a relationship between component size and incidence of PJI

• However, these studies would be difficult to perform as it would be difficult to isolate implant size as an independent variable
Recommendation: While a smaller implant may theoretically represent a smaller substrate for colonizing bacteria, there have been no conclusive studies linking implant size and the incidence of subsequent periprosthetic joint infection.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
PREVENTION

Local delivery of antimicrobials
G-100 (Former G-10) Can local antibiotic delivery alone be effective in the treatment of musculoskeletal infections?

RESEARCHED BY:

Jose Baeza  Peter Wahl  Jorge Manrique
Literature:

• 5 in-vitro studies were included and 5 retrospective clinical studies were included

• These included infection of primary to megaprosthesis implants with conflicting results and often lack of a control cohort.
Recommendation: At the present time and without further refinement of delivery mechanisms and improved pharmacokinetics, local antibiotic alone is not believed to be sufficient for management of patients with orthopaedic infections. Other adjunctive treatment modalities need to be combined with local delivery of antibiotics.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
G-101 (Former G-46) Does the local administration of vancomycin powder to wound during surgery reduce the risk of subsequent SSI/PJI? If so, what are the risk factors associated with its use?

RESEARCHED BY:
Andrew Fleischman
Marco Bernardo Cury
Literature:

• Meta-analysis 1, Prospective/Randomized 0, Retrospective 10

• There are no high-quality studies on vancomycin for the prevention of PJI as most are retrospective

• Abundance of retrospective spine literature suggests that vancomycin powder reduces the incidence of surgical site infection. However, the only RCT suggests that is has no impact.
**Recommendation:** No. There are no high-quality studies on vancomycin for the prevention of PJI. The abundance of retrospective spine literature suggests that vancomycin powder reduces the incidence of surgical site infection. However, the only RCT suggests that it has no impact.

**Level of Evidence:** Limited

- A. Agree (90%)
- B. Disagree (7%)
- C. Abstain (4%)
G-102 (Former G-97) Is there a difference in the bioavailability of vancomycin when administered through the intravenous route or intraosseous regional route in TKA?

RESEARCHED BY:

Simon W Young

Kelly Vince
• Meta-analysis 0, Prospective/Randomized 0, Retrospective 12

• Several studies demonstrate that intraosseus dosing increases the bioavailability compared to intravenous.

• There is minimal literature on whether intraosseus dosing decreases the infection rate
**Recommendation:** Yes. Tissue concentrations of vancomycin and other antibiotics are significantly higher when given via intraosseous regional administration for prophylaxis in total knee arthroplasty. Currently, it is unclear whether these higher concentrations will lead to a reduction in PJI rates.

**Level of Evidence:** Strong

A. Agree
B. Disagree
C. Abstain
G-103 (Former G-105) Is there a role for the use of antibiotic-loaded carriers (calcium sulfate/phosphate) in treatment of SSI/PJI?

RESEARCHED BY:

Jason Webb  Alex McLaren  Lars Lidgren
Literature:

• Meta-analysis 0, Prospective/Randomized 7, Retrospective 8

• No high level of evidence study that proves that the use of absorbable material containing antibiotics influences the outcome of surgical management of patients with PJI.

• Very heterogenic cohorts with large differences in the patients conditions, variations in material composition, the form and administration of the materials, variation in antibiotics used as well as the dosage makes comparison between the materials difficult.

• Many studies had no control groups
**Recommendation:** The use of antibiotic-loaded carriers, specifically Calcium Sulphate (CaS) and Calcium Phosphate (CaP) based materials, to locally deliver antimicrobials at sites of musculoskeletal infection, specifically SSI and PJI, should be based on clinical judgement considering all options for local antimicrobial delivery, dead space management, bone void reconstruction and stimulation of bone healing due to the lack of evidence.

**Level of Evidence:** Consensus

A. Agree
B. Disagree
C. Abstain
G-104 (Former G-8) Can fresh frozen allograft be used as a carrier to deliver local antibiotics during revision arthroplasty?

RESEARCHED BY:

Eivind Wits ø
Karan Goswami
Heinz Winkler
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 0, Basic science/animal studies 18

• Majority of studies are in vitro studies with bacterial colonization as an endpoint.

• There are very few high quality in vivo studies that demonstrate the influence on infection rate.
Recommendation: Emerging evidence suggests that specialized preparations of antibiotic-impregnated allograft are more effective than fresh frozen allograft admixed with antibiotics.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
G-105 (Former G-143) What is the optimal irrigation solution (type, volume, frequency) to be used during clean elective orthopedic procedures?

RESEARCHED BY:

Ashley Blom  Setor Kunutsor  Andrew Fleischman
Literature:

• Meta-analysis 0, Prospective/Randomized 5, Retrospective 14

• Many studies, including prospective RCTs, demonstrate that dilute betadine decreases the rate of infection

• There are minimal studies regarding the optimal volume of irrigation needed
Recommendation: There is ample evidence to support use of sterile dilute povodine-iodine for the irrigation of wounds during surgical procedures. The optimal volume of irrigation solution is not known.

Level of Evidence: Strong

A. Agree
B. Disagree
C. Abstain
G-106 (Former G-123) What antiseptics can be used to prevent biofilm formation?

RESEARCHED BY:

Silvestre Ortega-Pena  Mark Smeltzer  Kenneth Urish
Literature:

• Meta-analysis 0, Prospective/Randomized 1, Retrospective 5,

• There are minimal studies in orthopaedics and in-vivo regarding the use of antiseptic agents for biofilm formation.

• One randomized study for gingival biofilm formation

• Majority of studies are in-vitro
**Recommendation:** Although several studies have demonstrated the ability of certain antiseptic agents to prevent biofilm formation in vitro, the ability of antiseptics to provide prevention of biofilm formation in vivo is uncertain. They may have utility in the context of revision surgery due to existing infection but this issue has not been adequately studied.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-107 (Former G-20) Does addition of topical antibiotics (polymixin and/or bacitracin) to irrigation solution offer additional antibacterial properties?

RESEARCHED BY:

Karan Goswami

Jeong Eun Cho
Literature:

• Meta-analysis 1, Prospective/Randomized 5, Retrospective 8

• Recent literature demonstrates that the addition of topical antibiotics (most commonly bacitracin, polymyxin) adds no benefit

• Meta analysis and five RCTs demonstrate no difference with the addition of antibiotics
Recommendation: Guidelines from the WHO and NICE advise against the addition of topical antibiotics to irrigation solutions. Recent CDC recommendations suggest an uncertain trade-off between the benefits and harms of intraoperative antimicrobial irrigation for the prevention of SSI. While data regarding the antimicrobial efficacy of irrigation solutions containing antibiotics, such as polymyxin-bacitracin, is conflicting and largely based on non-orthopedic studies, we advocate against its intraoperative usage in the face of growing antimicrobial resistance concerns, cost and hypersensitivity implications.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
G-108 (Former HK-77) Is there a role for non-antibiotic natural antiseptic agents (eg honey, vinegar) as an irrigation solution during surgical debridement for PJI?

RESEARCHED BY:

Rhidian Morgan-Jones

Parvizi, Javad
Literature:

• Meta-analysis 0, Prospective/Randomized 5, Retrospective 14

• There are several retrospective and in-vitro studies on non-antibiotic antiseptic irrigation.

• Few have demonstrated clinical superiority in clinical studies.

• There are no randomized studies demonstrating clinical superiority.
**Recommendation:** There may be a role for non-antibiotic antiseptic agents (e.g., honey, vinegar,) as an irrigation solution during surgical debridement.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-110 (Former G-55) Does the pressure of the pulsatile delivery mechanism for irrigation fluid influence the efficacy of the irrigation solution to eradicate infecting organisms in the wound?

RESEARCHED BY:

Kenneth Urish

Constantinos Ketonis
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 19

• Several clinical studies do not demonstrate any clinical efficacy between high-pressure and low-pressure irrigation

• Animal studies and in-vitro studies are indeterminate

• Literature largely on traumatic wounds and open fractures
**Recommendation:** A series of clinical studies have been unable to observe differences in clinical outcomes or reoperation rates between high pressure as compared to low pressure irrigation of wounds. Tangential hydrosurgery is an emerging irrigation method that, though promising, still requires further investigation.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain
PREVENTION

Postoperative issues
G-111 (Former G-89) Is early mobilization after orthopedic procedures associated with an increased risk of wound drainage or SSI/PJI?

RESEARCHED BY:

Giles Scuderi  
Julio César García Ricaurte
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 10

• There are no studies that demonstrated increased wound drainage with early mobilization or infection.

• Furthermore, there are no studies that directly investigate this.
**Recommendation:** Current literature reports no increased risk of wound drainage or SSI/PJI with early mobilization following orthopedic procedures.

**Level of Evidence:** Limited

A. Agree  
B. Disagree  
C. Abstain
Is it necessary for a patient to postpone having an invasive dental procedure after TJA?

RESEARCHED BY:

William V Arnold

Martin Buttaro
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 19

• There is evidence that dental procedures should be delayed

• Literature primarily includes case reports
Recommendation: In the absence of evidence, we recommend that non-urgent invasive dental procedures, if possible, be delayed until osseointegration of uncemented components are complete.

Level of Evidence: Consensus

A. Agree 82%
B. Disagree 10%
C. Abstain 8%
G-113 (Former G-151) What is the role of prophylactic antibiotics for invasive procedures (dental, GI, urologic, etc) in the presence of an arthroplasty component to prevent subsequent PJI?

RESEARCHED BY:

Inma Neira
Aruna Poojary
María S Quevedo
Literature:

- Meta-analysis 0, Prospective/Randomized 1, Retrospective 9

- There is little evidence that invasive procedures necessitate prophylactic antibiotics

- The literature primarily includes case reports and large scale studies demonstrate no differences
**Recommendation:** There is no role for routine prophylactic antibiotic administration prior to dental or GU procedures. There is limited evidence that has shown certain GI procedures may be associated with a risk of subsequent PJI.

**Level of Evidence:** Limited

- A. Agree (64%)
- B. Disagree (28%)
- C. Abstain (8%)
G-114 (Former G-67) Does the type of wound closure (technique and material) affect the incidence of subsequent SSI/PJI?

RESEARCHED BY: Arash Aali Rezaie, Ran Schwarzkopf, Viktor Krebs, Yale Fillingham
Literature:

• Several high quality and randomized studies have been performed

• No wound closure method has been demonstrated to be superior
**Recommendation:** There is a lack of strong evidence clearly demonstrating the superiority of any wound closure method following total joint arthroplasty (TJA). The majority of the high quality studies demonstrate no difference between the various types of wound closure.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain
PREVENTION

Surgical wound management
G-115 (Former G-12) Do antibacterial-coated sutures reduce the risk of subsequent SSI/PJI?

RESEARCHED BY:

Feng Chih Kuo
Literature:

• Meta-analysis 1, Prospective/Randomized 1, Retrospective 14
• There are several high quality studies investigating the role of antibiotic-coated sutures, but only one relating to orthopaedics.
• Meta-analysis demonstrates that there is a reduced rate of infection using antibiotic coated sutures
**Recommendation:** The use of antibacterial-coated sutures reduces the risk of SSI following colorectal surgery. There is no conclusive evidence that its use reduces the risk of subsequent SSI/PJI in orthopedic patient population.

**Level of Evidence:** Limited

A. Agree 92%
B. Disagree 3%
C. Abstain 4%
G-116 (Former G-78) Does the use of topical incisional sealants (i.e. integuseal, dermabond, etc) reduce the incidence of subsequent PJI/SSI in patients undergoing orthopedic procedures?

RESEARCHED BY:

Andy Miller, MD  Farshad Adib, MD
Literature:

- Meta-analysis 0, Prospective/Randomized 4, Retrospective 16
- Randomized studies across surgical subspecialties have not shown significant reductions in
- infection rate with the use of these products
- Many studies underpowered to detect differences in drainage or infection rates
**Recommendation:** While we recognize that the use of topical incisional sealants has the potential to reduce wound drainage, there is no evidence that the use of such products has any impact on the incidence of SSI/PJI.

**Level of Evidence:** Limited

A. Agree 93%
B. Disagree 3%
C. Abstain 5%
Does the use of surgical drains increase the risk of subsequent SSI/PJI?

RESEARCHED BY:

Gregory Deirmengian, MD  Snir Heller, MD  Kier Blevins, MD
Literature:

- Meta-analysis 0, Prospective/Randomized 0, Retrospective 14
- Several studies demonstrate no difference in the infection rate with the use of drains.
- Several studies reveal an increased rate of blood transfusions in patients with drains.
**Recommendation:** There is no direct evidence to suggest that the use of surgical drains (for < 48 hours) leads to an increase in the rate of subsequent SSI/PJI. The use of surgical drains lead to a higher volume of blood loss and an increased need for allogeneic blood transfusion, which may indirectly increase the rate of SSI/PJI.

**Level of Evidence:** Limited

A. Agree 90%
B. Disagree 7%
C. Abstain 3%
G-118 (Former G-15) Do patients need to refrain from getting the surgical incision wet or submerged in water to prevent SSI/PJI? If so, for how long postoperatively?

RESEARCHED BY:

Emmanuel Thienpont  Georgios Komnos  Jessica Jennings  Elvira Montañez
Literature:

• Meta-analysis 1, Prospective/Randomized 4, Retrospective 17
• There are several studies in arthroplasty and outside orthopaedics that demonstrate no difference with early showering regarding infection rates.
Recommendation: Patients need to refrain from getting the surgical incision wet for the first 48 hours after surgery. However, with an occlusive dressing in place protecting the incision, the patients may shower during this period.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain

86% Agree
11% Disagree
4% Abstain
G-119 (Former G-132) What is the definition of persistent wound drainage?

RESEARCHED BY:

Paul Lachiewicz, MD
Literature:

• Meta-analysis 0, Prospective/Randomized 0, Retrospective 6
• Several studies demonstrate that wound drainage is a major risk factor for SSI and PJI
• Various definitions of continued wound drainage in the literature
**Recommendation:** There is no validated definition of “persistent wound drainage”. In the absence of such data, we define persistent wound drainage as any continued fluid extrusion from operative site occurring beyond 72 hours from index surgery.

**Level of Evidence:** Consensus

- A. Agree 78%
- B. Disagree 17%
- C. Abstain 5%
G-120 (Former G-165) What surgical dressing (i.e. occlusive, silver impregnated, dry gauze) is associated with a lower risk of SSI/PJI in patients undergoing orthopedic procedures?

RESEARCHED BY:

José Gomez, MD  Joseph Karam, MD  Peter Sharkey, MD  Mitchell Klement, MD
Literature:

• Meta-analysis 1, Prospective/Randomized 12, Retrospective 13
• Active and interactive shown to reduce rates of SSI/PJI after joint arthroplasty compared to passive dressing (dry gauze)
• RCTs needed to compare effectiveness of active and interactive in preventing SSI/PJI or other wound complications
**Recommendation:** Occlusive and/or silver impregnated dressings have been proven to reduce the rate of wound complications, surgical site infection (SSI) and periprosthetic joint infection (PJI) compared to standard gauze dressings and should be considered for routine use. The majority of the literature at present focuses on total joint arthroplasty. However, further research is required to see if the added antimicrobials (such as silver), the occlusive, active-nature of the dressing, or their combination is responsible for the demonstrated reduction in SSI/PJI.

**Level of Evidence: Moderate**

- A. Agree
- B. Disagree
- C. Abstain
G-121 (Former G-150) What is the role for vacuum-assisted incisional dressings in orthopedic patients?

RESEARCHED BY:

Mitch Harris, MD
Ruwais Binslaksar, MD
Gregory Deirmengian, MD
Literature:

• RCT: There was no difference in wound healing or wound complications between iNPWT in standard surgical dressings after routine total hip or knee arthroplasty.

• Multiple prospective randomized controlled trials have further shown that iNPWT decreases hematoma/seroma size and the time to a closed dry wound following high-energy trauma, 10 hemiarthroplasty, 11 total hip arthroplasty, 12 and spine fracture care.

• Periprosthetic fracture and revision surgery: iNPWT was associated with improved wound healing and fewer surgical site infections following revision total hip or knee arthroplasty, but there was no difference in wound dehiscence, deep infection or reoperation.
**Recommendation:** Prophylactic vacuum-assisted incisional dressings (iVAC) appear to be a reasonable option for improved wound healing and decreasing the infection rate in orthopaedic patients at-risk for such complications. Prophylactic iVACs used routinely in uncomplicated cases do not appear to provide benefit and lead to increase costs. Lastly, evidence suggests that iVACs may also play a role in resolving some cases of early, benign post-operative drainage.

**Level of Evidence: Moderate**
G-122 (Former G-168) When should sterile surgical dressings be removed and how frequently should subsequent dressings be changed following orthopedic procedures?

RESEARCHED BY:

Per Gundtoft, MD
Andres Orlando Villanueva, MD
Tommaso Bonanzinga, MD
Hamidreza Yazdi, MD
Literature:

• No meta-analyses or systematic reviews of RCT of early vs. late removal of sterile dressings in orthopedic surgery were found.

• One systematic review on early vs. late dressing removal including all surgical specialties was identified in which 3 RCTs were included with a total of 280 patients. Participants were randomized to early dressing removal (&lt;48 hours following surgery) or delayed dressing removal (continued dressing for &gt;48 hours following surgery). No difference found.

• Chrintz et al. compared removal of dressing after 24 hours with keeping the wound dressed until removal of the sutures and found no statistically significant difference in the incidence of surgical site infection.
Recommendation: The dressing placed over the surgical wound under sterile conditions in the operating room should be changed based on saturation of the dressing. Early removal and frequent changes of the surgical dressing are not needed if there is no significant bleeding or drainage on the original dressing. If the dressing remains dry, wound coverage for a minimum of 48 hours has been recommended.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
G-123 (Former G-19) Does prolonged hospitalization prior to elective total joint arthroplasty increase the risk of subsequent SSI/PJI?

RESEARCHED BY:

Jose Luque  Wadih Y Matar  Alexus M Cooper  Lowry C. Barnes
Literature:

- Meta-analysis 0, Prospective/Randomized 0, Retrospective 20
- A case-control study by Lee et al. reviewing the risk factors for SSI amongst elderly orthopedic patients found that admission on the day of surgery was associated with a decreased risk for SSI (OR = 0.42; 95% CI 0.24, 0.74; p=0.002) in a bivariate analysis
- In a series of 3672 primary hip arthroplasty cases, Maoz et al. reported non-same day surgery as a significant risk factor for PJI (OR = 4.16; 95% CI 1.44-12.02; p=0.008)
**Recommendation:** Yes, prolonged pre-operative hospitalization is associated with an increase in the risk of SSI/PJI.

**Level of Evidence:** Strong

A. Agree  
B. Disagree  
C. Abstain
G-124 (Former G-35) Does placement of patients with an infection in private hospital rooms decrease the risk of subsequent SSI/PJI for patients undergoing orthopedic procedures?

RESEARCHED BY:

Ashok Rajgopal  Shrinand Vaidya
Literature:

• Analysis of combined study data showed that MRSA control measures (including isolation) led to reduction in the rate of SSI from 1.14% (199 out of 17457) to 0.38% (128 out of 33328).

• Combined analysis of data from three studies show that ring-fencing of beds was effective in decreasing the rate of SSI from 1.31% (57 out of 4347) to 0.35% (32 out of 9230).

• However, in a review article by van de Glind et al. (46), the authors could not find an association between single patient rooms and reduced infection rates.
**Recommendation:** There is some evidence to suggest that isolation of patients who are carriers of methicillin-resistant *Staphylococcus aureus* (MRSA) or have an active infection by MRSA in private rooms and observing isolation protocols reduces the rate of hospital acquired infections. Patient isolation and contact precaution measures also play a key role in controlling outbreaks due to other multi-drug resistant organisms such as vancomycin-resistant *enterococci* (VRE), *E.coli*, *Klebsiella*, *Acinetobacter*, *Pseudomonas* and others. The issue of whether placing orthopedic patients with an active infection in private rooms has any effect on the rate of PJI for other patients has not been examined.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
Diagnostic
What is the definition of a sinus tract?
Literature:

• A sinus tract (latin: hollow, cavity) is an abnormal channel connecting a cavity lined with granulation tissue to an epithelial surface.

• Historically described by Edwin-Smith Papyrus, Hippocrates, Richard Wiseman

• Classifications made by Ger and Cierny-Mader
Recommendation: A sinus tract has the following characteristics:
1) It is an abnormal channel through the soft tissues that allows communication between a joint prosthesis and the outside environment, known or presumed to be colonized by bacteria.
2) Its presence may be confirmed with direct visualization of an underlying prosthesis, evidence of communication with fistulogram, ultrasound, computed tomography, or MRI.

Level of Evidence: Consensus

A. Agree
B. Disagree
C. Abstain
G-126 (Former G-131) What is the definition of implant “colonization” vs implant-related infection?

RESEARCHED BY:

Stephen Kates, MD

Christof Wagner, MD
Literature:

• Research into colonization of a prosthetic joint implant is scarce and currently there is no universally accepted definition for implant colonization.

• Non-pathogenic organisms can become pathogenic given specific conditions, and even the most virulent organism requires certain circumstances to cause a compromising infection.

• Recent studies suggest the presence of microbiome in aseptic, deep tissue.

• In a recent study using NGS, an organism was identified in 6 of 17 patients undergoing primary arthroplasty, with no clinical or laboratory evidence of infection.
**Recommendation:** Colonization is the presence of microbiota in a joint, with growth and multiplication of the organism, but without interaction between the organism and the host’s immune response thus avoiding any clinical expression. Infection is the invasion of a joint by disease-causing organisms that results in an interplay with the host’s immune response causing a clinical expression and disease state.

**Level of Evidence:** Limited

A. Agree 83%
B. Disagree 8%
C. Abstain 9%
G-127 (Former G-148) What is the recommended time interval that would divide acute and chronic PJI (four weeks, 90 days, etc)?

RESEARCHED BY:

Marjan Wouthuyzen-Bakker, MD  Jeppe Lange, MD
Literature:

• Meta-analysis 0, Prospective/Randomized 1, Retrospective 35

• Carli et al. observed in a mouse model with a proximal tibial implant infection, using a high initial bacterial inoculum (3x10^5 CFU), that a biofilm is evident after 2 weeks of injection, but extends and is covered by fibrinous tissue and multiple host cells after 6 weeks.

• The majority of the proposed PJI classification schemes in literature use a wide variety in time intervals (3 weeks - 3 months), but all are based on expert opinions.

• Some clinical reports have supported the usefulness of a 3-week time interval, but others have not.
**Recommendation:** There is no evidence-based time interval that divides acute from chronic PJI. The natural history of infection is a continuum from initiation to chronicity. Surgical treatment for patients with infection should not solely be based on the duration of symptoms or the time from implantation of the prosthesis. Other factors also should be considered such as implant stability, presence of sinus, virulence of the infective organism, and general health of the patient. It is important to note that the efficacy of surgical intervention, involving retention of the prosthesis, is more likely to fail as one moves more than 4 weeks from the index arthroplasty and/or duration of symptoms of infection.

**Level of Evidence: Limited**

- **A. Agree** 84%
- **B. Disagree** 15%
- **C. Abstain** 1%
Recommendation: We recommend to move away from the traditional division between acute and chronic infection that was based solely on time from index arthroplasty or duration of symptoms. Periprosthetic infection is a continuum that leads to establishment of biofilm.

Level of Evidence: Limited
Should we have specific time limit cut off between chronic and acute infection?

A. Agree 60%
B. Disagree 37%
C. Abstain 3%
What serum test(s) have the best diagnostic accuracy? Does the combination of any number of tests increase the diagnostic accuracy?

RESEARCHED BY:

Qiaojie Wang, MD  Sreeram Penna, MD  Alisina Shahi, MD
Literature:

- Meta-analyses: CRP and ESR have high sensitivity and specificity, especially when combined. May need a higher threshold value if less than three weeks post joint replacement.

- Pooled sensitivity of 45% and specificity of 87% for WBC count in the diagnosis of PJI (meta-analysis by Berberi et al.)

- Xie et al. (meta-analysis of 17 studies), found pooled sensitivity and specificity of serum IL6 were around 72% and 89%, respectively

- Ettinger et al., combining positive serum IL-6 (>5.2 pg/ml) and CRP (>0.3mg/dl) demonstrated an increased specificity to 98.2% and diagnostic odds ratio to 168.
Recommendation: Several serum biomarkers have been used as diagnostic tools for periprosthetic joint infection (PJI) with C reactive protein (CRP) and erythrocyte sedimentation rate (ESR) being the most commonly accepted screening tests. CRP and ESR are well-researched screening tests and have high sensitivity when used alone. Serum D-dimer for the diagnosis of PJI are being actively evaluated with encouraging early results. Combining serological tests have shown to improve diagnostic accuracy, but further work is needed to identify the optimal combination. It should also be noted that diagnosis of PJI cannot be based solely on serological tests at this time.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
G-129 (Former G-170) Which patient-specific factors (i.e. inflammatory arthritis, immunocompromised state) influence the thresholds for serum and synovial markers in acute and chronic PJI?

RESEARCHED BY:

Susan Goodman, MD
Jianhao Lin, MD
Literature:

- Meta-analysis 2, Prospective/Randomized 0, Retrospective 29
- The available published studies addressing the diagnosis of PJI in patients with inflammatory arthritis is limited by small numbers.
- Of the 6 studies that specifically addressed IA patients, [7,9,15,16,18] Cipriano et al. was the only study that directly compared results for PJI in IA vs. non-IA patients and showed that values for ESR, CRP and synovial WBC count and PMN percentage in patients with IA have a lower optimal diagnostic threshold and lower specificity.
- Bonanzinga et al. and Erdemeli et al.: alpha-defensin produced false negatives and no difference in absolute values between aseptic and septic groups.
**Recommendation:** There are currently no inflammatory arthritis-specific factors known to influence the thresholds for serum and synovial markers in PJIs. The literature on PJIs in inflammatory arthritis (IA) is sparse. While α-defensin is the best studied synovial biomarker, as with synovial WBC count and CRP, there appears to be overlap in values limiting their utility in differentiating septic from aseptic effusions in patients with inflammatory arthritis.

**Level of Evidence: Limited**

A. Agree

B. Disagree

C. Abstain
G-130 (Former G-41) Does prior use of antibiotics influence the accuracy of tests used to diagnose PJI?

RESEARCHED BY:

Arthur Malkani

AliSina Shahi
Literature:

• Berbari et al. reviewed 897 PJI cases, 60 (7%) of which had negative cultures. Of the culture negatives, 32 (53%) received a prior course of antimicrobial agents.

• Retrospective study on 106 hip and knee arthroplasties with MSIS defined PJIs from four different centers. 30/106 (28%) treated with antibiotics for PJI before diagnostic workups, and 76/106 (72%) did not receive antibiotics treatments prior to the diagnostic workup. Sensitivity of serum ESR and CRP, synovial WBC, percentage PMN, and alpha-defensin all significantly lower when therapeutic antibiotics were used (except for synovial fluid alpha-defensin).
**Recommendation:** Yes. The use of premature antibiotics can compromise the accuracy of the routine diagnostic tests that are used for PJI. We strongly urge the medical community to abstain from administration of antibiotics in patients with suspected PJI, unless the patient has significant systemic upset due to sepsis, and following discussion with an orthopaedic surgeon.

**Level of Evidence:** Strong

A. Agree  
B. Disagree  
C. Abstain
G-131 (Former G-63) Does the type of organism (i.e. Fungi, P. acnes, S. aureus) influence the thresholds for serum and synovial markers in acute and chronic PJI?

RESEARCHED BY:

Maureen Lynch  James Huddleston
Literature:
• Retrospective study over 15 year period: virulent organisms, such as resistant organisms or S. aureus, result in higher inflammatory markers while less virulent organisms demonstrated lower levels. Similar results for synovial markers, WBC and PMN%.
• Deirmengian et al. demonstrated that the median synovial fluid CRP level was significantly lower for less-virulent organisms, when compared to those organisms classified as virulent (15.10 mg/L vs 32.70 mg/L; P < .0001).
• There was no difference in the magnitude of the alpha-defensin level regardless of Gram stain characteristics, specific organism, virulence, oral or non-oral pathogen, or anatomic source.
• The characteristics of systemic inflammatory markers in patients with fungal PJIs have not been fully assessed.
Recommendation: Yes. Emerging data suggest that the type of organism influences the diagnostic thresholds for most serum and synovial biomarkers in the diagnosis of acute and chronic periprosthetic joint infection.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
Is there a role for procalcitonin blood test in the diagnosis of SSI/PJI in orthopaedic patients?

RESEARCHED BY:

Muhammad Kazim Rahim Najjad, MD

Kier Blevins, MD
Literature:

- Worthington et al.: PCT was not valuable in differentiating patients with aseptic loosening from those with septic loosening in revision TJA.

- Sousa et al. also showed that PCT synovial fluid tests showed no difference in patients with PJI and those without PJI.

- Drago et al. showed that the levels of serum PCT did not differ between patients with PJI and those without PJI.

- Xie et al., 2017, meta-analysis: PJI diagnosing utility of α-defensin vs PCT and found that α-defensin was also superior to serum PCT with regard to specificity (.95 vs. .92), positive likelihood ratio (19.6 vs. 6.8) and AUC (.99 vs. .76).
Recommendation: No. The literature demonstrates the existence of biomarkers with superior diagnostic value compared to serum procalcitonin blood test in determining the presence of infection in orthopedic patients.

Level of Evidence: Strong
G-133 (Former G-144) What is the optimal methodology for obtaining intra-operative cultures?

RESEARCHED BY:

Ruyin Hu, MD
Ana Lucia Munhoz Lima, MD
Olivier Cornu, MD
Literature:
• Many studies recommend 4 samples should be taken, including samples inoculated into blood culture bottles (Bemer et al., Peel at al., Gandhi et al.)
• Preference should be given to sampling the membrane at the implant-bone interface as such samples are most likely to yield positive results.
• Tissue cultures have a higher sensitivity and specificity than swab cultures for diagnosing PJI and therefore swabs should be avoided.
• The sensitivity of the synovial fluid inoculated into blood culture bottles is higher than traditional culture.
**Recommendation:** Each tissue sample should be collected using separate sterile instruments and transferred directly into culture bottles and transferred to laboratory as soon as possible. A minimum of three and maximum of five intraoperative cultures (periprosthetic tissue) should be obtained. It is preferable that samples are obtained from the implant-bone interface, whenever possible. Swab cultures should be avoided due to their poor diagnostic accuracy. Synovial fluid should also be collected and placed into blood culture bottles, where possible.

**Level of Evidence:** Moderate

A. Agree  
B. Disagree  
C. Abstain
G-134 (Former G-145) What is the optimal time for culture processing of tissue or synovial aspirate samples? How long should routine cultures be kept before declared negative?

RESEARCHED BY:

Kier Blevins, MD
Georgios Komnos, MD
Literature:

• Most tissue or synovial cultures are incubated for 5 days.

• Butler-Wu et al. found that minimum 13-day culture incubation for both aerobic and anaerobic cultures is necessary for diagnosing P. acnes.

• Schaffer et al. proposed that microbiological culture should be held for 14 days to diagnose infection in patients after conducting a large prospective study, in which tissue samples from 284 patients were cultured.

• In a prospective laboratory study over a 7-month period, tissue samples were taken from patients with suspected PJI. All samples were cultured for 14 days, using a BD BACTEC™ instrumented blood culture system. All but 1 out of the 66 culture-positive cases of PJI was detected within 3 days of incubation.
**Recommendation:** Cultures should be maintained for a period of 5 to 7 days. In cases of suspected periprosthetic joint infection (PJI) with low virulence organisms, or if preoperative cultures have proven to be negative and there is a high clinical suspicion for PJI (culture-negative PJI), the cultures should be maintained from 14 to 21 days.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain
G-135 (Former G-147) What is the recommended standardized laboratory culture protocol to minimize differences between medical centers?

RESEARCHED BY:

Kier Blevins
Arjun Saxena
Lars Frommelt
Literature:

- 40 randomized clinical trials comparing intravenous TA versus placebo
- Meta-analyses
- Strong evidence demonstrating that IV, topical and also oral TA reduce blood loss and the need for allogeneic blood transfusion
**Recommendation:** Based on current guidelines from the Infectious Disease Society of America (IDSA), specimens for culture should be transported in sterile containers at room temperature and processed promptly within a 2-hour window to limit specimen contamination or desiccation and subsequent death from nutrient deprivation.

**Level of Evidence:** Limited

A. Agree  
B. Disagree  
C. Abstain
G-136 (Former G-155) What methods can be utilized to increase diagnostic yield of microbiological culture in SSI/PJI?

RESEARCHED BY:

Mitchell Klement  Karan Goswami  Charles Nelson
Literature:

• 40 randomized clinical trials comparing intravenous TA versus placebo
  * Meta-analyses
  * Strong evidence demonstrating that IV, topical and also oral TA reduce blood loss and the need for allogeneic blood transfusion
Recommendation: At least four intraoperative cultures should be obtained to increase the diagnostic yield. There is limited evidence to suggest that cultures from the synovium, synovial fluid, or tissue in contact with prosthesis may be more likely to identify a pathogen. The samples should be inoculated in blood culture bottles and the addition of enriched media (such as a chocolate agar plate and Schaedler broth) or bead mill processing broth may also augment yield.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
G-137 (Former G-38) Does preoperative swabbing of a sinus tract have a role in isolation of the infecting organism?

RESEARCHED BY:

Sam Oussedik  Hernan Prieto
Literature:

• There is scarce literature regarding to the use of superficial cultures in the diagnosis of PJI.

• Tetreault et al., in a prospective, multicenter study evaluated the utility of culturing draining wounds or sinus tracts following hip or knee arthroplasty. This study included 55 patients, and reported that superficial cultures were concordant with deep cultures in less than half of the cohort (47.3%) and were more likely to generate polymicrobial results (27.3% versus 10.9%; p =0.023).
Recommendation: Superficial cultures obtained from a sinus tract should be discouraged in the setting of an infected arthroplasty. Cultures from superficial swabbing of a sinus tract exhibit a low rate of concordance with deep cultures, thus, the value of obtaining such cultures is limited. Furthermore, these cultures can confound the decision process in management of periprosthetic joint infection (PJI).

Level of Evidence: Moderate
G-138 (Former G-87) How should synovial fluid sample be sent (via laboratory vacuum tube, syringe, blood culture tubes, etc) for culture to increase the culture yield?

RESEARCHED BY:

Kier Blevins

Vanya Gant
Literature:

• There is a current void in research regarding the optimal method for synovial fluid specimen transport.

• Infectious Disease Society of America (IDSA) recommends PJI synovial fluid samples be procured at room temperature in a sterile container that is to be processed and incubated within a two-hour window for optimal culture results.

• Culture yield will be increased by transporting and processing synovial fluid in one or more blood culture bottles albeit with slightly higher bacterial contamination rates.
Recommendation: The IDSA recommends that synovial fluid specimens for culture be transported at room temperature in sterile containers and when ample amounts are available, additional procurement should be made in blood culture bottles (aerobic, and anaerobic if enough specimen volume exists to do so) alongside traditional culture methods in an effort to increase culture yield.

Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain
G-139 (Former G-113) Should perioperative antibiotics be withheld prior to obtaining an intra-operative aspirate and/or tissue samples for culture in suspected infected revision total joint arthroplasty cases?

RESEARCHED BY:

Natividad Benito  Robert Barrack  Giuseppe Sessa
Literature:

• Two randomized clinical trials, two prospective cohort studies, one systematic review of the literature, three retrospective studies.

• The literature overwhelmingly supports giving prophylactic antibiotics at the onset of the case, rather than holding them for cultures to be obtained.
**Recommendation:** Prophylactic antibiotics should not be withheld in patients undergoing revision joint arthroplasty.

**Level of Evidence:** Moderate

A. Agree  
B. Disagree  
C. Abstain
G-140 (Former G-86) How should divergent results between intraoperative tissue cultures and sonication of the prosthesis be managed?

RESEARCHED BY:

Maria Eugenia Portillo  Tiziana Ascione  Michael O’Malley
Literature:

- Eleven manuscripts compared sonication fluid culture (SFC) to tissue culture (TC) and reported on dis-coordinate culture results.

- Liu, 2017, meta-analysis, reported SFC sensitivity of 79% and specificity of 95%

- Although several studies exist that support sonication as a superior method for microbiological diagnosis over tissue culture there are several limitations.
**Recommendation:** Evidence on how to address contradictory results between intraoperative tissue cultures and sonication of the prosthesis is still lacking. Current research shows that sonication yields superior sensitivity and specificity over intraoperative tissue culture for the pathogen identification of prosthetic joint infection. There is statistical support for ≥5 CFU as optimal threshold defining a positive sonicate fluid culture; however, clinical outcomes and validation are lacking. We recommend that the data be evaluated in light of clinical picture presented.

**Level of Evidence: Moderate**

- A. Agree (86%)
- B. Disagree (6%)
- C. Abstain (8%)
G-141 (Former G-133) What is the diagnostic accuracy of intraoperative Gram stain for the diagnosis of SSI/PJI?

RESEARCHED BY:

Robert Barrack  Jess H Lonner  Yale Finningham
Literature:

• 14 retrospective studies investigating use of intra-operative gram stain

• All publications demonstrate agreement on the poor diagnostic ability of intra-operative gram stain
**Recommendation:** Intra-operative Gram Stain is an unreliable test to diagnose periprosthetic joint infection (PJI). It carries a low sensitivity and high rate of false negatives. Therefore, it is not recommended for the diagnosis of SSI/PJI.

**Level of Evidence:** Strong

A. Agree
B. Disagree
C. Abstain
G-142 (Former G-104) Is there a role for routine acid-fast bacilli (AFB) and fungal testing in suspected SSI/PJI cases?

RESEARCHED BY:

Rajesh Malhotra  Syed Shahid Noor  Barry Brause
Literature:

• Limited retrospective evidence demonstrating the low prevalence of AFB and fungal infections

• Given the low incidence of AFB and fungal infections, routine testing is low yield with a high cost
**Recommendation:** No. Testing for acid-fast bacilli (AFB) and fungi should not be performed routinely in suspected SSI/PJI. Testing of suspected cases of SSI/PJI should be limited to only those patients at higher risk of atypical infections which included the following:

a. Immunocompromised host.
b. Previous history of atypical infection.
c. Patient is living in an area with endemic atypical infections.
d. Culture negative PJI.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-143 (Former G-100) Is there a method to detect sessile microorganisms that have resulted in an infection following orthopedic procedures?

RESEARCHED BY:

Fernando Motta

William Ni
Literature:

• Several high level diagnostic studies have demonstrated the accuracy of polymerase chain reaction, next generation sequencing, alpha-defensin, and leukocyte esterase testing to detect sessile organisms

• Further investigation will be warranted on new methods of organism identification
Recommendation: Yes. Molecular techniques such as polymerase chain reaction (PCR), Next Generation Sequencing (NGS), and synovial biomarkers such as alpha-defensin or leukocyte esterase have been shown to be powerful tools in detecting prosthetic joint infections (PJI) with negative cultures, although conflicting data exists on PCR. Sonication of explanted prosthetics can enhance the sensitivity of conventional cultures and PCR.

Level of Evidence: Strong

A. Agree
B. Disagree
C. Abstain
G-144 (Former G-129) What is the best diagnostic method for identifying a P. acnes SSI/PJI?

RESEARCHED BY:

Pablo S Corona
Daniel Monsalvo
Hamidreza Yazdi
Literature:

• Diagnostic studies have demonstrated the need for extended duration cultures for up to 14 days

• Thioglycolate broth has the possibility of demonstrating further improvement of culture identification of P. acnes
**Recommendation:** Microbiological cultures, incubated for a prolonged period (up to 14 days) is currently regarded as the best diagnostic method for identifying P. acnes. Subculture in thioglycolate broth is believed to improve the yield of culture for P. acnes.

**Level of Evidence:** Moderate

A. Agree 92%
B. Disagree 3%
C. Abstain 5%
G-145 (Former G-146) What is the preferred type of sample (tissue, fluid, etc) for molecular analysis in diagnosis of orthopedic infections?

RESEARCHED BY:

Majd Tarabichi

Karan Goswami
Literature:

• The retrospective nature of the studies and significant heterogeneity limit the ability to provide a recommendation on the type of sample used for molecular analysis
**Recommendation:** Several molecular methods have been developed in an effort to provide a viable culture-independent alternative for diagnosis of orthopedic infections. However, due to the variation between studies with respect to the techniques and variety of samples collected, it remains difficult to recommend collection of one specimen type over another. While we cannot recommend a single molecular diagnostic test, careful assessment of the individual technique (location, volume, medium, temperature and transport) utilized is needed for appropriate collection and yield from the corresponding samples.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
G-146 (Former G-121) Should organisms (e.g. Treponema spp., Corynebacteria spp.) identified through molecular or genetic testing be treated the same as the pathogens isolated by culture?

RESEARCHED BY:

Alexander Shope  
Naomi Kobayashi  
Adolfo Llinas Volpe
Literature:

- Unusual organisms are rarely studied so only a very limited amount of evidence suggests routine testing for these organisms
Recommendation: The significance of organisms isolated by molecular and genetic techniques remains unknown. The treating orthopedic surgeon and infectious disease specialists should take note of these isolated organisms and individualize care based on the clinical scenario.

Level of Evidence: Limited

A. Agree (93%)
B. Disagree (2%)
C. Abstain (5%)
G-147 (Former G-134) What is the diagnostic accuracy of MRI for osteomyelitis in the presence and absence of implants?

RESEARCHED BY:

Theo LB Le Roux  
Felipe Gomez Garcia
• Systematic review pooling the sensitivity and specificity has been investigated regarding the diagnostic accuracy of MRI for osteomyelitis

• MRI can have limited diagnostic capabilities around metallic implants, but the diagnostic capabilities of MRI for osteomyelitis is poor compared to the gold standard
**Recommendation:** MRI is useful for the diagnosis of osteomyelitis in the absence of metal implants, although there are other diagnostic tools that show greater specificity and sensitivity. The pooled sensitivity and specificity for MRI in diagnosing osteomyelitis without presence of implants are 84% and 60%, respectively. There are no identifiable studies on the diagnostic accuracy of MRI for osteomyelitis around metal implants. Several techniques for reducing metal artifact exist.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain
G-148 (Former HK-115) What are the radiological signs indicative of infection in patients with an arthroplasty component in place?

RESEARCHED BY:

Jiří Gallo

Stuart Goodman
Literature:

• Although radiographs can commonly appear normal in the presence of PJI, classic signs of possible PJI include are early loosening, component migration, radiolucent lines and/or bone erosions around the prosthetic components
**Recommendation:** The radiographic signs associated with PJI at the site of hip and knee are early loosening, component migration, radiolucent lines and/or bone erosions around the prosthetic components, particularly if seen at less than five years postoperatively. However, it is important to note that plain radiographs are generally normal in the setting of PJI.

**Level of Evidence:** Strong

A. Agree 98%
B. Disagree 1%
C. Abstain 1%
What is the role of nuclear medicine imaging modalities (three phase bone scintigraphy, bone marrow scintigraphy, white blood cell scintigraphy (with 99mTc or 111In), anti-granulocyte monoclonal antibody scintigraphy, and FDG-PET/CT scan) in diagnosing PJI?

RESEARCHED BY:

Claudio Diaz  
Adolfo Llinas Volpe  
Andor Glaudemans
Literature:

• Systematic review and meta-analysis of diagnostic studies are available on the accuracy of nuclear medicine imaging for PJI

• Only a moderate level of evidence would support the use of nuclear medicine imaging; however, are useful in the setting of other inconclusive tests
**Recommendation:** Nuclear imaging may be used for the diagnosis of hip and knee PJI in a select group of patients. The test may be ordered in patients in whom PJI is suspected but when other tests are inconclusive, such as patients with dry aspiration of the joint.

**Level of Evidence:** Moderate

A. Agree 85%
B. Disagree 10%
C. Abstain 5%
G-150 (Former HK-120) What imaging modalities are available to help evaluate the extent of an infection and guide bone resection?
Literature:

• Meta-analysis 4, Prospective/Randomized 0, Retrospective 20
• There is no evidence for using CR as a tool for visualizing tissues affected by PJI
  • Exception is when CR shows clear presence of osteomyelitis, periosteal reaction, etc
• A small number of case studies provide limited evidence for the use US for detecting collections of fluid inside/around infected joint
  • US-guided aspiration (biopsy) also improves reliability of aspiration
• CT should be combined with other imaging/laboratory methods in order to visualize the extension of the soft-tissue/bone damage associated with PJI
• MRI especially with gadolinium has good specificity for abscess detection
  • MRI should be still combined with other imaging/laboratory methods in order to demonstrate the true extension of soft-tissue/bone damage associated with PJI
• Nuclear medicine techniques have shown great diagnostic potential however recent innovations are not fully represented in this review
**Recommendation:** Imaging methods have a potential to demonstrate the extent of soft-tissue/bone involvement in patients with periprosthetic joint infection. However, the use of computed tomography, magnetic resonance imaging or nuclear medicine techniques, may help to delineate the extent of bone and soft tissue involvement and may guide bone resection.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain
Treatment
G-151 (Former G-141) What is the optimal choice and duration of antibiotic therapy in polymicrobial PJI/SSI?

RESEARCHED BY:

Matthias Wimmer
Camelia Marculescu
Literature:

• No high level evidence studies have demonstrate the optimal duration of antibiotic therapy in the treatment of polymicrobial PJI

• Antibiotic should be chosen based on the culture sensitivities
Recommendation: The optimal choice and duration of antimicrobial therapy in polymicrobial PJIs remain unknown. Antimicrobial therapy for polymicrobial PJIs should be targeted at the organisms that are present. We recommend at least 4-6 weeks of intravenous, or highly available oral antimicrobial therapy, that is based on the in vitro susceptibilities of the individual microorganisms, patient allergies, and intolerances. An initial regimen may include a broad spectrum antibiotic when local antimicrobial resistance to gram-negative bacilli is high, with adjustment as soon as culture and susceptibility results are available.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
G-152 (Former G-166) What systemic antibiotic therapies should be used in patients with SSI/PJI caused by resistant organisms?

RESEARCHED BY:

Juan Pablo Horcajada

John Stammers
Literature:

• Limited evidence supports a specific statement, but culture sensitivities should drive the choice of antibiotic therapy

• Infectious Disease consultation should be routine utilized in patients with resistant organism PJI
Recommendation: The choice of antibiotic therapy in patients with surgical site infection or periprosthetic joint infection (SSI/PJI) caused by resistant organisms is not fully answered by literature. There are a number of antibiotic choices available for patients with SSI/PJI caused by resistant organisms. The antibiotic selection process should consider patient comorbidities, mode of administration, risk of Clostridium difficile, need for monitoring, allergy profile of the patient, intolerance, regional resistance patterns, cost, and availability. Ideally, apart from having activity against the resistant organisms, antibiotic choice should have good bone and soft tissue penetration and activity against biofilm. Consultation with infectious diseases specialists and clinical microbiologists is warranted in these cases.

Level of Evidence: Limited
G-153 (Former G-115) Should PJI caused by P. acnes be treated the same as other bacterial causes of PJI?

RESEARCHED BY:
Scott R Nodzo
Randi Silibovsky
Literature:

• Only retrospective studies can provide guidance on the treatment of PJI caused by P. acnes

• Despite the low virulence of the infection, it should be treated similar to other organisms causing PJI
**Recommendation:** Yes. Periprosthetic joint infections (PJI) caused by Propionibacterium acnes should be treated in the same fashion as other causes of PJI.

**Level of Evidence:** Moderate

A. Agree  
B. Disagree  
C. Abstain
G-154 (Former G-138) What is the most effective antibiotic in the treatment of P. acnes PJI?

RESEARCHED BY:

Harriett Hughes
Literature:

• No evidence has identified the most effective antibiotic to treat *Cutibacterum acnes*
**Recommendation:** Unknown. High rates of susceptibility to narrow spectrum beta-lactams make these a good initial intravenous option, though the optimum oral switch is not known. The role of rifampicin is controversial. Prospective clinical studies are required to determine the optimal antimicrobial therapy for C.acnes PJI.

**Level of Evidence: Consensus**

A. Agree
B. Disagree
C. Abstain
G-155 (Former G-122) What antibiotic therapy and duration should be used in SSI/PJI caused by Mycobacterium tuberculosis?

RESEARCHED BY:

Giovanni Riccio

Parham Sendi
Literature:

- Retrospective cohort studies have demonstrated ideal treatment of Mycobacterium tuberculosis is done with a combination of isoniazid/pyridoxine, rifampin, pirazinamide, and ethambutol.
**Recommendation:** Mycobacterium tuberculosis (TB) Periprosthetic joint infection (PJI) must be treated in collaboration with an infectious diseases specialist noting that the duration of treatment (minimum six months and up to two years) and the type of antimicrobials (usually a combination of four drugs) is determined based on the resistance profile of the pathogen.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain
G-156 (Former G-169) Which antifungal agents are heat stable and what dose of these agents should be used in cement spacers for fungal PJI?

RESEARCHED BY:

Chih Feng Kuo  
Alex McLaren
Literature:

• Despite definitive evidence regarding the ideal antifungal in a cement spacer, it must be heat stable. Amphotericin B, preferably the liposomal formulation, and voriconazole are heat stable antifungal agents available in powder form.
**Recommendation:** Amphotericin B, preferably the liposomal formulation, and voriconazole are heat stable antifungal agents that are available in powder form and can be added to PMMA cement for spacers during treatment of patients with fungal PJI. The optimal dose of the antifungals that need to be added to spacer is not known. However, in the literature the dose of amphotericin B ranging from 150 to 1500 mg per 40g cement and the dose of voriconazole ranging from 200 to 1000mg per 40g cement. Antibiotics combined with antifungals should be considered for treatment/prevention of coexisting fungal and bacterial infection.

**Level of Evidence: Consensus**

A. Agree (92%)
B. Disagree (2%)
C. Abstain (6%)
G-157 (Former G-114) Should PJII cases be referred to a regional center to improve the outcome of treatment and decrease cost?

RESEARCHED BY:

Chun Hoi Yan

Viktor Voloshin

Carla Renata Arciola
Literature:

• No evidence supports the need for PJI cases to be treated at tertiary centers

• However, established multidisciplinary teams of tertiary centers would potentially provide improved outcomes for patients
Recommendation: Patients with chronic periprosthetic joint infections are best treated in a tertiary care center where a multidisciplinary group of healthcare providers can provide optimal care.

Level of Evidence: Consensus

A. Agree
B. Disagree
C. Abstain
G-158 (Former G-128) What intraoperative findings during surgical management of orthopedic infections need to be communicated with the ID specialist?

RESEARCHED BY:
Christopher E Pelt  Claudio Diaz  Rashid Tikhilov
Literature:

• No evidence would support an explicit list of intra-operative information necessary to be communicated to the Infectious Disease specialist
**Recommendation:** Intraoperative findings that contribute to the diagnosis of Periprosthetic Joint Infection (PJI) must be communicated to the infectious disease (ID) specialist. The presence of a sinus tract (major diagnostic criteria) or any other valuable objective data such as cell count, neutrophil differential, frozen section, as well as the result of the point of care diagnostic tests, such as leukocyte esterase and lateral flow alpha-defensin need to be communicated to the ID specialist. The extent of infection, in terms of involvement of soft tissues and bone, any hardware retained and the antibiotic type and dose used in the cement spacer are also useful information that should be detailed in the operative report for communication with the ID specialist.

**Level of Evidence: Consensus**

A. Agree  
B. Disagree  
C. Abstain
G-159 (Former G-162) What quality of life (QOL) measures should be used when determining the functional outcomes of PJI treatment?

RESEARCHED BY:

Ari-Pekka Puhto

Claudio Diaz

Samual Parra Aguilera
Literature:

- No evidence supports the use of a specific quality of life measure(s) to determine the outcome of PJI
Recommendation: Currently, there are no quality of life (QOL) measures specific to determining outcome in periprosthetic joint infection (PJI). However, when determining the outcomes of any arthroplasty related procedure, the current recommendations are to use both a general well-being/QOL measure (i.e. PROMIS Global 10, SF-36, VR-12, EQ-5D) and a joint/disease specific (i.e. WOMAC, HOOS Jr or KOOS Jr) patient reported outcome measure. Supplemental information such as surgeon-reported outcome measures, an activity-specific score, and satisfaction surveys may be helpful. However, the ideal combination has yet to be determined and validated for patients treated for PJI.

Level of Evidence: Consensus

A. Agree 96%
B. Disagree 1%
C. Abstain 3%
Research Caveats
G-160 (Former HK-19) Does an animal model for PJI exist?

RESEARCHED BY:

Rahul Goel  Alberto Carli  Thomas Schaer  Camila Novaes de Santana
Literature:

• Several animal models of PJI have been reported utilizing mice, rabbit, rat, ovine, or canine

• No ideal animal model has been identified because most are not representative of clinical PJI
**Recommendation:** Yes, there are several animal models using different species and implant designs that have claimed to pertain to PJI. However, the majority of these models are not representative of clinical PJI.

**Level of Evidence:** Limited

A. Agree 88%
B. Disagree 4%
C. Abstain 9%
G-161 (Former G-98) Is there a distinct microbiome in the joints?

RESEARCHED BY:

Holger Rohde

Karan Goswami
Literature:

• Meta-analysis 0, Prospective/Randomized 5, Retrospective 16

• A basic characteristic of infections caused by more innocuous organisms derived from skin microbiota is the ability to form biofilm. There is limited data available as to which extent native joints also can also harbor such micro-organisms.

• Studies of explanted prosthetic devices from patients with aseptic loosening of a joint found cases in which bacteria were unambiguously identified from the sample but that didn’t show any sign of infection according to current standards.
Recommendation: It remains unclear whether the native joint or a joint after arthroplasty can be considered a microbiological niche in which specific organisms reside without causing any manifestation of infection. However, given the innocuous character of microorganisms (such as Coagulase-Negative Staphylococcus, Cutibacterium species) recovered from clinical specimens in the context of aseptic loosening it appears plausible to hypothesize that chronic colonization of devices can occur and be of long-lasting nature before signs and symptoms of clinical infection occur, if they occur at all.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain
Has the profile of organisms causing SSI/PJI following orthopedic procedures changed over recent years?

RESEARCHED BY:

Peter Sculco  
Karan Goswami  
Hannah Groff
Literature:

• Meta-analysis 0, Prospective/Randomized 1, Retrospective 22

• There is consensus that Gram-positive aerobic bacteria (Staphylococcus aureus, Staphylococcus epidermidis and Group B Streptococcus) continue to remain the most common offending organisms.

• The prevalence of resistant pathogens and atypical organisms continues to rise. The prevalence of methicillin-resistant Staphylococcal aureus and culture-negative infection is also increasing.
**Recommendation:** While the majority of organisms causing SSI/PJI continue to be Staphylococcal species, the prevalence of resistant pathogens and atypical organisms continues to rise. In particular, incidence of methicillin-resistant Staphylococcal aureus (MRSA) is increasing. Isolated studies have reported an increased prevalence of culture-negative PJI. Further work regarding the flux in organism profile is needed, as it may confer significant antibiotic selection implications.

**Level of Evidence: Moderate**

A. Agree  
B. Disagree  
C. Abstain
G-163 (Former G-3) Are there any concerns regarding the use of joint registries or administrative databases to conduct infection studies?

RESEARCHED BY:

Ola Rolfson
Henrik Malchau
Alexander Rondon
Literature:

• Meta-analysis 0, Prospective/Randomized 1, Retrospective 40

• Reporting on infection varies between national joint registries, with inconsistent definitions of infection and no distinction between superficial and deep infection.

• Patients with infection whom are not subjected to further surgery are not captured.

• Studies linking joint registries with microbiological and drug registries, have found a 40% higher incidence of infection following THA than data from joint registries alone.

• Multiple studies corroborate the conclusion that registry data underestimate the incidence of infection.
**Recommendation:** Yes. Infections are of a multi-factorial character and, currently, national joint registries alone do not provide adequate data for a comprehensive approach to infection research.

**Level of Evidence:** Consensus

- A. Agree: 91%
- B. Disagree: 6%
- C. Abstain: 3%
What methods can the FDA and other regulatory bodies use to evaluate the efficacy of novel anti-infective technologies?

RESEARCHED BY:

Thomas Grupp MD
Literature:

• Metanalysis 0, Prospective/Randomized 8, Retrospective 4

• For longer-term biofilm testing, the ASTM E2562 CDC flow reactor is a lab-scale model suitable for testing coupons from medical devices or entire small devices.

• The use of ex vivo porcine skin explants has shown great promise as a tool to study the development of more mature biofilms with greater resistance to antimicrobials. The next logical step will be to extrapolate this technique with human tissue models.
**Recommendation:** The FDA and other regulatory bodies can use in vitro cell culture methods to evaluate the antimicrobial efficacy against pathogens, followed by animal studies to evaluate osseointegration issues, and a subsequent osteomyelitis/PJI animal model to evaluate the in vivo efficacy. However, clinical trials may be required for clearance or approval of some novel anti-infective technologies.

**Level of Evidence:** Moderate

A. **Agree**

B. **Disagree**

C. **Abstain**
G-165 (Former G-156b) What are some of the emerging pre-clinical methods for evaluating novel antimicrobial technologies?

RESEARCHED BY:

Phillips, K. Scott MD
Literature:

- Metanalysis 0, Prospective/Randomized 8, Retrospective 4

- For longer-term biofilm testing, the ASTM E2562 CDC flow reactor is a lab-scale model suitable for testing coupons from medical devices or entire small devices.

- The use of ex vivo porcine skin explants has shown great promise as a tool to study the development of more mature biofilms with greater resistance to antimicrobials. The next logical step will be to extrapolate this technique with human tissue models.
**Recommendation:** At present, most in vitro testing provides limited insight into the potential of novel antimicrobial technologies. More recently, in vitro models that incorporate animal or human tissue are emerging to test adherence and colonization to devices in contact with human tissues. Further development and validation of these models is needed, as well as approaches to include the element of human immune response.

**Level of Evidence: Limited**

A. Agree (81%)

B. Disagree (2%)

C. Abstain (17%)