



SYSTEMATIC LITERATURE REVIEW ON THE MANAGEMENT OF SURGICAL SITE INFECTIONS

**Adopted by the American Academy of Orthopaedic Surgeons
Board of Directors
June 9, 2018**

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Disclaimer

This Systematic literature review was developed by an AAOS physician volunteer Systematic literature review development group based on a systematic review of the current scientific and clinical information and accepted approaches to treatment and/or diagnosis. This Systematic literature review is not intended to be a fixed protocol, as some patients may require more or less treatment or different means of diagnosis. Clinical patients may not necessarily be the same as those found in a clinical trial. Patient care and treatment should always be based on a clinician's independent medical judgment, given the individual patient's clinical circumstances.

Disclosure Requirement

In accordance with AAOS policy, all individuals whose names appear as authors or contributors to Systematic literature review filed a disclosure statement as part of the submission process. All panel members provided full disclosure of potential conflicts of interest prior to voting on the recommendations contained within this Systematic literature reviews.

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FDA Clearance

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SUMMARY OF RECOMMENDATIONS

MEDICAL IMAGING

Limited evidence supports the use of medical imaging in the diagnostic evaluation of patients with a suspected organ/space (i.e. bone, joint, and implant) surgical site infection.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more “Low” quality studies with consistent findings or evidence from a single “Moderate” quality study recommending for or against the intervention or diagnostic test or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

CULTURES

Strong evidence supports that synovial fluid and tissue cultures are strong rule-in tests for the diagnosis of infection; negative synovial fluid and tissue cultures do not reliably exclude infection.

Strength of Recommendation: Strong ★★★★★

Description: Evidence from two or more “High” strength studies with consistent findings for recommending for or against the intervention.

C-REACTIVE PROTEIN

Strong evidence supports that C-reactive Protein is a strong rule-in and rule-out marker for patients with suspected surgical site infections.

Strength of Recommendation: Strong ★★★★★

Description: Evidence from two or more “High” strength studies with consistent findings for recommending for or against the intervention.

ERYTHROCYTE SEDIMENTATION RATE

Limited strength evidence does not support the use of ESR, alone, to rule in and rule out surgical site infections due to conflicting data.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more “Low” quality studies with consistent findings or evidence from a single “Moderate” quality study recommending for or against the intervention or diagnostic test or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

CLINICAL EXAM FOR THE DIAGNOSIS OF SURGICAL SITE INFECTIONS

Moderate strength evidence supports that clinical exam (i.e. pain, drainage, fever) is a moderate to strong rule-in test (i.e. high probability of presence of infection, if test is positive) for patients with suspected surgical site infections, but a weak rule-out test.

Strength of Recommendation: Moderate ★★★★★

Description: Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.

STRONG EVIDENCE OF FACTORS ASSOCIATED WITH INCREASED RISK OF SSI

Strong evidence supports that the following factors are associated with an increased risk of infection:


- **Anemia**
- **Duration of Hospital Stay**
- **Immunosuppressive Medications**
- **History of Alcohol Abuse**
- **Obesity**
- **Depression**
- **History of Congestive Heart Failure**
- **Dementia**
- **HIV/AIDS**

Strength of Recommendation: Strong 

Description: Evidence from two or more “High” strength studies with consistent findings for recommending for or against the intervention.

MODERATE EVIDENCE OF INCREASED ASSOCIATED RISK OF SSI

Moderate strength evidence supports that patients with chronic kidney disease are at an increased risk of infection after hip and knee arthroplasty.

Strength of Recommendation: Moderate 

Description: Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.

LIMITED EVIDENCE OF INCREASED ASSOCIATED SSI RISK

Limited strength evidence supports that patients meeting one or more of the following criteria are at an increased risk of infection after hip and knee arthroplasty:


- **Diabetes (conflicting evidence)**
- **Tobacco Use/Smoking (conflicting evidence)**
- **Cancer (conflicting evidence)**
- **Hypertension (conflicting evidence)**
- **Liver Disease (conflicting evidence)**
- **Malnutrition (conflicting evidence)**

Strength of Recommendation: Limited 

Description: Evidence from two or more “Low” quality studies with consistent findings or evidence from a single “Moderate” quality study recommending for or against the intervention or diagnostic test or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

ANTIBIOTIC DURATION FOR MANAGEMENT OF SURGICAL SITE INFECTIONS


Moderate evidence supports that, in the setting of retained total joint arthroplasty, antibiotic protocols of 8 weeks do not result in significantly different outcomes when compared to protocols of 3 to 6-month duration.

Strength of Recommendation: Moderate 

Description: Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.

RIFAMPIN USE FOR MANAGEMENT OF SURGICAL SITE INFECTIONS

Moderate evidence supports that rifampin, as a second antimicrobial, increases the probability of treatment success for staphylococcal infections in the setting of retained orthopaedic implants.

Strength of Recommendation: Moderate 

Description: Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.

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The following participants contributed to the development of the preliminary recommendations during the introductory meeting, but did not participate in the final meeting where the evidence was reviewed and the final recommendations were developed:

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INTRODUCTION

OVERVIEW

A systematic review of the English language published studies was conducted to include management of surgical site infections strictly following AAOS guidelines for systematic reviews, the findings from which were the basis of the Clinical Practice Guidelines CPG that are presented here. As with any systematic review, data were included or excluded in light of how they were generated. Observations of occurrences and relationships that appear in cases or case series add to experiential knowledge but cannot be used as a foundation to broad recommendations that extend beyond anecdotal circumstances. Study methodologies are important to generate valid data, including defining and isolating the studied effect, preventing sampling and observer bias and mathematically appropriate analysis. Deficiencies in study design weaken the validity of the data, lowering the level of evidence and weakening the strength of related recommendation. When experimental design leads to data that truly supports a cause and effect relationship, those findings require confirmation from other studies before they can be relied upon as medical knowledge used in patient care decisions. In addition to providing practice recommendations, this systematic review also highlights limitations in the literature and areas that require future research.

GOALS AND RATIONALE

The purpose of this CPG is to provide care providers with an up to date summary and analysis of the credible evidence related to the management of SSI available as of June 2017, so that sound clinical decisions can be based on best evidence to afford their patients the highest possible quality of care and best possible treatment outcomes within individual circumstances. The purpose of the CPG is not to replace clinical judgement or compromise the care needed by individual patients. The data published on management of SSI spans all subspecialties of orthopaedics, other areas of clinical medicine and basic science, however, the majority of the data that was included by the rules used to conduct the systematic review came from the arthroplasty literature, notably hip and knee reconstruction. The findings identify clinical areas where there is good evidence, where evidence is lacking, and where future research is needed. It is emphasized that many data may only be applicable to the specific conditions of the study from which they were generated while other data can contribute to general principles and concepts. It is expected the individual providers will use their expertise, experience and clinical judgement when they apply findings from this systematic review and recommendations from the CPG to decisions in similar but not identical circumstances. The findings and recommendations do not include all acceptable methods of care and do not invalidate methods of care that are not included but are reasonably expected to meet the needs of the patient(s). The treatment of surgical site infections can be extremely challenging. The recommendations and consensus statements that follow were generated by isolating of data on individual factors to determine independent effects. Patient specific factors and local resources are paramount in clinical decision making often requiring consideration of multiple factors and concurrently delivering more than one intervention. The ultimate judgment regarding any specific procedure or treatment must be made in light of all circumstances pertinent to an individual patient .

INTENDED USERS

This SR and CPG is intended to be used by orthopaedic surgeons, infectious disease specialists and other care providers that manage orthopaedic surgical site infections. Typically, these care providers SSI have completed accredited training including additional sub-specialty training, gaining an understanding of the issues and nuances inherent to SSI management. Insurance payers, governmental bodies, and health-policy decision-makers may also find the SR and CPG useful to understand the evolving evidence guiding management of surgical site infections. Adult primary care physicians, geriatricians, hospital based adult medicine specialists, physical therapists, occupational therapists, nurse practitioners, physician assistants, emergency physicians, and other healthcare professionals who provide respective care for related and

concurrent conditions in patients with SSIs in various practice settings may also benefit from the information in the CPG.

Management of surgical site infection is based on the assumption that decisions are predicated on physician discussion with the patient and/or the patient's qualified health care advocate about available treatments and procedures applicable to each individual patient. Once the patient and/or their advocate are informed of available therapies and have discussed these options with his/her physician, an informed decision can be made. Clinician input based on experience with conservative management and medical and surgical interventions increases the probability of identifying the most beneficial treatment options for each individual patient.

PATIENT POPULATION

This document addresses the management of surgical site infections occurring in patients who have undergone orthopaedic surgery.

INCIDENCE AND PREVALENCE

Surgical site infections occur following a small percentage of surgical procedures. Approximately 1% of patients undergoing orthopaedic procedures develop an infection at the surgical site.¹⁹⁴ For this systematic review, the Centers for Disease Control and Prevention (CDC) definitions of superficial, deep and organ space surgical site infection were used.¹⁹⁴ In 2011, the CDC estimated that there were 157,500 surgical site infections from all inpatient surgeries performed in the United States.¹⁹⁴

ETIOLOGY

Surgical site infections are the result of disease-causing bacteria or fungi which enter the body through a surgical wound.^{M4} Since the definition of "surgical site infection" can be interpreted differently, we used the standard definition from the Centers for Disease Control described in the previous paragraph. The CDC describes a surgical site infection as "... an infection that occurs after surgery in the part of the body where the surgery took place. Surgical site infections can sometimes be superficial infections involving the skin only. Other surgical site infections are more serious and can involve tissues under the skin, organs, or implanted material." During the time when the reviewed studies were being performed the definition of a SSI change from infections occurring during the 12 months following the procedure to infections that occurred within 3 months of the procedure. This does not represent a change in fundamental condition that was studied or lead to a change in the conclusions drawn from the data; more that the small proportion of cases that occur after the first 3 months does not meaningfully change the analysis but is associated with onerous logistics and an unjustified expense. The findings were not stratified reports that include or do not include cases from 3 -12 months post op.

RISK FACTORS

Possible risk factors for surgical site infections are complex. During the design phase it was recognized that risk factors effecting occurrence and severity of SSI have implications for management. To that end risk factors were included in the systematic review and development of the CPGs, but, this work is not a comprehensive review or analysis of factors that occur preoperatively, or are unrelated to management, including risks factors. Please refer to the recommendations on [prognostic indicators for risk of surgical site infections](#) for further information.

POTENTIAL BENEFITS, HARMS, AND CONTRAINDICATIONS

Most treatments are associated with some known risks, especially invasive and operative treatments. Contraindications vary widely based on the treatment and the patient. A particular concern when managing surgical site infections is the potential for the underlying orthopaedic treatment to be compromised resulting in increased morbidity or decreased function compared to initial expectations. Additional factors may affect the physician's choice of treatment, including co-morbidities such as low

bone mass or arthropathy in other joints. Provider judgement based on clinical experience increases the probability of identifying the treatment options for each individual patient that have the most favorable risk/benefit expectation.

FUTURE RESEARCH

Consideration for future research is provided for each recommendation within this document are based on the work groups clinical experience and perceived need for better guiding data.

METHODS

The methods used to perform this systematic review were employed to minimize bias and enhance transparency in the selection, appraisal, and analysis of the available evidence. These processes are vital to the development of reliable, transparent, and accurate clinical recommendations for management of surgical site infections. To view the full AAOS clinical practice guideline methodology please visit the SSI SR eAppendix or www.aaos.org/cpg.

This systematic literature review evaluates the effectiveness of treatments for management of surgical site infections. The AAOS approach incorporates practicing physicians (clinical experts) and methodologists who are free of potential conflicts of interest relevant to the topic under study, as recommended by systematic literature review development experts.¹

This systematic literature review was prepared by the AAOS Management of Surgical Site Infections systematic literature review physician development group (clinical experts) with the assistance of the AAOS Quality and Value (QV) Unit in the Department of Research, Quality and Scientific Affairs (methodologists). To develop this systematic literature review, the systematic literature review development group held an introductory meeting on September 25, 2015 to establish the scope of the systematic literature review. As the physician experts, the systematic literature review development group defined the scope of the systematic literature review by creating PICO Questions (i.e. population, intervention, comparison, and outcome) that directed the literature search. The AAOS Medical Librarian created and executed the search (see [SSI SR eAppendix 1](#) for search strategy).

DEFINITION OF “SURGICAL SITE INFECTION”

The Centers for Disease Control’s (CDC) most current criteria for defining surgical site infection was used for this review (i.e. “date of event for infection occurs within 30 days after any NHSN operative procedure, where day 1=the procedure date”); however, this definition was updated from previous CDC criteria defining surgical site infections as occurring within one year. Because many of the studies evaluated within this review we published using the previous (one year) definition of surgical site infections, it should be noted that the findings used to create recommendations within this document incorporate both the current and past CDC criteria for defining surgical site infections.

BEST EVIDENCE SYNTHESIS

We included only the best available evidence for any given outcome addressing a recommendation. Accordingly, we first included the highest quality evidence for any given outcome if it was available. In the absence of two or more occurrences of an outcome at this quality, we considered outcomes of the next lowest quality until at least two or more occurrences of an outcome had been acquired. For example, if there were two ‘moderate’ quality occurrences of an outcome that addressed a recommendation, we did not include ‘low’ quality occurrences of this outcome. A summary of excluded articles can be viewed in the [SSI SR eAppendix 1](#). All of the detailed data for each recommendation can be found via the [SSI SR eAppendix 2](#).

LITERATURE SEARCHES

The medical librarian conducted a comprehensive search of PubMed, Embase, and the Cochrane Central Register of Controlled Trials based on key terms and concepts from the systematic literature review development group’s preliminary recommendations. Bibliographies of relevant systematic reviews were hand searched for additional references. All databases were last searched on March 13, 2017 with limits for publication dates from 1966-2017 and English language.

DEFINING THE STRENGTH OF THE RECOMMENDATIONS

Judging the strength of evidence is only a stepping stone towards arriving at the strength of a systematic literature review recommendation. The strength of recommendation (Table 1) also takes into account the quality, quantity, and the trade-off between the benefits and harms of a treatment, the magnitude of a treatment’s effect, and whether there is data on critical outcomes. Table 2 addresses how to interpret the strength of each recommendation.

VOTING ON THE RECOMMENDATIONS

The recommendations and their strength were voted on by the guideline development group members during the final meeting. If disagreement between the guideline development group occurred, there was further discussion to see whether the disagreement(s) could be resolved. Recommendations were approved and adopted in instances where a simple majority (60%) of the guideline development group voted to approve; however, the guideline development group had consensus (100% approval) when voting on every recommendation for this guideline.

INTERPRETING THE STRENGTH OF EVIDENCE

Table I. Strength of Recommendation Descriptions





Strength	Overall Strength of Evidence	Description of Evidence Quality	Strength Visual
Strong	Strong	Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.	
Moderate	Moderate	Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.	
Limited	Low or Conflicting Evidence	Evidence from two or more “Low” quality studies with consistent findings or evidence from a single “Moderate” quality study recommending for against the intervention or diagnostic or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.	
Consensus*	No Evidence	There is no supporting evidence. In the absence of reliable evidence, the systematic literature review development group is making a recommendation based on their clinical opinion. Consensus statements are published in a separate, complimentary document.	

Table II. Clinical Applicability: Interpreting the Strength of a Recommendation

Strength of Recommendation	Patient Counseling (Time)	Decision Aids	Impact of Future Research
Strong	Least	Least Important, unless the evidence supports no difference between two alternative interventions	Not likely to change
Moderate	Less	Less Important	Less likely to change
Limited	More	Important	Change possible/anticipated
Consensus	Most	Most Important	Impact unknown

PEER REVIEW

Following the final meeting, the systematic literature review draft undergoes a two week peer review for additional input from external content experts. Written comments are provided on the structured review form (SSI SR Peer Review and Public Comment eReport). All peer reviewers are required to disclose their conflicts of interest.

PUBLIC COMMENTARY

After modifying the draft in response to peer review, the systematic literature review was subjected to a two week period of “Public Commentary.” Commentators consist of members of the AAOS Board of Directors (BOD), members of the Council on Research and Quality (CORQ), members of the Board of Councilors (BOC), and members of the Board of Specialty Societies (BOS). The systematic literature review is automatically forwarded to the AAOS BOD and CORQ so that they may review it and provide comment prior to being asked to approve the document. Members of the BOC and BOS are solicited for interest. If they request to see the document, it is forwarded to them for comment. Based on these bodies, over 200 commentators have the opportunity to provide input into this systematic literature review. To view comments, visit the SSI SR Peer Review and Public Comment View background material via the SSI SR Peer review/Public Comment eReport.

THE AAOS SYSTEMATIC LITERATURE REVIEW APPROVAL PROCESS

This final systematic literature review draft must be approved by the AAOS Committee on Evidence Based Quality and Value Committee, the AAOS Council on Research and Quality, and the AAOS Board of Directors. These decision-making bodies are described in the SSI SR eAppendix. Their charge is to approve or reject its publication by majority vote.

REVISION PLANS

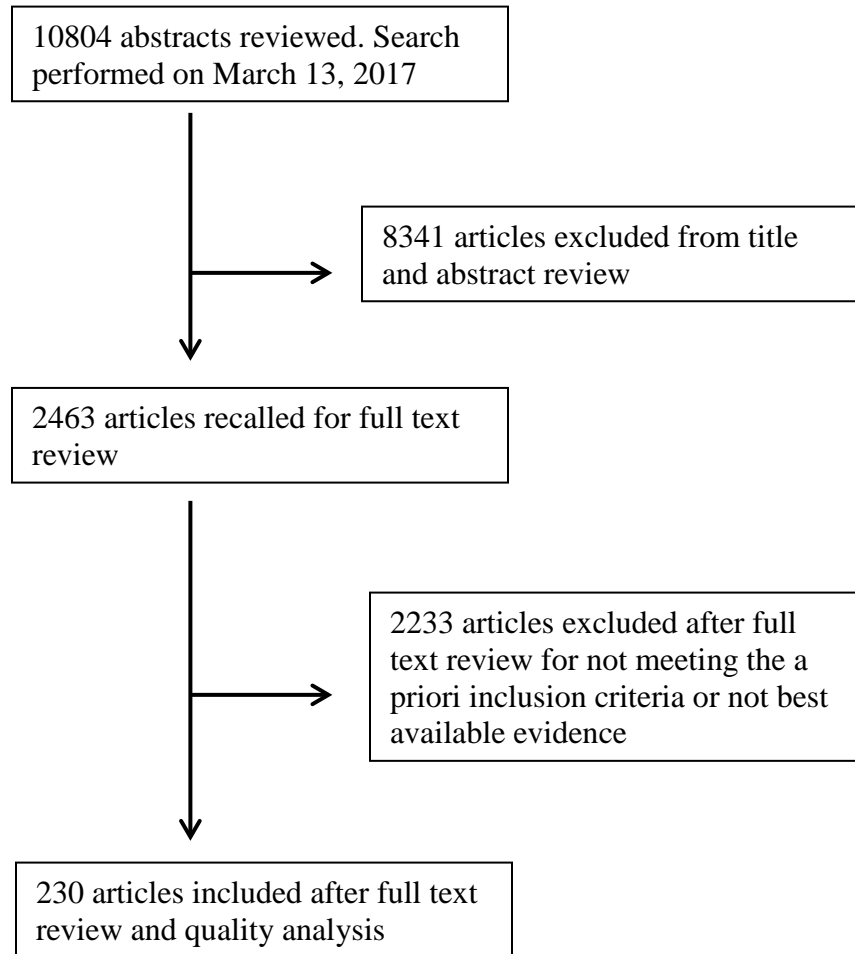
This systematic literature review represents a cross-sectional view of current treatment and may become outdated as new evidence becomes available. This systematic literature review will be revised in accordance with new evidence, changing practice, rapidly emerging treatment options, and new technology. This systematic literature review will be updated or withdrawn in five years in accordance with the standards of the National Guidelines Clearinghouse.

SYSTEMATIC LITERATURE REVIEW DISSEMINATION PLANS

The primary purpose of the present document is to provide interested readers with full documentation of the best available evidence for various procedures associated with the topic of this review. Publication of most systematic literature reviews is announced by an Academy press release, articles authored by the systematic literature review development group and published in the Journal of the American Academy of Orthopaedic Surgeons, and articles published in AAOS *Now*. Most systematic literature reviews are also distributed at the AAOS Annual Meeting in various venues such as on Academy Row and at Committee Scientific Exhibits.

Selected systematic literature reviews are disseminated by webinar, an Online Module for the Orthopaedic Knowledge Online website, Radio Media Tours, Media Briefings, and by distributing them at relevant Continuing Medical Education (CME) courses and at the AAOS Resource Center.

STUDY ATTRITION FLOWCHART



RECOMMENDATIONS

MEDICAL IMAGING

Limited evidence supports the use of medical imaging in the diagnostic evaluation of patients with a suspected organ/space (i.e. bone, joint, and implant) surgical site infection.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more “Low” quality studies with consistent findings or evidence from a single “Moderate” quality study recommending for or against the intervention or diagnostic test or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

Radiography

There was one moderate quality study (Bernard 2004) evaluating the use of radiography for patients with suspected hip and knee prosthesis infection. This study showed poor agreement of radiography with the confirmed infections as both a “rule in” test and a “rule out” test. However Radiography is widely available and inexpensive relative to other imaging modalities, and the consensus of the workgroup is that radiographs be considered as the initial imaging exam for suspected cases of bone and/or implant infection interpreted in combination by a provider with skill and experience in interpretation of musculoskeletal radiographs to assess any and all radiographic features of infection, or other causes of the patient’s symptoms, without commenting on or recommending any single finding or combination of findings.

Radiolabeled Leukocyte Imaging

There were five high quality (Scher 2000, Simonsen 2007, Rand 1990, Pelosi 2004, Joseph 2001) and 10 moderate quality (Pons 1999, Glithero 1993, Kim 2014, Love 2004, Segura 2004, Chik 1996, El Espera 2004, Bernard 2004, Fuster 2011, Wolf 2003) studies evaluating the use of radiolabeled leukocyte imaging (with Indium-111 or Tc-99m hexamethylpropyleneamine oxine) for patients with suspected surgical site infections, predominantly patients with suspected hip and knee prosthesis infection. The duration of time between the initial surgery and the performance of the scan was either unclear or greater than 1 year, on average, for most of these studies. These studies showed inconsistent agreement of radiolabeled leukocyte imaging with the confirmed infections as “rule in” and “rule out” tests. For example, two high quality studies (Scher 2000, Simonsen 2007) showed moderate-strong agreement of radiolabeled leukocyte imaging with the reference standard as a “rule in” test, and weak-moderate agreement as a “rule out” test, for patients with suspected infected hip prostheses. By contrast, two high quality studies (Rand 1990, Scher 2000) showed only weak-moderate agreement of radiolabeled leukocyte imaging with the confirmed infections as a “rule in” test for patients with suspected infected knee prostheses. Stronger agreement with the reference test might be possible in combination with single photon emission computed tomography (Kim 2014) or Tc-99m sulfur colloid bone marrow scintigraphy (Love 2004). The consensus of the workgroup is that radiolabeled leukocyte imaging can be useful as a diagnostic tool (i.e., among other tests) as a “rule in” or “rule out” test for prosthetic joint infection, but its routine use for diagnosis of such infection is not justified, as there may be difficulties diagnosing insidious infections or differentiating infection from aseptic loosening. When radiolabeled leukocyte imaging is performed, the addition of bone marrow scintigraphy can help increase specificity.

Tc-99m-Diphosphonate Skeletal Scintigraphy (“Bone Scan”)

There were three moderate quality studies (Nagoya 2008, Battaglia 2011 and Segura 2004) evaluating the use of skeletal scintigraphy for patients with suspected hip and knee prosthesis infection occurring, on

average, greater than one year following surgery. Although one study (Segura 2004) showed strong agreement of two-phase (blood pool and delayed imaging) skeletal scintigraphy with the confirmed infections as a “rule out” test, other studies showed moderate (Nagoya 2008, 3-phase scintigraphy) or weak (Battaglia 2011, unknown number of phases) agreement. Two of the studies (Battaglia 2011, Segura 2004) showed poor agreement of skeletal scintigraphy with the confirmed infections as a “rule in” test, while Nagoya 2008 showed moderate agreement of (3-phase scintigraphy) as a “rule in” test. Skeletal scintigraphy can be useful as a diagnostic tool (i.e., among other tests) as a “rule out” test for delayed (>1 year) prosthetic joint infection if radiolabeled leukocyte imaging is not available, but its role in the diagnosis of such infection is limited.

Positron Emission Tomography (PET) Imaging

There were four high quality (Chacko 2002, Chryssikos 2008, Aksoy 2014, DeWinter 2003) and 3 moderate quality (Kobayashi 2011, Love 2004, Wenter 2015, 2017) studies evaluating the use of F-18 fluorodeoxyglucose (FDG) PET imaging for patients with suspected surgical site infections, with most patients having suspected infection of orthopaedic implants including joint prostheses. The duration of time between the initial surgery and the performance of the scan was either unclear or greater than one year, on average, for most of these studies. These studies showed inconsistent agreement of PET imaging with the confirmed infections as a “rule in” test. For example, two high quality studies (Chacko 2002, Chryssikos 2008) showed strong agreement of FDG-PET imaging with the confirmed infections as a “rule in” test for prosthetic hip joint infection when uptake at the prosthesis-bone interface was used as the criterion for infection. However, another high-quality study (Aksoy 2014) showed that 39/39 hip and knee prostheses with aseptic loosening also showed increased FDG uptake, resulting in poor agreement with the confirmed infections as a “rule in” test for infection. A couple of high quality studies (Chacko 2002, DeWinter 2003) suggest that FDG-PET imaging may be useful as a “rule out” test, showing strong agreement with the confirmed infections; however, other studies show inconsistent results. Better agreement with the reference test might be possible in combination with computed tomography (Wenter 2015). The presence of metallic implants may also affect the diagnostic ability of FDG PET; one high quality study (DeWinter 2003) evaluating the use of FDG PET imaging for patients with suspected surgical site infections of the spine showed weak agreement of PET with the confirmed infections as a “rule in” test when metallic implants were present, but strong agreement as a “rule in” test when implants were not present. Although FDG-PET can be useful as a diagnostic tool (i.e., among other tests) as a “rule in” or “rule out” test for infection, its availability, expense, and current issues with reimbursement are limiting factors, and its routine use is not justified in this setting.

Cross-Sectional Imaging (Magnetic Resonance Imaging, Computed Tomography, Ultrasonography)

There is a lack of data regarding the use of cross-sectional imaging for the diagnosis of orthopaedic surgical site infection. Two moderate quality studies (Li 2016, Płodkowski 2013) evaluating the use of magnetic resonance imaging (MRI) for patients with suspected knee prosthesis infection showed moderate-strong agreement of MRI with the confirmed infections as a “rule in” test, but poor-moderate agreement as a “rule out” test. However, artifacts caused by metallic implants can be significant and limit detection of adjacent bone and soft tissue infection on MRI as well as on computed tomography (CT). Cross-sectional imaging can potentially be useful as a diagnostic tool in certain patients with suspected surgical site infection (e.g., to identify soft-tissue fluid collections) or to guide aspiration/biopsy procedures in such patients, but the potential value of a given imaging exam should be considered on a case-by-case basis.

Possible Harms of Implementation

There are no known harms of implementation of this recommendation beyond those risks associated with the individual imaging procedures, e.g., potential adverse effects of ionizing radiation, intravenous injection of contrast materials and radiopharmaceuticals, metallic implants (MRI), etc.

Future Research

Most of the literature exploring the imaging of suspected postoperative infections pertains to patients with prosthetic joints, with cohorts of patients whose imaging examinations occurred months to years following surgery. Furthermore, there is a lack of data regarding the sensitivity and specificity of imaging tests for the diagnosis of infections during the first 90 days following surgery as well as surgical site infections not associated with implants. Future research exploring the diagnostic value of imaging for surgical site infections in patients with or without orthopaedic implants in the early (<90 days) postoperative period is necessary. This could include comparative studies between various imaging modalities which may further clarify the utility of each modality for the diagnosis of suspected surgical site infection

CULTURES

Strong evidence supports that synovial fluid and tissue cultures are strong rule-in tests for the diagnosis of infection; negative synovial fluid and tissue cultures do not reliably exclude infection.

Strength of Recommendation: Strong ★★★★★

Description: Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.

RATIONALE

Ten high quality studies were identified that addressed the role of culture in the diagnosis of surgical site infection; notably only two of the studies (Holinka, Puig-Verdie) included patients with infections involving orthopaedic sites other than hip or knee arthroplasties.

SYNOVIAL FLUID CULTURES

Three high quality studies (Gallo, Tomas, Spangehl) evaluated the yield of synovial fluid cultures in the diagnosis of prosthetic joint infection. Two of the studies found strong evidence to support fluid culture in the diagnosis of PJI (Tomas, Spangehl) while one found moderate evidence in support (Gallo).

INTRAOPERATIVE TISSUE CULTURES

Seven high quality studies evaluated the yield of intra-operative tissue cultures in the diagnosis of surgical site infection (Aggarwal, Holinka, Hughes, Panousis, Puig-Verdie, Spangehl, Trampuz). Of these, six of the seven studies revealed strong evidence in support of tissue culture to rule in the diagnosis of infection; one found the evidence to be moderate (Holinka). Additionally, the method by which the organism was grown was relevant. In these seven studies, there was variability in the performance of tissue culture in excluding infection. One high quality study evaluated the value of positive culture only from enrichment broth (Smith). Broth-only positive cultures showed poor correlation as a rule-in or rule-out test for infection. Two high-quality studies evaluated the performance of tissue cultures compared with swab cultures (Aggarwal, Spangehl). Both demonstrated better accuracy of tissue cultures over swab cultures.

NUMBER OF INTRAOPERATIVE CULTURES

Multiple tissue cultures should be collected to improve the accuracy of infection diagnosis. One moderate quality study (Atkins) quantified the number of samples needed to confirm the diagnosis of infection. A single positive culture for an organism of limited virulence was shown to have poor predictive value as a rule-in test. Two distinct positive cultures for the same organism provided strong evidence of periprosthetic infection.

DURATION OF CULTURE INCUBATION

One high quality (Schafer) and one moderate quality (Butler-Wu) study reviewed the duration of culture incubation for chronic periprosthetic infection. Both studies demonstrated improved yield when both aerobic and anaerobic cultures were incubated for 14 days.

PRIOR ANTIBIOTIC EXPOSURE

One high quality study evaluated the effect of prior antibiotic therapy on the yield of sonicate and tissue culture. The yield of culture was reduced when antibiotic therapy was administered within 14 days of culture collection.

POSSIBLE HARMS OF IMPLEMENTATION:

In the setting of low suspicion for infection, there is greater likelihood that a single positive culture will represent a false-positive and may further confound management decisions. Further, in the setting of low clinical suspicion for infection, synovial fluid aspiration may unnecessarily expose the patient to risk. External swabbing of wound drainage may lead to false positive cultures that may lead to unnecessary treatment.

FUTURE RESEARCH

The majority of studies on the role of culture in the diagnosis of surgical site infection stemmed from studies in periprosthetic infection. Development of optimal culture protocols for surgical site infections other than periprosthetic joint infections are needed. Future research directions may also include advanced non-culture based diagnostic modalities including PCR and next generation sequencing.

C-REACTIVE PROTEIN

Strong evidence supports that C-reactive Protein is a strong rule-in and rule-out marker for patients with suspected surgical site infections.

Strength of Recommendation: Strong ★★★★★

Description: Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.

Multiple high-quality studies and meta-analysis of the study data support the use of C-reactive protein in the diagnosis of surgical site infection (Bottner et al 2007, Glehr et al 2013, Cipriano et al 2012, Jacovides et al 2011). Several moderate quality studies (Yi et al 2015, Piper et al 2009, 2010, Bedair et al 2011) also support its use. It was found to be both sensitive and specific in detecting periprosthetic infection and served as an accurate screening tool, with a positive or negative value demonstrating the likelihood of the presence or absence of infection. Studies vary with respect to the timing and thresholds used to diagnose infection. Both Yi et al 2015 and Bedair et al 2011 confirmed its utility during the early postoperative period. Despite this variation, it has proven its accuracy across investigations. While cutoff values at which an infection is diagnosed vary between studies, and based on time postoperatively it has been shown to be a superior screening test relative to other serological studies.

Possible Harms of Implementation

There is no risk with implementation of this test. However, elevated CRP can be misleading in cases of chronic inflammatory conditions, neoplasms, metabolic syndrome that can cause its elevation and therefore should be monitored over the entire course of treatment.

Future Research

Much of the work on inflammatory markers has been focused upon total joint arthroplasty. Future research should focus on identifying more accurate inflammatory markers, and distinguishing a standardized set of criteria and thresholds to aid in the diagnosis of surgical site infection not only as it pertains to PJI but in other cases of SSI.

ERYTHROCYTE SEDIMENTATION RATE

Limited strength evidence does not support the use of ESR, alone, to rule in and rule out surgical site infections due to conflicting data.

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more “Low” quality studies with consistent findings or evidence from a single “Moderate” quality study recommending for or against the intervention or diagnostic test or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

Multiple high-quality studies (Bottner et al 2007, Cipriano et al 2012, Panousis et al 2005) have demonstrated moderate to weak ability of ESR as a solitary test to diagnose or exclude surgical site infection. It is felt to be too variable with respect to time from surgery and in the presence of other confounding factors (such as inflammatory arthropathy) to be considered an accurate tool in diagnosis alone but may be considered as a tool to be used in conjunction with other tests.

Possible Harms of Implementation

There is no risk with implementation of this test/recommendation, however ESR should rarely be considered in isolation. ESR should be used in combination with other tests to mitigate the risk of incorrect diagnoses.

Future Research

ESR is of limited utility in the diagnosis of SSI as an isolated test. Future investigations will likely examine the use of ESR in combination with other diagnostic markers.

CLINICAL EXAM FOR THE DIAGNOSIS OF SURGICAL SITE INFECTIONS

Moderate strength evidence supports that clinical exam (i.e. pain, drainage, fever) is a moderate to strong rule-in test (i.e. high probability of presence of infection, if test is positive) for patients with suspected surgical site infections, but a weak rule-out test.

Strength of Recommendation: Moderate 

Description: Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.

Patients with suspected surgical site infections should be assessed by a history and physical examination. Specific data were available for a structured history, presence of fever, and persistent wound drainage. One study of moderate evidence by Pons 1999 used a structured interview to evaluate 80 patients undergoing revision total hip arthroplasty of whom 16 patients had proven infection by histology and microbiology culture. A positive clinical examination was the presence of one of the following: current painful joint, history of chronic joint pain; or a history of wound drainage or fever lasting greater than 48 hours in the first month after primary surgery. A positive history had a sensitivity of 0.625 and specificity of 0.98.

One moderate strength study by Bernard 2004 evaluated the presence of fever and persistent drainage against the confirmed infections of positive culture in 230 patients undergoing revision joint surgery. Fever had a sensitivity of 0.53 and specificity of 0.90, and persistent drainage had a sensitivity of 0.53 and specificity of 0.90.

Possible Harms of Implementation

There are no known harms associated with implementing this recommendation. It should be noted that the absence of pain after treatment does not assure the absence of infection.

Future Research

Clinical factors that can be determined from history and physical exam that identify patients at risk for surgical site need further investigation. The possible linkage of persistent fevers and the wound drainage to surgical site infections are needed. Characterization and development of protocols to manage early poorly healing or inflamed wounds are needed.

STRONG EVIDENCE OF FACTORS ASSOCIATED WITH INCREASED RISK OF SSI

Strong evidence supports that the following factors are associated with an increased risk of infection:

- **Anemia**
- **Duration of Hospital Stay**
- **Immunosuppressive Medications**
- **History of Alcohol Abuse**
- **Obesity**
- **Depression**
- **History of Congestive Heart Failure**
- **Dementia**
- **HIV/AIDS**

Strength of Recommendation: Strong ★★★★★

Description: Evidence from two or more “High” quality studies with consistent findings for recommending for or against the intervention.

Anemia

There were eight high quality studies on the association of Anemia with the risk of SSI. Of these, five revealed an association between anemia and SSI. Four studies reviewed the risk of PJI and the 5th study reviewed the risk of infection and cervical spine fusion. Determinations were based on regression analyses of large data bases. Greenky et al 2012 identified the significant risk of anemia in PJI of development of SSI.

Possible Harms of Implementation

There are no known harms associated with implementing this recommendation

Future Research

Continue studies comparing preoperative anemia with orthopaedic procedures is warranted to identify both the level of anemia that leads to an increased SSI risk and how different types of anemia can influence SSI risk.

Duration of Hospital Stay

There were 11 high quality studies that examined the association between the length of hospital stay and the risk of SSI. Of these, seven revealed an association between increased length of stay and the risk of SSI. The studies were a range of multi-variant analysis and regression analysis. Three studies revealed that prolonged preoperative inpatient stays were related to increased risk of infection. Four studies revealed that prolonged post op hospitalization correlated with an increased risk of SSI. Longer hospital stays, including both pre-op and post-op stays correlated with increasing risk of SSI development.

Possible Harms of Implementation

Premature discharge of patients without identifying unstable medical conditions is a risk of shortened hospital stay.

Future Research

Attempts at identifying the optimal length of stay should be continued. Identify optimal discharge pathways for each individual patient. The correlation with early discharge and rates of readmission needs to be assessed. Understand the relative contribution of comorbidity-severity related to the duration of hospital stay.

Immunosuppressive Medication

Ten high quality studies were reviewed that looked at the effects of immunosuppressive agents. Of these, seven revealed a strong correlation between the use of immunosuppressive medications and an increased risk of SSI. These studies reviewed the effects of these medications on the risk of SSI associated with total joint replacement, spine surgery and ACL reconstruction. Momohara 2011 identified specifically that infliximab and etanercept combined with prolonged disease duration were associated with increased SSI risk. Giles 2006 identified increased risks of SSI associated with taking Tumor Necrosis Factor medications

Possible Harms of Implementation

There are no known harms associated with implementing this recommendation. Stopping the administration of immunosuppressive drugs however may increase the risk of developing a flare up of the underlying inflammatory disease. [The American College of Rheumatology systematic literature review](#) on perioperative management of antirheumatic medications provides further guidance on how to effectively administer immunosuppressive medications to patients undergoing surgery.

Future Research

The list of immunosuppressive drugs is expanding rapidly and the research on the effects of these newer drugs is needed. Also, additional information about dosing, discontinuing medication before surgery and additional orthopaedic procedures that might be impacted are also needed. Future trials should examine optimal time for discontinuing immunosuppressive medications prior to surgery.

Alcohol abuse

Five high quality articles were reviewed. Three revealed a strong correlation between alcohol abuse and the risk of SSI. The articles used multi-variant analysis and looked a range of orthopaedic procedures and the effect of alcohol abuse on the risk of SSI on these procedures. Large multivariate studies from Cavanaugh 2015, Grammatico 2015 and Jain 2015, surveying thousands of patients, consistently show increased risks associated with increased alcohol consumption.

Possible Harms of Implementation

Alcohol withdrawal is a risk.

Future Research

Further research is needed on assessment tools to assess the relation of alcohol consumption and surgical risk.

Obesity

Fourteen high quality studies showed a correlation between obesity and the risk of SSI. These studies used multivariate analysis showing that increasing BMI correlated strongly with the risk of post op infection. All of the studies showed significantly increased risk of SSI that correlate well with increased BMI. Several studies identified additional risks associated with increased BMI over 40. These risks include cardiac, pulmonary and systemic complications in addition to the increased SSI risks.

Possible Harms of Implementation

There are no known harms associated with implementing this recommendation. Although there is an association between obesity and increased risk of postop SSIs, the risk of denying care to this patient population could have significant implications to the socioeconomic burden and quality of life of this population.

Future Research

Future research is needed to assess the role of nutrition in the modification of obesity and the effects of high BMI and BMI-associated comorbidities on the risk surgical site infections.

Depression

Four high quality studies confirmed a correlation between depression and the risk of SSI. All four studies used regression analysis. In each of the multivariate studies a correlation between clinically detected depression and increased risks of surgical site infection was identified.

Possible Harms of Implementation

The risks are unknown.

Future Research

Needed to see if treatment of depression alters the association between severity of depression and the risk of wound infections. The precise pathophysiology of this correlation is unknown.

Congestive Heart Failure

Two high quality studies revealed a strong correlation between the risk of CHF and SSI. These studies were all multi-variant regression analysis studies. Patients with CHF also have a higher risk of other vascular problems.

Possible Harms of Implementation

There are no known risks to optimizing congestive heart failure prior to surgical intervention.

Future Research

The correlation between adequate control of CHF and the severity of CHF, and the risk of SSI need to be further investigated.

Dementia

Two large high quality studies using regression analysis revealed a strong correlation between Dementia and the risk of SSI in geriatric fractures patients. Dementia is an independent risk factor for occurrence of a surgical site infection

Possible Harms of Implementation

There are no known harms associated with implementing this recommendation

Future Research

Future research should focus on preoperative assessment of patients with dementia.

HIV/AIDS

Four high quality studies revealed a high correlation between the diagnosis of HIV/AIDs and the risks of SSI. There was a strong correlation between the diagnosis of HIV/AIDs and the risk of infection. Boylan revealed an increased risk of SSI of 17%.

Possible Harms of Implementation

Patients with HIV infection should receive antiretroviral therapy, and have control of opportunistic infections, and immune reconstitution, when possible, prior to any orthopaedic surgery. There are no known harms with implementing this recommendation.

Future Research

Ongoing research in HIV/AIDS infection is needed to optimize surgical care of this patient population.

MODERATE EVIDENCE OF INCREASED ASSOCIATED RISK OF SSI

Moderate strength evidence supports that patients meeting one or more of the following criteria are at an increased risk of infection after hip and knee arthroplasty:

- **Chronic Kidney Disease**
- **Diabetes (conflicting evidence)**
- **Tobacco Use/Smoking (conflicting evidence)**
- **Malnutrition (conflicting evidence)**

Strength of Recommendation: Moderate 

Description: Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.

Chronic Kidney Disease

The risk of SSI in patients with chronic kidney disease (CKD) correlates positively with the severity of renal disease. Five high quality studies revealed using multivariate analysis and to identify the increased risk of SSI in patients with CKD. The severity of CKD and the description of dialysis and transplant patients were not identifiable within the studies.

Possible Harms of Implementation

There are no known harms associated with implementing this recommendation.

Future Research

Future research should evaluate and correlate the severity of renal disease with precise risk of SSI. Additionally, it should use common terminology for renal disease and stratify by dialysis, transplant, and severity of disease.

Diabetes

26 high quality studies were reviewed. 13 of the studies showed a correlation between diabetes and the risk of SSI. 13 studies showed no correlation between diabetes and the risk of SSI. The strength of the recommendation was classified as “moderate” due to the divergence between the study findings. The impact of quality diabetic control could not be determined on the outcomes of the studies.

Possible Harms of Implementation

Risks include potential over or under-control of blood sugar levels, both preoperatively and postoperatively. See [Endocrine society’s guideline](#) on control of diabetes in patients preoperatively and postoperatively.

Future Research

Further studies are needed to identify the relationship between the control of diabetes, Hgb A1C, and the risk of post-operative infection.

Tobacco Use

22 high quality studies were reviewed. 9 studies showed an association between tobacco use and increased risk of SSI. 12 studies showed no statistically significant differences between smokers and nonsmokers regarding associated risk of SSI. Many of the studies do not define the amount of tobacco

used, description of current versus former smokers, or the length of time for use of tobacco. While tobacco use is widely accepted as a risk factor for increasing the risk of SSI, of 22 HQ studies, 9 confirmed the correlation and 12 failed to confirm the correlation, and one showed a negative association with smoking and risk of SSI. This may be due to the definition of magnitude, effect size, heterogeneity of populations between studies.

Possible Harms of Implementation

There are no known harms associated with recommending the cessation of smoking to decrease the risk of SSI. If smoking cessation is not counseled based on limited evidence, that could lead to additional harms to the patient.

Future Research

Research is needed to define the exact correlation between the extent and length of time of tobacco use and the risk of SSI. Determine role of smoking cessation and reducing the risk of SSI. Further study is needed to delineate the duration of smoking cessation and its impact on the occurrence of SSI.

Malnutrition

Malnutrition is a known risk factor for patients undergoing surgical procedures. Patients with malnutrition can suffer from a range of poor outcomes including increased risk of death, sepsis and poor wound healing. Six high quality articles were reviewed. Of these, three articles identified a correlation with increased risk of SSI. Bohl et al 2016 identified significantly increased risks of SSI associated with hypoalbuminemia. Grammatico et al 2015 also showed higher risks of SSI due to malnutrition.

Possible Harms of Implementation

There are no known harms associated with implementing this recommendation.

Future Research

Further research is needed to correlate the severity of malnutrition with the concomitant risk of SSI. Also, research into correcting malnutrition and how long after correction will the risk of SSI be reduced. Better definitions of malnutrition should be established via future research.

LIMITED EVIDENCE OF INCREASED ASSOCIATED SSI RISK

Limited strength evidence supports that patients meeting one or more of the following criteria are at an increased risk of infection after hip and knee arthroplasty:

- **Cancer**
- **Hypertension (conflicting evidence)**
- **Liver Disease (conflicting evidence)**

Strength of Recommendation: Limited ★★☆☆

Description: Evidence from two or more “Low” quality studies with consistent findings or evidence from a single “Moderate” quality study recommending for or against the intervention or diagnostic test or the evidence is insufficient or conflicting and does not allow a recommendation for or against the intervention.

Cancer

Two high quality studies showed a correlation between cancer and the risk of SSI. Many of the studies did not specify the type of cancer or the staging of the cancer, which is why this recommendation was downgraded to “limited”. Cancer encompasses a wide variety of disorders, tissues and severity.

Possible Harms of Implementation

There are no known harms associated with implementing this recommendation. Failing to coordinate treatment with oncologic care may increase the risk of complications.

Future Research

Specific analysis between the types, severity and metastasis of cancer needs to be performed to identify the exact correlation between the type of cancer and risk of post op infection.

Hypertension

Seven high quality studies were reviewed. Four of the studies showed no correlation between hypertension and risk of surgical site infection. The magnitude of the effect of hypertension on the risk of SSI could not be determined from the included studies.

Possible Harms of Implementation

There are no known harms associated with implementing this recommendation.

Future Research

Further research is needed to further delineate the correlation between SSI and hypertension and the preoperative optimization of hypertension and its effect on SSI need to be established.

Liver Disease

Five studies reviewed the correlation between unspecified liver disease, cirrhosis and SSI. Three of the studies showed a correlation between liver disease and SSI in larger multivariant studies.

Possible Harms of Implementation

There are no known harms associated with implementing this recommendation

Future Research

Further research is needed to further delineate the correlation between SSI and liver disease and cirrhosis.

ANTIBIOTIC DURATION FOR MANAGEMENT OF SURGICAL SITE INFECTIONS

Moderate evidence supports that, in the setting of retained total joint arthroplasty, antibiotic protocols of 8 weeks do not result in significantly different outcomes when compared to protocols of 3 to 6-month duration.

Strength of Recommendation: Moderate 

Description: Evidence from two or more “Moderate” quality studies with consistent findings, or evidence from a single “High” quality study for recommending for or against the intervention.

The optimal duration of antibiotic therapy is not known. There was one high quality study (Lora-Tamayo 2016) and two low quality (Puhto 2012, Siqueira 2015) studies that evaluated short term antibiotics vs long term antibiotics in the setting of infected total joint arthroplasties. Both studies showed no significant difference in resolution of infection according to treatment duration.

In the study by Lora-Tamayo 2016, patients with staphylococcal infection were treated with debridement and implant retention and then randomized to either eight weeks or three (hips) or six (knees) months of antibiotic therapy. Resolution of infection was similar in both groups.

In the Puhto 2012 study, which included patients with a variety of microbes, they compared short term (two months total for hips and three months for knees) to their previously used long term (three months for hips and six months for knees). Again, they found no difference in success.

While antibiotic duration may not impact likelihood of cure, long term suppression may reduce the risk of relapse for patients who are not cured (Siqueira 2015). The benefit of chronic antibiotic suppression in this low-quality study was only seen for patients with *Staphylococcus aureus* infection managed with implant retention.

Possible Harms of Implementation

There are no known harms associated with implementation of this recommendation.

Future Research

As the vast majority of research on antibiotic duration currently centers on the topic of periprosthetic joint infections, future research is needed focusing on other orthopaedic settings, like trauma, pediatrics, and spine. Comparative high-quality studies are needed in order to better delineate the term of antibiotics necessary with implant retention. Also needed are further studies comparing term of antibiotics vs chronic suppression. In addition, future research is needed on antibiotic treatment and duration as related to implant removal. Furthermore, not much data exists on microbes other than *Staphylococcus aureus*.

RIFAMPIN USE FOR MANAGEMENT OF SURGICAL SITE INFECTIONS

Moderate evidence supports that rifampin, as a second antimicrobial, increases the probability of treatment success for staphylococcal infections in the setting of retained orthopaedic implants.

Strength of Recommendation: Moderate 

Very few high quality studies were identified regarding the optimal antibiotic treatment regarding specific microbes. One high quality study (Zimmerli 1998) and one low-quality studies (El Helou 2010) addressed the addition of Rifampin and its effect on infection resolution in the setting of debridement and implant retention.

In the high quality study Zimmerli 1998 examined the role of rifampin in the setting of a retained fracture fixation implants and total joint prostheses with *Staphylococcal* infections. Patients who were randomized to receive rifampin as part of their treatment regimen had a lower risk of treatment failure.

Possible Harms of Implementation

Rifampin should never be used in monotherapy. Rifampin is a drug with many potentially adverse drug interactions; its use is best-directed by infectious disease specialists or in conjunction with a pharmacist. Rifampin is not always well-tolerated.

Future Research

Future research is needed to define optimal abx protocols in areas other than joint replacement and organisms other than staph. Very little data exists on the optimal antibiotic regimen in relation to orthopaedic surgical site infection, especially when considering implants outside of joint replacement; in addition, when considering microbes other than *Staphylococcus*.

REFERENCES

1. Abdel-Salam,A., Eyres,K.S. Effects of tourniquet during total knee arthroplasty. A prospective randomised study. *J Bone Joint Surg Br* 1995/3; 2: 250-253
2. Abou El-Khier,N.T., El,Ganainy Ael, Elgeidy,A., Rakha,S.A. Assessment of interleukin-6 and other inflammatory markers in the diagnosis of Egyptian patients with periprosthetic joint infection. *Egypt.J Immunol.* 2013; 2: 93-99
3. Achermann,Y., Stasch,P., Preiss,S., Lucke,K., Vogt,M. Characteristics and treatment outcomes of 69 cases with early prosthetic joint infections of the hip and knee. 2014/6; 3: 511-519
4. Adhikary,S.D., Liu,W.-M., Memtsoudis,S.G., Davis,C.M., Liu,J. Body Mass Index More Than 45 kg/m(2) as a Cutoff Point Is Associated With Dramatically Increased Postoperative Complications in Total Knee Arthroplasty and Total Hip Arthroplasty. *J.Arthroplasty* 2016/4; 4: 749-753
5. Aggarwal,V.K., Higuera,C., Deirmengian,G., Parvizi,J., Austin,M.S. Swab cultures are not as effective as tissue cultures for diagnosis of periprosthetic joint infection. *Clin Orthop Relat Res* 2013/10; 10: 3196-3203
6. Ahn,J.S., Lee,H.J., Park,E., Park,I.Y., Lee,J.W. Suction Drain Tip Culture after Spine Surgery: Can It Predict a Surgical Site Infection?. *Asian Spine J.* 2015/12; 6: 863-868
7. Aksoy,S.Y., Asa,S., Ozhan,M., Ocak,M., Sager,M.S., Erkan,M.E., Halac,M., Kabasakal,L., Sonmezoglu,K., Kanmaz,B. FDG and FDG-labelled leucocyte PET/CT in the imaging of prosthetic joint infection. *Eur J Nucl.Med Mol Imaging* 2014/3; 3: 556-564
8. Aldebeyan,S., Nooh,A., Aoude,A., Weber,M.H., Harvey,E.J. Hypoalbuminaemia-a marker of malnutrition and predictor of postoperative complications and mortality after hip fractures. 2017/2; 2: 436-440
9. Alijanipour,P., Bakhshi,H., Parvizi,J. Diagnosis of periprosthetic joint infection: the threshold for serological markers. *Clin Orthop Relat Res* 2013/10; 10: 3186-3195
10. Alvi,H.M., Mednick,R.E., Krishnan,V., Kwasny,M.J., Beal,M.D., Manning,D.W. The Effect of BMI on 30 Day Outcomes Following Total Joint Arthroplasty. *J Arthroplasty* 2015/7; 7: 1113-1117
11. Anakwenze,O., Fokin,A., Chocas,M., Dillon,M.T., Navarro,R.A., Yian,E.H., Singh,A. Complications in total shoulder and reverse total shoulder arthroplasty by body mass index. *J.Shoulder Elbow Surg.* 2017/1/30; 0: -
12. Artini,M., Romano,C., Manzoli,L., Scoarughi,G.L., Papa,R., Meani,E., Drago,L., Selan,L. Staphylococcal IgM enzyme-linked immunosorbent assay for diagnosis of periprosthetic joint infections. *J Clin Microbiol.* 2011/1; 1: 423-425
13. Ascione,T., Pagliano,P., Mariconda,M., Rotondo,R., Balato,G., Toro,A., Barletta,V., Conte,M., Esposito,S. Factors related to outcome of early and delayed prosthetic joint infections. *J Infect.* 2015/1; 1: 30-36
14. Atkins,B.L., Athanasou,N., Deeks,J.J., Crook,D.W., Simpson,H., Peto,T.E., McLardy-Smith,P., Berendt,A.R. Prospective evaluation of criteria for microbiological diagnosis of prosthetic-joint infection at revision arthroplasty. The OSIRIS Collaborative Study Group. *J Clin Microbiol.* 1998/10; 10: 2932-2939
15. Banit,D.M., Kaufer,H., Hartford,J.M. Intraoperative frozen section analysis in revision total joint arthroplasty. *Clin Orthop Relat Res* 2002/8; 401: 230-238
16. Basques,B.A., Louie,P.K., Shifflett,G.D., Fice,M.P., Mayo,B.C., Massel,D.H., Guzman,J.Z., Bohl,D.D., Singh,K. The Effect of Surgeon Volume on Complications, Length of Stay, and Costs Following Anterior Cervical Fusion. *Spine (Phila.Pa.1976.)* 2016/6/29; 0: -
17. Battaglia,M., Vannini,F., Guaraldi,F., Rossi,G., Biondi,F., Sudanese,A. Validity of preoperative ultrasound-guided aspiration in the revision of hip prosthesis. *Ultrasound Med Biol* 2011/12; 12: 1977-1983
18. Bauer,S., Bouldouyre,M.A., Oufella,A., Palmari,P., Bakir,R., Fabreguettes,A., Gros,H. Impact of a multidisciplinary staff meeting on the quality of antibiotherapy prescription for bone and joint infections in orthopedic surgery. *Med Mal Infect.* 2012/12; 12: 603-607

19. Bedair,H., Ting,N., Jacovides,C., Saxena,A., Moric,M., Parvizi,J., Della Valle,C.J. The Mark Coventry Award: diagnosis of early postoperative TKA infection using synovial fluid analysis. *Clin Orthop Relat Res* 2011/1; 1: 34-40
20. Bemer,P., Plouzeau,C., Tande,D., Leger,J., Giraudeau,B., Valentin,A.S., Jolivet-Gougeon,A., Vincent,P., Corvec,S., Gibaud,S., Juvin,M.E., Hery-Arnaud,G., Lemarie,C., Kempf,M., Bret,L., Quentin,R., Coffre,C., de,Pinieux G., Bernard,L., Burucoa,C. Evaluation of 16S rRNA gene PCR sensitivity and specificity for diagnosis of prosthetic joint infection: a prospective multicenter cross-sectional study. *J Clin Microbiol.* 2014/10; 10: 3583-3589
21. Bernard,L., Lubbeke,A., Stern,R., Bru,J.P., Feron,J.M., Peyramond,D., Denormandie,P., Arvieux,C., Chirouze,C., Perronne,C., Hoffmeyer,P. Value of preoperative investigations in diagnosing prosthetic joint infection: retrospective cohort study and literature review. *Scand.J Infect.Dis* 2004; 6: 410-416
22. Bernard,L., Pron,B., Vuagnat,A., Gleizes,V., Signoret,F., Denormandie,P., Si-Ali,A., Perrone,C., Feron,J.M., Gaillard,J.L. The value of suction drainage fluid culture during aseptic and septic orthopedic surgery: a prospective study of 901 patients. *Clin Infect.Dis* 2002/1/1; 1: 46-49
23. Bhandari,M., Jeray,K.J., Petrisor,B.A., Devereaux,P.J., Heels,Ansdell D., Schemitsch,E.H., Anglen,J., Della-Rocca,G.J., Jones,C., Kreder,H., Liew,S., McKay,P., Papp,S., Sancheti,P., Sprague,S., Stone,T.B., Sun,X., Tanner,S.L., Tornetta,P., Tufescu,T., Walter,S., Guyatt,G.H. A Trial of Wound Irrigation in the Initial Management of Open Fracture Wounds. *The New England journal of medicine* 2015; 0: 2629-2641
24. Bingham,J., Clarke,H., Spangehl,M., Schwartz,A., Beauchamp,C., Goldberg,B. The alpha defensin-1 biomarker assay can be used to evaluate the potentially infected total joint arthroplasty. *Clin Orthop Relat Res* 2014/12; 12: 4006-4009
25. Blackmur,J.P., Tang,E.Y., Dave,J., Simpson,A.H. Use of broth cultures peri-operatively to optimise the microbiological diagnosis of musculoskeletal implant infections. *Bone Joint J* 2014/11; 11: 1566-1570
26. Blomfeldt,R., Kasina,P., Ottosson,C., Enocson,A., Lapidus,L.J. Prosthetic joint infection following hip fracture and degenerative hip disorder: a cohort study of three thousand, eight hundred and seven consecutive hip arthroplasties with a minimum follow-up of five years. *Int Orthop* 2015/11; 11: 2091-2096
27. Boehm,T.D., Werner,A., Radtke,S., Mueller,T., Kirschner,S., Gohlke,F. The effect of suture materials and techniques on the outcome of repair of the rotator cuff: a prospective, randomised study. *J Bone Joint Surg Br* 2005/6; 6: 819-823
28. Bohl,D.D., Shen,M.R., Mayo,B.C., Massel,D.H., Long,W.W., Modi,K.D., Basques,B.A., Singh,K. Malnutrition Predicts Infectious and Wound Complications Following Posterior Lumbar Spinal Fusion. *Spine (Phila.Pa.1976.)* 2016/11/1; 21: 1693-1699
29. Bonanzinga,T., Zahar,A., Dutsch,M., Lausmann,C., Kendoff,D., Gehrke,T. How Reliable Is the Alpha-defensin Immunoassay Test for Diagnosing Periprosthetic Joint Infection? A Prospective Study. *Clin.Orthop Relat.Res.* 2017/2; 2: 408-415
30. Borens,O., Yusuf,E., Steinrucken,J., Trampuz,A. Accurate and early diagnosis of orthopedic device-related infection by microbial heat production and sonication. *J Orthop Res* 2013/11; 11: 1700-1703
31. Bori,G., Munoz-Mahamud,E., Garcia,S., Mallofre,C., Gallart,X., Bosch,J., Garcia,E., Riba,J., Mensa,J., Soriano,A. Interface membrane is the best sample for histological study to diagnose prosthetic joint infection. *Mod.Pathol.* 2011/4; 4: 579-584
32. Born,P., Ilchmann,T., Zimmerli,W., Zwicky,L., Graber,P., Ochsner,P.E., Clauss,M. Eradication of infection, survival, and radiological results of uncemented revision stems in infected total hip arthroplasties. *Acta Orthop* 2016/12; 6: 637-643
33. Bottner,F., Wegner,A., Winkelmann,W., Becker,K., Erren,M., Gotze,C. Interleukin-6, procalcitonin and TNF-alpha: markers of peri-prosthetic infection following total joint replacement. *J Bone Joint Surg Br* 2007/1; 1: 94-99
34. Boylan,M.R., Basu,N., Naziri,Q., Issa,K., Maheshwari,A.V., Mont,M.A. Does HIV Infection Increase the Risk of Short-Term Adverse Outcomes Following Total Knee Arthroplasty?. *J.Arthroplasty* 2015/9; 9: 1629-1632

35. Bozic,K.J., Ward,D.T., Lau,E.C., Chan,V., Wetters,N.G., Naziri,Q., Odum,S., Fehring,T.K., Mont,M.A., Gioe,T.J., Della Valle,C.J. Risk factors for periprosthetic joint infection following primary total hip arthroplasty: a case control study. *J Arthroplasty* 2014/1; 1: 154-156
36. Breier,A.C., Brandt,C., Sohr,D., Geffers,C., Gastmeier,P. Laminar airflow ceiling size: no impact on infection rates following hip and knee prosthesis. *Infect.Control Hosp Epidemiol.* 2011/11; 11: 1097-1102
37. Butler-Wu,S.M., Burns,E.M., Pottinger,P.S., Magaret,A.S., Rakeman,J.L., Matsen,F.A.,III, Cookson,B.T. Optimization of periprosthetic culture for diagnosis of *Propionibacterium acnes* prosthetic joint infection. *J Clin Microbiol.* 2011/7; 7: 2490-2495
38. Buttaro,M.A., Quinteros,M., Martorell,G., Zanotti,G., Comba,F., Piccaluga,F. Skin staples versus intradermal wound closure following primary hip arthroplasty: a prospective, randomised trial including 231 cases. *Hip international : the journal of clinical and experimental research on hip pathology and therapy* 2015; 0: 563-567
39. Buttaro,M.A., Tanoira,I., Comba,F., Piccaluga,F. Combining C-reactive protein and interleukin-6 may be useful to detect periprosthetic hip infection. *Clin Orthop Relat Res* 2010/12; 12: 3263-3267
40. Calderwood,M.S., Kleinman,K., Huang,S.S., Murphy,M.V., Yokoe,D.S., Platt,R. Surgical Site Infections: Volume–Outcome Relationship and Year-to-Year Stability of Performance Rankings. *Med.Care* 2017/1; 1: 79-85
41. Cancienne,J.M., Werner,B.C., Puvanesarajah,V., Hassanzadeh,H., Singla,A., Shen,F.H., Shimer,A.L. Does the Timing of Preoperative Epidural Steroid Injection Affect Infection Risk After ACDF or Posterior Cervical Fusion?. *Spine (Phila.Pa.1976.)* 2017/1/15; 2: 71-77
42. Cavanaugh,P.K., Chen,A.F., Rasouli,M.R., Post,Z.D., Orozco,F.R., Ong,A.C. Complications and Mortality in Chronic Renal Failure Patients Undergoing Total Joint Arthroplasty: A Comparison Between Dialysis and Renal Transplant Patients. *J Arthroplasty* 2015/9/9; 0: -
43. Cavanaugh,P.K., Chen,A.F., Rasouli,M.R., Post,Z.D., Orozco,F.R., Ong,A.C. Total joint arthroplasty in transplant recipients: in-hospital adverse outcomes. *J Arthroplasty* 2015/5; 5: 840-845
44. Chacko,T.K., Zhuang,H., Stevenson,K., Moussavian,B., Alavi,A. The importance of the location of fluorodeoxyglucose uptake in periprosthetic infection in painful hip prostheses. *Nucl.Med Commun.* 2002/9; 9: 851-855
45. Chawla,H., van der List,J.P., Fein,N.B., Henry,M.W., Pearle,A.D. Barbed Suture Is Associated With Increased Risk of Wound Infection After Unicompartmental Knee Arthroplasty. *J.Arthroplasty* 2016/7; 7: 1561-1567
46. Chen,A.T., Vallier,H.A. Noncontiguous and open fractures of the lower extremity: Epidemiology, complications, and unplanned procedures. 2016/3; 3: 742-747
47. Cheng,M.T., Chang,M.C., Wang,S.T., Yu,W.K., Liu,C.L., Chen,T.H. Efficacy of dilute betadine solution irrigation in the prevention of postoperative infection of spinal surgery. *Spine (Phila.Pa.1976.)* 2005/8/1; 15: 1689-1693
48. Chik,K.K., Magee,M.A., Bruce,W.J., Higgs,R.J., Thomas,M.G., Allman,K.C., van der Wall,H. Tc-99m stannous colloid-labeled leukocyte scintigraphy in the evaluation of the painful arthroplasty. *Clin Nucl.Med* 1996/11; 11: 838-843
49. Chiu,F.Y., Lin,C.F. Antibiotic-impregnated cement in revision total knee arthroplasty. A prospective cohort study of one hundred and eighty-three knees. *J Bone Joint Surg Am* 2009/3/1; 3: 628-633
50. Choi,H.R., Agrawal,K., Bedair,H. The diagnostic thresholds for synovial fluid analysis in late periprosthetic infection of the hip depend on the duration of symptoms. *Bone Joint J.* 2016/10; 10: 1355-1359
51. Choi,H.R., Kwon,Y.M., Freiberg,A.A., Malchau,H. Comparison of one-stage revision with antibiotic cement versus two-stage revision results for infected total hip arthroplasty. *J Arthroplasty* 2013/9; 8: 66-70
52. Choi,H.R., Malchau,H., Bedair,H. Are prosthetic spacers safe to use in 2-stage treatment for infected total knee arthroplasty?. *J Arthroplasty* 2012/9; 8: 1474-1479
53. Choi,H.R., von,Knoch F., Kandil,A.O., Zurakowski,D., Moore,S., Malchau,H. Retention treatment after periprosthetic total hip arthroplasty infection. *Int Orthop* 2012/4; 4: 723-729

54. Choi,H.R., von,Knoch F., Zurakowski,D., Nelson,S.B., Malchau,H. Can implant retention be recommended for treatment of infected TKA?. *Clin Orthop Relat Res* 2011/4; 4: 961-969
55. Chrastil,J., Anderson,M.B., Stevens,V., Anand,R., Peters,C.L., Pelt,C.E. Is Hemoglobin A1c or Perioperative Hyperglycemia Predictive of Periprosthetic Joint Infection or Death Following Primary Total Joint Arthroplasty?. *J.Arthroplasty* 2015/7; 7: 1197-1202
56. Chryssikos,T., Parvizi,J., Ghanem,E., Newberg,A., Zhuang,H., Alavi,A. FDG-PET imaging can diagnose periprosthetic infection of the hip. *Clin Orthop Relat Res* 2008/6; 6: 1338-1342
57. Cipriano,C., Maiti,A., Hale,G., Jiranek,W. The host response: Toll-like receptor expression in periprosthetic tissues as a biomarker for deep joint infection. *J Bone Joint Surg Am* 2014/10/15; 20: 1692-1698
58. Cipriano,C.A., Brown,N.M., Michael,A.M., Moric,M., Sporer,S.M., Della Valle,C.J. Serum and synovial fluid analysis for diagnosing chronic periprosthetic infection in patients with inflammatory arthritis. *J Bone Joint Surg Am* 2012/4/4; 7: 594-600
59. Croft,L.D., Pottinger,J.M., Chiang,H.Y., Ziebold,C.S., Weinstein,S.L., Herwaldt,L.A. Risk factors for surgical site infections after pediatric spine operations. *Spine (Phila Pa 1976)* 2015/1/15; 2: E112-E119
60. Cunningham,D.J., Kavolus,J.J., Bolognesi,M.P., Wellman,S.S., Seyler,T.M. Specific Infectious Organisms Associated With Poor Outcomes in Treatment for Hip Periprosthetic Infection. *J.Arthroplasty* 2017/1/26; 0: -
61. Cunningham,D.J., Kavolus,J.J., Bolognesi,M.P., Wellman,S.S., Seyler,T.M. Specific Infectious Organisms Associated With Poor Outcomes in Treatment for Hip Periprosthetic Infection. *J.Arthroplasty* 2017/1/26; 0: -
62. da Cunha,B.M., de Oliveira,S.B., Santos-Neto,L. Incidence of infectious complications in hip and knee arthroplasties in rheumatoid arthritis and osteoarthritis patients. *Rev Bras Reumatol.* 2011/12; 6: 609-615
63. Dahl,A., Toksvig-Larsen,S. Infection prophylaxis: a prospective study in 106 patients operated on by tibial osteotomy using the hemicallotasis technique. *Arch Orthop Trauma Surg* 2006/9; 7: 441-447
64. Dale,H., Hallan,G., Hallan,G., Espehaug,B., Havelin,L.I., Engesaeter,L.B. Increasing risk of revision due to deep infection after hip arthroplasty. *Acta Orthop* 2009/12; 6: 639-645
65. Dale,H., Skramm,I., Lower,H.L., Eriksen,H.M., Espehaug,B., Furnes,O., Skjeldestad,F.E., Havelin,L.I., Engesaeter,L.B. Infection after primary hip arthroplasty: a comparison of 3 Norwegian health registers. *Acta Orthop* 2011/12; 6: 646-654
66. de Boer,A.S., Geubbels,E.L., Wille,J., Mintjes-de Groot,A.J. Risk assessment for surgical site infections following total hip and total knee prostheses. *J Chemother.* 2001/11; 1: 42-47
67. de Boer,A.S., Mintjes-de Groot,A.J., Severijnen,A.J., van den Berg,J.M., van,Pelt W. Risk assessment for surgical-site infections in orthopedic patients. *Infect.Control Hosp Epidemiol.* 1999/6; 6: 402-407
68. De,Vecchi E., Villa,F., Bortolin,M., Toscano,M., Tacchini,L., Romano,C.L., Drago,L. Leucocyte esterase, glucose and C-reactive protein in the diagnosis of prosthetic joint infections: a prospective study. *Clin.Microbiol.Infect.* 2016/6; 6: 555-560
69. De,Winter F., Gemmel,F., Van de Wiele,C., Poffijn,B., Uyttendaele,D., Dierckx,R. 18-Fluorine fluorodeoxyglucose positron emission tomography for the diagnosis of infection in the postoperative spine. *Spine (Phila Pa 1976)* 2003/6/15; 12: 1314-1319
70. De,Winter F., Gemmel,F., Van,Laere K., De,Winter O., Poffijn,B., Dierckx,R.A., Van de Wiele,C. 99mTc-ciprofloxacin planar and tomographic imaging for the diagnosis of infection in the postoperative spine: experience in 48 patients. *Eur J Nucl.Med Mol Imaging* 2004/2; 2: 233-239
71. Deirmengian,C., Kardos,K., Kilmartin,P., Cameron,A., Schiller,K., Booth,R.E.,Jr., Parvizi,J. The alpha-defensin test for periprosthetic joint infection outperforms the leukocyte esterase test strip. *Clin Orthop Relat Res* 2015/1; 1: 198-203
72. Deleuran,T., Vilstrup,H., Overgaard,S., Jepsen,P. Cirrhosis patients have increased risk of complications after hip or knee arthroplasty. *Acta Orthop* 2015/2; 1: 108-113
73. Della Valle,C.J., Scher,D.M., Kim,Y.H., Oxley,C.M., Desai,P., Zuckerman,J.D., Di Cesare,P.E. The role of intraoperative Gram stain in revision total joint arthroplasty. *J Arthroplasty* 1999/6; 4: 500-504
74. Demirkol,M.O., Adalet,I., Unal,S.N., Tozun,R., Cantez,S. 99Tc(m)-polyclonal IgG scintigraphy in the detection of infected hip and knee prostheses. *Nucl.Med Commun.* 1997/6; 6: 543-548

75. Di, Benedetto P., Povegliano, L., Cainero, V., Gisonni, R., Beltrame, A., Causero, A. The role of intraoperative frozen section in arthroplasty revision surgery: our experience. *Acta Biomed* 2016/4/15; 0: 34-40
76. Dinneen, A., Guyot, A., Clements, J., Bradley, N. Synovial fluid white cell and differential count in the diagnosis or exclusion of prosthetic joint infection. *Bone Joint J* 2013/4; 4: 554-557
77. Dowsey, M.M., Choong, P.F. Obese diabetic patients are at substantial risk for deep infection after primary TKA. *Clin Orthop Relat Res* 2009/6; 6: 1577-1581
78. Drago, L., Signori, V., De, Vecchi E., Vassena, C., Palazzi, E., Cappelletti, L., Romano, D., Romano, C.L. Use of dithiothreitol to improve the diagnosis of prosthetic joint infections. *J Orthop Res* 2013/11; 11: 1694-1699
79. Dzaja, I., Howard, J., Somerville, L., Lanting, B. Functional outcomes of acutely infected knee arthroplasty: a comparison of different surgical treatment options. *Can J Surg* 2015/12; 6: 402-407
80. El Espera, I., Blondet, C., Moullart, V., Saidi, L., Havet, E., Mertl, P., Canarelli, B., Schmit, J.L., Meyer, M.E. The usefulness of ^{99m}Tc sulfur colloid bone marrow scintigraphy combined with ¹¹¹In leucocyte scintigraphy in prosthetic joint infection. *Nucl. Med Commun.* 2004/2; 2: 171-175
81. El Helou, O.C., Berbari, E.F., Lahr, B.D., Eckel-Passow, J.E., Razonable, R.R., Sia, I.G., Virk, A., Walker, R.C., Steckelberg, J.M., Wilson, W.R., Hanssen, A.D., Osmon, D.R. Efficacy and safety of rifampin containing regimen for staphylococcal prosthetic joint infections treated with debridement and retention. *Eur J Clin Microbiol. Infect. Dis* 2010/8; 8: 961-967
82. El Helou, O.C., Berbari, E.F., Marculescu, C.E., El Atrouni, W.I., Razonable, R.R., Steckelberg, J.M., Hanssen, A.D., Osmon, D.R. Outcome of enterococcal prosthetic joint infection: is combination systemic therapy superior to monotherapy?. *Clin Infect. Dis* 2008/10/1; 7: 903-909
83. Elward, A., Yegge, J., Recktenwald, A., Jadwisiak, L., Kieffer, P., Hohrein, M., Hopkins-Broyles, D., Woeltje, K.F. Risk Factors for Craniotomy or Spinal Fusion Surgical Site Infection. *Pediatr Infect. Dis J* 2015/9/7; 0: -
84. Engesaeter, L.B., Dale, H., Schrama, J.C., Hallan, G., Lie, S.A. Surgical procedures in the treatment of 784 infected THAs reported to the Norwegian Arthroplasty Register. *Acta Orthop* 2011/10; 5: 530-537
85. Engesaeter, L.B., Dale, H., Schrama, J.C., Hallan, G., Lie, S.A. Surgical procedures in the treatment of 784 infected THAs reported to the Norwegian Arthroplasty Register. *Acta Orthop* 2011/10; 5: 530-537
86. Engesaeter, L.B., Dale, H., Schrama, J.C., Hallan, G., Lie, S.A. Surgical procedures in the treatment of 784 infected THAs reported to the Norwegian Arthroplasty Register. *Acta Orthop* 2011/10; 5: 530-537
87. Engesaeter, L.B., Espehaug, B., Lie, S.A., Furnes, O., Havelin, L.I. Does cement increase the risk of infection in primary total hip arthroplasty? Revision rates in 56,275 cemented and uncemented primary THAs followed for 0-16 years in the Norwegian Arthroplasty Register. *Acta Orthop* 2006/6; 3: 351-358
88. Engesaeter, L.B., Lie, S.A., Espehaug, B., Furnes, O., Vollset, S.E., Havelin, L.I. Antibiotic prophylaxis in total hip arthroplasty: effects of antibiotic prophylaxis systemically and in bone cement on the revision rate of 22,170 primary hip replacements followed 0-14 years in the Norwegian Arthroplasty Register. *Acta Orthop Scand.* 2003/12; 6: 644-651
89. Ercolano, L.B., Christensen, T., McGough, R., Weiss, K. Treatment solutions are unclear for perimegaprosthetic infections. *Clin Orthop Relat Res* 2013/10; 10: 3204-3213
90. Ettinger, M., Calliess, T., Kielstein, J.T., Sibai, J., Bruckner, T., Lichtinghagen, R., Windhagen, H., Lukasz, A. Circulating biomarkers for discrimination between aseptic joint failure, low-grade infection, and high-grade septic failure. *Clin Infect. Dis* 2015/8/1; 3: 332-341
91. Fehring, T.K., McAlister, J.A., Jr. Frozen histologic section as a guide to sepsis in revision joint arthroplasty. *Clin Orthop Relat Res* 1994/7; 304: 229-237
92. Fink, B., Gebhard, A., Fuerst, M., Berger, I., Schafer, P. High diagnostic value of synovial biopsy in periprosthetic joint infection of the hip. *Clin Orthop Relat Res* 2013/3; 3: 956-964
93. Fink, B., Makowiak, C., Fuerst, M., Berger, I., Schafer, P., Frommelt, L. The value of synovial biopsy, joint aspiration and C-reactive protein in the diagnosis of late peri-prosthetic infection of total knee replacements. *J Bone Joint Surg Br* 2008/7; 7: 874-878

94. Frances, Borrego A., Martinez, F.M., Cebrian Parra, J.L., Graneda, D.S., Crespo, R.G., Lopez-Duran, Stern L. Diagnosis of infection in hip and knee revision surgery: intraoperative frozen section analysis. *Int Orthop* 2007/2; 1: 33-37
95. Frangiamore, S.J., Saleh, A., Grosso, M.J., Kovac, M.F., Higuera, C.A., Iannotti, J.P., Ricchetti, E.T. alpha-Defensin as a predictor of periprosthetic shoulder infection. *J Shoulder Elbow Surg* 2015/7; 7: 1021-1027
96. Frangiamore, S.J., Saleh, A., Kovac, M.F., Grosso, M.J., Zhang, X., Bauer, T.W., Daly, T.M., Ricchetti, E.T., Iannotti, J.P. Synovial fluid interleukin-6 as a predictor of periprosthetic shoulder infection. *J Bone Joint Surg Am* 2015/1/7; 1: 63-70
97. Frangiamore, S.J., Siqueira, M.B., Saleh, A., Daly, T., Higuera, C.A., Barsoum, W.K. Synovial Cytokines and the MSIS Criteria Are Not Useful for Determining Infection Resolution After Periprosthetic Joint Infection Explantation. *Clin.Orthop Relat.Res.* 2016/7; 7: 1630-1639
98. Friedrich, M.J., Randau, T.M., Wimmer, M.D., Reichert, B., Kuberra, D., Stoffel-Wagner, B., Wirtz, D.C., Gravius, S. Lipopolysaccharide-binding protein: a valuable biomarker in the differentiation between periprosthetic joint infection and aseptic loosening?. *Int Orthop* 2014/10; 10: 2201-2207
99. Fukuda, H., Kuroki, M. The development of statistical models for predicting surgical site infections in Japan: Toward a statistical model-based standardized infection ratio. *Infect.Control Hosp.Epidemiol.* 2016; 3: 260-271
100. Fuster, D., Soriano, A., Garcia, S., Piera, C., Suades, J., Rodriguez, D., Martinez, J.C., Mensa, J., Campos, F., Pons, F. Usefulness of 99mTc-ciprofloxacin scintigraphy in the diagnosis of prosthetic joint infections. *Nucl.Med Commun.* 2011/1; 1: 44-51
101. Gallo, J., Kolar, M., Dendis, M., Loveckova, Y., Sauer, P., Zapletalova, J., Koukalova, D. Culture and PCR analysis of joint fluid in the diagnosis of prosthetic joint infection. *New Microbiol.* 2008/1; 1: 97-104
102. Gandhi, R., Razak, F., Pathy, R., Davey, J.R., Syed, K., Mahomed, N.N. Antibiotic bone cement and the incidence of deep infection after total knee arthroplasty. *J Arthroplasty* 2009/10; 7: 1015-1018
103. Garcia-Alvarez, F., Al-Ghanem, R., Garcia-Alvarez, I., Lopez-Baillon, A., Bernal, M. Risk factors for postoperative infections in patients with hip fracture treated by means of Thompson arthroplasty. *Arch Gerontol.Geriatr.* 2010/1; 1: 51-55
104. George, J., Kwiecien, G., Klika, A.K., Ramanathan, D., Bauer, T.W., Barsoum, W.K., Higuera, C.A. Are Frozen Sections and MSIS Criteria Reliable at the Time of Reimplantation of Two-stage Revision Arthroplasty?. *Clin.Orthop Relat.Res.* 2016/7; 7: 1619-1626
105. George, M.D., Baker, J.F., Yenchih, Hsu J., Wu, Q., Xie, F., Chen, L., Yun, H., Curtis, J.R. Perioperative timing of infliximab and the risk of serious infection after elective hip and knee arthroplasty. *Arthritis Care Res.(Hoboken.)* 2017/1/27; 0: -
106. Ghanem, E., Parvizi, J., Burnett, R.S., Sharkey, P.F., Keshavarzi, N., Aggarwal, A., Barrack, R.L. Cell count and differential of aspirated fluid in the diagnosis of infection at the site of total knee arthroplasty. *J Bone Joint Surg Am* 2008/8; 8: 1637-1643
107. Giles, J.T., Bartlett, S.J., Gelber, A.C., Nanda, S., Fontaine, K., Ruffing, V., Bathon, J.M. Tumor necrosis factor inhibitor therapy and risk of serious postoperative orthopedic infection in rheumatoid arthritis. *Arthritis Rheum.* 2006/4/15; 2: 333-337
108. Glehr, M., Friesenbichler, J., Hofmann, G., Bernhardt, G.A., Zacherl, M., Avian, A., Windhager, R., Leithner, A. Novel biomarkers to detect infection in revision hip and knee arthroplasties. *Clin Orthop Relat Res* 2013/8; 8: 2621-2628
109. Glithero, P.R., Grigoris, P., Harding, L.K., Hesselwood, S.R., McMinn, D.J. White cell scans and infected joint replacements. Failure to detect chronic infection. *J Bone Joint Surg Br* 1993/5; 3: 371-374
110. Gomez, E., Cazanave, C., Cunningham, S.A., Greenwood-Quaintance, K.E., Steckelberg, J.M., Uhl, J.R., Hanssen, A.D., Karau, M.J., Schmidt, S.M., Osmon, D.R., Berbari, E.F., Mandrekar, J., Patel, R. Prosthetic joint infection diagnosis using broad-range PCR of biofilms dislodged from knee and hip arthroplasty surfaces using sonication. *J Clin Microbiol.* 2012/11; 11: 3501-3508
111. Grammatico-Guillon, L., Baron, S., Rosset, P., Gaborit, C., Bernard, L., Rusch, E., Astagneau, P. Surgical Site Infection After Primary Hip and Knee Arthroplasty: A Cohort Study Using a Hospital Database. *Infect.Control Hosp Epidemiol.* 2015/10; 10: 1198-1207

- 112.Greenky,M., Gandhi,K., Pulido,L., Restrepo,C., Parvizi,J. Preoperative anemia in total joint arthroplasty: is it associated with periprosthetic joint infection?. *Clin Orthop Relat Res* 2012/10; 10: 2695-2701
- 113.Greenwood-Quaintance,K.E., Uhl,J.R., Hanssen,A.D., Sampath,R., Mandrekar,J.N., Patel,R. Diagnosis of prosthetic joint infection by use of PCR-electrospray ionization mass spectrometry. *J Clin Microbiol.* 2014/2; 2: 642-649
- 114.Greidanus,N.V., Masri,B.A., Garbuz,D.S., Wilson,S.D., McAlinden,M.G., Xu,M., Duncan,C.P. Use of erythrocyte sedimentation rate and C-reactive protein level to diagnose infection before revision total knee arthroplasty. A prospective evaluation. *J Bone Joint Surg Am* 2007/7; 7: 1409-1416
- 115.Grosso,M.J., Frangiamore,S.J., Saleh,A., Kovac,M.F., Hayashi,R., Ricchetti,E.T., Bauer,T.W., Iannotti,J.P. Poor utility of serum interleukin-6 levels to predict indolent periprosthetic shoulder infections. *J Shoulder Elbow Surg* 2014/9; 9: 1277-1281
- 116.Gruskay,J.A., Fu,M., Basques,B., Bohl,D.D., Buerba,R., Webb,M.L., Grauer,J.N. Factors Affecting Length of Stay and Complications Following Elective Anterior Cervical Discectomy and Fusion: A Study of 2164 Patients From The American College of Surgeons National Surgical Quality Improvement Project Database (ACS NSQIP). *J Spinal Disord.Tech* 2014/2/12; 0: -
- 117.Guerado,E., Cano,J.R., Cruz,E., Bertrand,M.L., Hirschfeld,M., Benitez-Parejo,N. Should hip fractures be operated upon only by specialist hip unit surgeons in order to lower rates of surgical site infection?. *Int Orthop* 2015/1; 1: 105-110
- 118.Haddad,S., Millhouse,P.W., Maltenfort,M., Restrepo,C., Kepler,C.K., Vaccaro,A.R. Diagnosis and neurologic status as predictors of surgical site infection in primary cervical spinal surgery. *Spine J.* 2016/5; 5: 632-642
- 119.Hatta,T., Werthel,J.D., Wagner,E.R., Itoi,E., Steinmann,S.P., Cofield,R.H., Sperling,J.W. Effect of smoking on complications following primary shoulder arthroplasty. *J.Shoulder Elbow Surg.* 2017/1; 1: 1-6
- 120.Helito,C.P., Junqueira,J.J., Gobbi,R.G., Angelini,F.J., Rezende,M.U., Tirico,L.E., Demange,M.K., Mota e Albuquerque RF, Pecora,J.R., Camanho,G.L. Effect of postoperative use of nasal oxygen catheter supplementation in wound healing following total knee arthroplasty. *Clinics (Sao Paulo)* 2014/11; 11: 735-739
- 121.Hoh,D.J., Rahman,M., Fargen,K.M., Neal,D., Hoh,B.L. Establishing standard hospital performance measures for cervical spinal trauma: a Nationwide In-patient Sample study. 2015/10/20; 0: -
- 122.Holinka,J., Bauer,L., Hirschl,A.M., Graninger,W., Windhager,R., Presterl,E. Sonication cultures of explanted components as an add-on test to routinely conducted microbiological diagnostics improve pathogen detection. *J Orthop Res* 2011/4; 4: 617-622
- 123.Hort,K.R., DeOrio,J.K. Residual bacterial contamination after surgical preparation of the foot or ankle with or without alcohol. *Foot.Ankle.Int* 2002/10; 10: 946-948
- 124.Hsieh,P.H., Huang,K.C., Lee,P.C., Lee,M.S. Two-stage revision of infected hip arthroplasty using an antibiotic-loaded spacer: retrospective comparison between short-term and prolonged antibiotic therapy. *J Antimicrob.Chemother.* 2009/8; 2: 392-397
- 125.Hughes,H.C., Newnham,R., Athanasou,N., Atkins,B.L., Bejon,P., Bowler,I.C. Microbiological diagnosis of prosthetic joint infections: a prospective evaluation of four bacterial culture media in the routine laboratory. *Clin Microbiol.Infect.* 2011/10; 10: 1528-1530
- 126.Hunter,J.G., Dawson,L.K., Soin,S.P., Baumhauer,J.F. Randomized, Prospective Study of the Order of Preoperative Preparation Solutions for Patients Undergoing Foot and Ankle Orthopedic Surgery. *Foot Ankle Int.* 2016/5; 5: 478-482
- 127.Huotari,K., Lyytikainen,O., Seitsalo,S. Patient outcomes after simultaneous bilateral total hip and knee joint replacements. *J Hosp Infect.* 2007/3; 3: 219-225
- 128.Hutter,G., von,Felten S., Sailer,M.H., Schulz,M., Mariani,L. Risk factors for postoperative CSF leakage after elective craniotomy and the efficacy of fleece-bound tissue sealing against dural suturing alone: a randomized controlled trial. *J Neurosurg.* 2014/9; 3: 735-744
- 129.Inacio,M.C., Pratt,N.L., Roughead,E.E., Graves,S.E. Predicting Infections After Total Joint Arthroplasty Using a Prescription Based Comorbidity Measure. *J Arthroplasty* 2015/10; 10: 1692-1698
- 130.Iwata,E., Shigematsu,H., Koizumi,M., Nakajima,H., Okuda,A., Morimoto,Y., Masuda,K., Yamamoto,Y., Tanaka,Y. Lymphocyte Count at 4 Days Postoperatively and CRP Level at 7 Days

- Postoperatively: Reliable and Useful Markers for Surgical Site Infection Following Instrumented Spinal Fusion. *Spine (Phila.Pa.1976.)* 2016/7/15; 14: 1173-1178
131. Iyengar, K.P., Vinjamuri, S. Role of 99mTc Sulesomab in the diagnosis of prosthetic joint infections. *Nucl. Med Commun.* 2005/6; 6: 489-496
 132. Jacovides, C.L., Krefl, R., Adeli, B., Hozack, B., Ehrlich, G.D., Parvizi, J. Successful identification of pathogens by polymerase chain reaction (PCR)-based electron spray ionization time-of-flight mass spectrometry (ESI-TOF-MS) in culture-negative periprosthetic joint infection. *J Bone Joint Surg Am* 2012/12/19; 24: 2247-2254
 133. Jacovides, C.L., Parvizi, J., Adeli, B., Jung, K.A. Molecular markers for diagnosis of periprosthetic joint infection. *J Arthroplasty* 2011/9; 6: 99-103
 134. Jacquot, A., Sirveaux, F., Roche, O., Favard, L., Clavert, P., Mole, D. Surgical management of the infected reversed shoulder arthroplasty: a French multicenter study of reoperation in 32 patients. *J Shoulder Elbow Surg* 2015/11; 11: 1713-1722
 135. Jain, R.K., Shukla, R., Singh, P., Kumar, R. Epidemiology and risk factors for surgical site infections in patients requiring orthopedic surgery. *Eur J Orthop Surg Traumatol.* 2015/2; 2: 251-254
 136. Jansen, E., Huhtala, H., Puolakka, T., Moilanen, T. Risk factors for infection after knee arthroplasty. A register-based analysis of 43,149 cases. *J Bone Joint Surg Am* 2009/1; 1: 38-47
 137. Janssen, D.M., Geurts, J.A., Jutten, L.M., Walenkamp, G.H. 2-stage revision of 120 deep infected hip and knee prostheses using gentamicin-PMMA beads. *Acta Orthop* 2016/8; 4: 324-332
 138. Janssen, D.M., Geurts, J.A., Jutten, L.M., Walenkamp, G.H. 2-stage revision of 120 deep infected hip and knee prostheses using gentamicin-PMMA beads. *Acta Orthop* 2016/8; 4: 324-332
 139. Johnson, D.P. Infection after knee arthroplasty. Clinical studies of skin hypoxia and wound healing. *Acta Orthop Scand. Suppl* 1993; 0: 1-48
 140. Jordan, R.W., Saithna, A., Smith, N., Norris, R., Sprowson, A., Foguet, P. Does intraoperative tissue sample enrichment help or hinder the identification of microorganisms in prosthetic joint infection?. *Eur J Orthop Surg Traumatol.* 2015/5; 4: 731-736
 141. Joseph, T.N., Mujtaba, M., Chen, A.L., Maurer, S.L., Zuckerman, J.D., Maldjian, C., Di Cesare, P.E. Efficacy of combined technetium-99m sulfur colloid/indium-111 leukocyte scans to detect infected total hip and knee arthroplasties. *J Arthroplasty* 2001/9; 6: 753-758
 142. Kasahara, Y., Majima, T., Kimura, S., Nishiike, O., Uchida, J. What are the causes of revision total knee arthroplasty in Japan?. *Clin Orthop Relat Res* 2013/5; 5: 1533-1538
 143. Kasperek, M.F., Kasperek, M., Boettner, F., Faschingbauer, M., Hahne, J., Dominkus, M. Intraoperative Diagnosis of Periprosthetic Joint Infection Using a Novel Alpha-Defensin Lateral Flow Assay. *J. Arthroplasty* 2016/12; 12: 2871-2874
 144. Kessler, B., Knupp, M., Graber, P., Zwicky, L., Hintermann, B., Zimmerli, W., Sendi, P. The treatment and outcome of peri-prosthetic infection of the ankle: a single cohort-centre experience of 34 cases. *Bone Joint J* 2014/6; 6: 772-777
 145. Kheir, M.M., Ackerman, C.T., Tan, T.L., Benazzo, A., Tischler, E.H., Parvizi, J. Leukocyte Esterase Strip Test Can Predict Subsequent Failure Following Reimplantation in Patients With Periprosthetic Joint Infection. *J. Arthroplasty* 2017/1/26; 0: -
 146. Khoshbin, A., Lysenko, M., Law, P., Wright, J.G. Outcomes of infection following pediatric spinal fusion. *Can J Surg* 2015/4; 2: 107-113
 147. Kim, H.O., Na, S.J., Oh, S.J., Jung, B.S., Lee, S.H., Chang, J.S., Bin, S.I., Ryu, J.S. Usefulness of adding SPECT/CT to 99mTc-hexamethylpropylene amine oxime (HMPAO)-labeled leukocyte imaging for diagnosing prosthetic joint infections. *J Comput Assist Tomogr.* 2014/3; 2: 313-319
 148. Klett, R., Kordelle, J., Stahl, U., Khalisi, A., Puille, M., Steiner, D., Bauer, R. Immunoscintigraphy of septic loosening of knee endoprosthesis: a retrospective evaluation of the antigranulocyte antibody BW 250/183. *Eur J Nucl. Med Mol Imaging* 2003/11; 11: 1463-1466
 149. Kobayashi, N., Inaba, Y., Choe, H., Ike, H., Fujimaki, H., Tezuka, T., Hirata, Y., Tateishi, U., Inoue, T., Saito, T. Use of F-18 fluoride PET to differentiate septic from aseptic loosening in total hip arthroplasty patients. *Clin Nucl. Med* 2011/11; 11: e156-e161

150. Kobayashi, N., Inaba, Y., Choe, H., Iwamoto, N., Ishida, T., Yukizawa, Y., Aoki, C., Ike, H., Saito, T. Rapid and sensitive detection of methicillin-resistant *Staphylococcus periprosthetic* infections using real-time polymerase chain reaction. *Diagn. Microbiol. Infect. Dis* 2009/6; 2: 172-176
151. Kourbatova, E. V., Halvosa, J. S., King, M. D., Ray, S. M., White, N., Blumberg, H. M. Emergence of community-associated methicillin-resistant *Staphylococcus aureus* USA 300 clone as a cause of health care-associated infections among patients with prosthetic joint infections. *Am J Infect. Control* 2005/9; 7: 385-391
152. Koutsoumbelis, S., Hughes, A. P., Girardi, F. P., Cammisa, F. P., Jr., Finerty, E. A., Nguyen, J. T., Gausden, E., Sama, A. A. Risk factors for postoperative infection following posterior lumbar instrumented arthrodesis. *J Bone Joint Surg Am* 2011/9/7; 17: 1627-1633
153. Kurtz, S. M., Lau, E., Ong, K. L., Carreon, L., Watson, H., Albert, T., Glassman, S. Infection risk for primary and revision instrumented lumbar spine fusion in the Medicare population. *J Neurosurg. Spine* 2012/10; 4: 342-347
154. Kurtz, S. M., Ong, K. L., Lau, E., Bozic, K. J., Berry, D., Parvizi, J. Prosthetic joint infection risk after TKA in the Medicare population. *Clin Orthop Relat Res* 2010/1; 1: 52-56
155. L  bbeke, A., Zingg, M., Vu, D., Miozzari, H. H., Christofilopoulos, P., U  skay, I., Harbarth, S., Hoffmeyer, P. Body mass and weight thresholds for increased prosthetic joint infection rates after primary total joint arthroplasty. *Acta Orthopaedica* 2016/3/3; 2: 132-138
156. Laffer, R. R., Graber, P., Ochsner, P. E., Zimmerli, W. Outcome of prosthetic knee-associated infection: evaluation of 40 consecutive episodes at a single centre. *Clin Microbiol. Infect.* 2006/5; 5: 433-439
157. Lai, K., Bohm, E. R., Burnell, C., Hedden, D. R. Presence of medical comorbidities in patients with infected primary hip or knee arthroplasties. *J Arthroplasty* 2007/8; 5: 651-656
158. Lange, J., Troelsen, A., Soballe, K. Chronic Periprosthetic Hip Joint Infection. A Retrospective, Observational Study on the Treatment Strategy and Prognosis in 130 Non-Selected Patients. *PLoS One* 2016; 9: e0163457-
159. Lee, F. H., Shen, P. C., Jou, I. M., Li, C. Y., Hsieh, J. L. A Population-Based 16-Year Study on the Risk Factors of Surgical Site Infection in Patients after Bone Grafting: A Cross-Sectional Study in Taiwan. *Medicine (Baltimore.)* 2015/11; 47: e2034-
160. Lee, Q. J., Mak, W. P., Wong, Y. C. Risk factors for periprosthetic joint infection in total knee arthroplasty. *J. Orthop Surg. (Hong Kong)* 2015/12; 3: 282-286
161. Legout, L., Stern, R., Assal, M., Rohner, P., Merle, C., Hoffmeyer, P., Bernard, L. Suction drainage culture as a guide to effectively treat musculoskeletal infection. *Scand. J Infect. Dis* 2006; 5: 341-345
162. Lewallen, L. W., Maradit, Kremers H., Lahr, B. D., Mabry, T. M., Steckelberg, J. M., Berry, D. J., Hanssen, A. D., Berbari, E. F., Osmon, D. R. External validation of the national healthcare safety network risk models for surgical site infections in total hip and knee replacements. *Infect. Control Hosp Epidemiol.* 2014/11; 11: 1323-1329
163. Li, A. E., Sneag, D. B., Greditzer, H. G., Johnson, C. C., Miller, T. T., Potter, H. G. Total Knee Arthroplasty: Diagnostic Accuracy of Patterns of Synovitis at MR Imaging. 2016/11; 2: 499-506
164. Li, Z., Zhou, Z., Li, P., Zeng, W., Qing, H., Tang, W. Retrospective Study on Multidrug-Resistant Bacterium Infections After Rigid Internal Fixation of Mandibular Fracture. *J. Oral Maxillofac. Surg.* 2016/4; 4: 770-777
165. Lim, S., Edelstein, A. I., Jain, U., Puri, L., Kim, J. Y. Impact of preoperative myocardial infarction on surgical outcomes in inpatient orthopaedic surgery. *Int Orthop* 2013/12; 12: 2483-2489
166. Lindberg-Larsen, M., Jorgensen, C. C., Bagger, J., Schroder, H. M., Kehlet, H. Revision of infected knee arthroplasties in Denmark. *Acta Orthop* 2016/8; 4: 333-338
167. Lizaur-Utrilla, A., Gonzalez-Parreno, S., Gil-Guillen, V., Lopez-Prats, F. A. Debridement with prosthesis retention and antibiotherapy vs. two-stage revision for periprosthetic knee infection within 3 months after arthroplasty: a case-control study. *Clin Microbiol. Infect.* 2015/9; 9: 851-857
168. Lizaur-Utrilla, A., Gonzalez-Parreno, S., Gil-Guillen, V., Lopez-Prats, F. A. Debridement with prosthesis retention and antibiotherapy vs. two-stage revision for periprosthetic knee infection within 3 months after arthroplasty: a case-control study. *Clin Microbiol. Infect.* 2015/9; 9: 851-857

169. Lonner, J.H., Desai, P., DiCesare, P.E., Steiner, G., Zuckerman, J.D. The reliability of analysis of intraoperative frozen sections for identifying active infection during revision hip or knee arthroplasty. *J Bone Joint Surg Am* 1996/10; 10: 1553-1558
170. Lora-Tamayo, J., Euba, G., Cobo, J., Horcajada, J.P., Soriano, A., Sandoval, E., Pigrau, C., Benito, N., Falgueras, L., Palomino, J., del Toro, M.D., Jover-Saenz, A., Iribarren, J.A., Sanchez-Somolinos, M., Ramos, A., Fernandez-Sampedro, M., Riera, M., Baraia-Etxaburu, J.M., Ariza, J. Short- versus long-duration levofloxacin plus rifampicin for acute staphylococcal prosthetic joint infection managed with implant retention: a randomised clinical trial. *Int.J.Antimicrob.Agents* 2016/9; 3: 310-316
171. Love, C., Marwin, S.E., Tomas, M.B., Krauss, E.S., Tronco, G.G., Bhargava, K.K., Nichols, K.J., Palestro, C.J. Diagnosing infection in the failed joint replacement: a comparison of coincidence detection 18F-FDG and 111In-labeled leukocyte/99mTc-sulfur colloid marrow imaging. *J Nucl.Med* 2004/11; 11: 1864-1871
172. Luo, S., Jiang, T., Yang, Y., Yang, X., Zhao, J. Combination therapy with vancomycin-loaded calcium sulfate and vancomycin-loaded PMMA in the treatment of chronic osteomyelitis. *BMC Musculoskelet.Disord.* 2016/12/22; 1: 502-
173. Malizos, K., Blauth, M., Danita, A., Capuano, N., Mezzoprete, R., Logoluso, N., Drago, L., Romano, C.L. Fast-resorbable antibiotic-loaded hydrogel coating to reduce post-surgical infection after internal osteosynthesis: a multicenter randomized controlled trial. *J.Orthop Traumatol.* 2017/2/2; 0: -
174. Maradit, Kremers H., Lewallen, L.W., Mabry, T.M., Berry, D.J., Berbari, E.F., Osmon, D.R. Diabetes mellitus, hyperglycemia, hemoglobin A1C and the risk of prosthetic joint infections in total hip and knee arthroplasty. *J Arthroplasty* 2015/3; 3: 439-443
175. Maragakis, L.L., Cosgrove, S.E., Martinez, E.A., Tucker, M.G., Cohen, D.B., Perl, T.M. Intraoperative fraction of inspired oxygen is a modifiable risk factor for surgical site infection after spinal surgery. 2009/3; 3: 556-562
176. Marin, M., Garcia-Lechuz, J.M., Alonso, P., Villanueva, M., Alcalá, L., Gimeno, M., Cercenado, E., Sanchez-Somolinos, M., Radice, C., Bouza, E. Role of universal 16S rRNA gene PCR and sequencing in diagnosis of prosthetic joint infection. *J Clin Microbiol.* 2012/3; 3: 583-589
177. Marmor, S., Bauer, T., Desplaces, N., Heym, B., Roux, A.L., Sol, O., Roge, J., Mahe, F., Desire, L., Aegerter, P., Ghout, I., Ropers, J., Gaillard, J.L., Rottman, M. Multiplex Antibody Detection for Noninvasive Genus-Level Diagnosis of Prosthetic Joint Infection. *J.Clin.Microbiol.* 2016/4; 4: 1065-1073
178. Massin, P., Delory, T., Lhotellier, L., Pasquier, G., Roche, O., Cazenave, A., Estellat, C., Jenny, J.Y. Infection recurrence factors in one- and two-stage total knee prosthesis exchanges. *Knee Surg Sports Traumatol.Arthrosc.* 2015/11/26; 0: -
179. Massin, P., Delory, T., Lhotellier, L., Pasquier, G., Roche, O., Cazenave, A., Estellat, C., Jenny, J.Y. Infection recurrence factors in one- and two-stage total knee prosthesis exchanges. *Knee Surg Sports Traumatol.Arthrosc.* 2015/11/26; 0: -
180. Matson, A.P., Morwood, M.P., Peres Da, Silva A., Cone, E.B., Hurwitz, S.R., Zura, R.D. Obese Patients Have Fewer Wound Complications Following Fixation of Ankle Fractures. *Foot Ankle Spec.* 2016/12/1; 0: 1938640016685146-
181. McKee, M.D., Li-Bland, E.A., Wild, L.M., Schemitsch, E.H. A prospective, randomized clinical trial comparing an antibiotic-impregnated bioabsorbable bone substitute with standard antibiotic-impregnated cement beads in the treatment of chronic osteomyelitis and infected nonunion. *J.Orthop.Trauma* 2010; 0: 483-490
182. Melendez, D.P., Uhl, J.R., Greenwood-Quaintance, K.E., Hanssen, A.D., Sampath, R., Patel, R. Detection of prosthetic joint infection by use of PCR-electrospray ionization mass spectrometry applied to synovial fluid. *J Clin Microbiol.* 2014/6; 6: 2202-2205
183. Menendez, M.E., Lu, N., Unizony, S., Choi, H.K., Ring, D. Surgical site infection in hand surgery. *Int Orthop* 2015/11; 11: 2191-2198
184. Meyer, E., Weitzel-Kage, D., Sohr, D., Gastmeier, P. Impact of department volume on surgical site infections following arthroscopy, knee replacement or hip replacement. *BMJ Qual Saf* 2011/12; 12: 1069-1074

185. Miric, A., Inacio, M.C., Namba, R.S. Can total knee arthroplasty be safely performed in patients with chronic renal disease?. *Acta Orthop* 2014/2; 1: 71-78
186. Molina, C.S., Stinner, D.J., Fras, A.R., Evans, J.M. Risk factors of deep infection in operatively treated pilon fractures (AO/OTA: 43). *Journal of Orthopaedics* 2015; 0: S7-S13
187. Momohara, S., Kawakami, K., Iwamoto, T., Yano, K., Sakuma, Y., Hiroshima, R., Imamura, H., Masuda, I., Tokita, A., Ikari, K. Prosthetic joint infection after total hip or knee arthroplasty in rheumatoid arthritis patients treated with nonbiologic and biologic disease-modifying antirheumatic drugs. *Mod.Rheumatol.* 2011/10; 5: 469-475
188. Moojen, D.J., Spijkers, S.N., Schot, C.S., Nijhof, M.W., Vogely, H.C., Flier, A., Verbout, A.J., Castelein, R.M., Dhert, W.J., Schouls, L.M. Identification of orthopaedic infections using broad-range polymerase chain reaction and reverse line blot hybridization. *J Bone Joint Surg Am* 2007/6; 6: 1298-1305
189. Morey, V.M., Song, Y.D., Whang, J.S., Kang, Y.G., Kim, T.K. Can Serum Albumin Level and Total Lymphocyte Count be Surrogates for Malnutrition to Predict Wound Complications After Total Knee Arthroplasty?. *J.Arthroplasty* 2016/6; 6: 1317-1321
190. Morgan, P.M., Sharkey, P., Ghanem, E., Parvizi, J., Clohisy, J.C., Burnett, R.S., Barrack, R.L. The value of intraoperative Gram stain in revision total knee arthroplasty. *J Bone Joint Surg Am* 2009/9; 9: 2124-2129
191. Morrison, T.N., Chen, A.F., Taneja, M., Kucukdurmaz, F., Rothman, R.H., Parvizi, J. Single vs Repeat Surgical Skin Preparations for Reducing Surgical Site Infection After Total Joint Arthroplasty: A Prospective, Randomized, Double-Blinded Study. *J.Arthroplasty* 2016/6; 6: 1289-1294
192. Mortazavi, S.M., Schwartzberger, J., Austin, M.S., Purtill, J.J., Parvizi, J. Revision total knee arthroplasty infection: incidence and predictors. *Clin Orthop Relat Res* 2010/8; 8: 2052-2059
193. Mortazavi, S.M., Vegari, D., Ho, A., Zmistowski, B., Parvizi, J. Two-stage exchange arthroplasty for infected total knee arthroplasty: predictors of failure. *Clin Orthop Relat Res* 2011/11; 11: 3049-3054
194. Mu, Y., et al., "Improving risk-adjusted measures of surgical site infection for the national healthcare safety network". *Infection Control Hospital Epidemiology*, 32(10): (2011): 970-86.
195. Mudd, C.D., Boudreau, J.A., Moed, B.R. A prospective randomized comparison of two skin closure techniques in acetabular fracture surgery. *J Orthop Traumatol.* 2014/9; 3: 189-194
196. Muilwijk, J., van den Hof, S., Wille, J.C. Associations between surgical site infection risk and hospital operation volume and surgeon operation volume among hospitals in the Dutch nosocomial infection surveillance network. *Infect.Control Hosp Epidemiol.* 2007/5; 5: 557-563
197. Muilwijk, J., Walenkamp, G.H., Voss, A., Wille, J.C., van den Hof, S. Random effect modelling of patient-related risk factors in orthopaedic procedures: results from the Dutch nosocomial infection surveillance network 'PREZIES'. *J Hosp Infect.* 2006/3; 3: 319-326
198. Mulcahy, D.M., Fenelon, G.C., McInerney, D.P. Aspiration arthrography of the hip joint. Its uses and limitations in revision hip surgery. *J Arthroplasty* 1996/1; 1: 64-68
199. Munoz-Mahamad, E., Garcia, S., Bori, G., Martinez-Pastor, J.C., Zumbado, J.A., Riba, J., Mensa, J., Soriano, A. Comparison of a low-pressure and a high-pressure pulsatile lavage during debridement for orthopaedic implant infection. *Arch Orthop Trauma Surg* 2011/9; 9: 1233-1238
200. Murphy, M.V., Du, D.T., Hua, W., Cortez, K.J., Butler, M.G., Davis, R.L., DeCoster, T.A., Johnson, L., Li, L., Nakasato, C., Nordin, J.D., Ramesh, M., Schum, M., Von, Worley A., Zinderman, C., Platt, R., Klompas, M. Risk Factors for Surgical Site Infections Following Anterior Cruciate Ligament Reconstruction. *Infect.Control Hosp.Epidemiol.* 2016/7; 7: 827-833
201. Nagoya, S., Kaya, M., Sasaki, M., Tateda, K., Yamashita, T. Diagnosis of peri-prosthetic infection at the hip using triple-phase bone scintigraphy. *J Bone Joint Surg Br* 2008/2; 2: 140-144
202. Nakano, N., Matsumoto, T., Ishida, K., Tsumura, N., Muratsu, H., Hiranaka, T., Kuroda, R., Kurosaka, M. Factors influencing the outcome of deep infection following total knee arthroplasty. *Knee* 2015/9; 4: 328-332
203. Namba, R.S., Chen, Y., Paxton, E.W., Slipchenko, T., Fithian, D.C. Outcomes of routine use of antibiotic-loaded cement in primary total knee arthroplasty. *J Arthroplasty* 2009/9; 6: 44-47
204. Namba, R.S., Inacio, M.C., Paxton, E.W. Risk factors associated with deep surgical site infections after primary total knee arthroplasty: an analysis of 56,216 knees. *J Bone Joint Surg Am* 2013/5/1; 9: 775-782

205. Naranje, S., Lendway, L., Mehle, S., Gioe, T.J. Does operative time affect infection rate in primary total knee arthroplasty?. *Clin Orthop Relat Res* 2015/1; 1: 64-69
206. Nelson, C.L., Evans, R.P., Blaha, J.D., Calhoun, J., Henry, S.L., Patzakis, M.J. A comparison of gentamicin-impregnated polymethylmethacrylate bead implantation to conventional parenteral antibiotic therapy in infected total hip and knee arthroplasty. *Clin Orthop Relat Res* 1993/10; 295: 96-101
207. Newman, J.M., George, J., Klika, A.K., Hatem, S.F., Barsoum, W.K., Trevor, North W., Higuera, C.A. What is the Diagnostic Accuracy of Aspirations Performed on Hips With Antibiotic Cement Spacers?. *Clin.Orthop Relat.Res.* 2017/1; 1: 204-211
208. Nguyen, S., Pasquet, A., Legout, L., Beltrand, E., Dubreuil, L., Migaud, H., Yazdanpanah, Y., Senneville, E. Efficacy and tolerance of rifampicin-linezolid compared with rifampicin-cotrimoxazole combinations in prolonged oral therapy for bone and joint infections. *Clin Microbiol.Infect.* 2009/12; 12: 1163-1169
209. Nguyen, S., Pasquet, A., Legout, L., Beltrand, E., Dubreuil, L., Migaud, H., Yazdanpanah, Y., Senneville, E. Efficacy and tolerance of rifampicin-linezolid compared with rifampicin-cotrimoxazole combinations in prolonged oral therapy for bone and joint infections. *Clin Microbiol.Infect.* 2009/12; 12: 1163-1169
210. Nijhof, M.W., Oyen, W.J., Van, Kampen A., Claessens, R.A., van der Meer, J.W., Corstens, F.H. Hip and knee arthroplasty infection. In-111-IgG scintigraphy in 102 cases. *Acta Orthop Scand.* 1997/8; 4: 332-336
211. Nunez, L.V., Buttarò, M.A., Morandi, A., Pusso, R., Piccaluga, F. Frozen sections of samples taken intraoperatively for diagnosis of infection in revision hip surgery. *Acta Orthop* 2007/4; 2: 226-230
212. Oethinger, M., Warner, D.K., Schindler, S.A., Kobayashi, H., Bauer, T.W. Diagnosing periprosthetic infection: false-positive intraoperative Gram stains. *Clin Orthop Relat Res* 2011/4; 4: 954-960
213. Omar, M., Ettinger, M., Reichling, M., Petri, M., Guenther, D., Gehrke, T., Krettek, C., Mommsen, P. Synovial C-reactive protein as a marker for chronic periprosthetic infection in total hip arthroplasty. *Bone Joint J* 2015/2; 2: 173-176
214. Omar, M., Suero, E.M., Liodakis, E., Reichling, M., Guenther, D., Decker, S., Stiesch, M., Krettek, C., Eberhard, J. Diagnostic performance of swab PCR as an alternative to tissue culture methods for diagnosing infections associated with fracture fixation devices. 2016/7; 7: 1421-1426
215. Omeis, I.A., Dhir, M., Sciubba, D.M., Gottfried, O.N., McGirt, M.J., Attenello, F.J., Wolinsky, J.P., Gokaslan, Z.L. Postoperative surgical site infections in patients undergoing spinal tumor surgery: incidence and risk factors. *Spine (Phila Pa 1976)* 2011/8/1; 17: 1410-1419
216. Ong, K.L., Kurtz, S.M., Lau, E., Bozic, K.J., Berry, D.J., Parvizi, J. Prosthetic joint infection risk after total hip arthroplasty in the Medicare population. *J Arthroplasty* 2009/9; 6: 105-109
217. Ovadia, D., Luger, E., Bickels, J., Menachem, A., Dekel, S. Efficacy of closed wound drainage after total joint arthroplasty. A prospective randomized study. *J.Arthroplasty* 1997; 0: 317-321
218. Ovaska, M.T., Makinen, T.J., Madanat, R., Huotari, K., Vahlberg, T., Hirvensalo, E., Lindahl, J. Risk factors for deep surgical site infection following operative treatment of ankle fractures. *J Bone Joint Surg Am* 2013/2/20; 4: 348-353
219. Panousis, K., Grigoris, P., Butcher, I., Rana, B., Reilly, J.H., Hamblen, D.L. Poor predictive value of broad-range PCR for the detection of arthroplasty infection in 92 cases. *Acta Orthop* 2005/6; 3: 341-346
220. Parkkinen, M., Madanat, R., Lindahl, J., Makinen, T.J. Risk Factors for Deep Infection Following Plate Fixation of Proximal Tibial Fractures. *J.Bone Joint Surg.Am.* 2016/8/3; 15: 1292-1297
221. Parvizi, J., Ghanem, E., Menashe, S., Barrack, R.L., Bauer, T.W. Periprosthetic infection: what are the diagnostic challenges?. *J Bone Joint Surg Am* 2006/12; 0: 138-147
222. Parvizi, J., Jacovides, C., Antoci, V., Ghanem, E. Diagnosis of periprosthetic joint infection: the utility of a simple yet unappreciated enzyme. *J Bone Joint Surg Am* 2011/12/21; 24: 2242-2248
223. Pauzenberger, L., Grieb, A., Hexel, M., Laky, B., Anderl, W., Heuberger, P. Infections following arthroscopic rotator cuff repair: incidence, risk factors, and prophylaxis. *Knee Surg.Sports Traumatol.Arthrosc.* 2017/2; 2: 595-601
224. Pedersen, A.B., Svendsson, J.E., Johnsen, S.P., Riis, A., Overgaard, S. Risk factors for revision due to infection after primary total hip arthroplasty. A population-based study of 80,756 primary procedures in the Danish Hip Arthroplasty Registry. *Acta Orthop* 2010/10; 5: 542-547

225. Peel, T.N., Dylla, B.L., Hughes, J.G., Lynch, D.T., Greenwood-Quaintance, K.E., Cheng, A.C., Mandrekar, J.N., Patel, R. Improved Diagnosis of Prosthetic Joint Infection by Culturing Periprosthetic Tissue Specimens in Blood Culture Bottles. *MBio*. 2016/1/5; 1: e01776-15
226. Pelosi, E., Baiocco, C., Pennone, M., Migliaretti, G., Varetto, T., Maiello, A., Bello, M., Bisi, G. ^{99m}Tc-HMPAO-leukocyte scintigraphy in patients with symptomatic total hip or knee arthroplasty: improved diagnostic accuracy by means of semiquantitative evaluation. *J Nucl. Med* 2004/3; 3: 438-444
227. Piper, K.E., Fernandez-Sampedro, M., Steckelberg, K.E., Mandrekar, J.N., Karau, M.J., Steckelberg, J.M., Barbari, E.F., Osmon, D.R., Hanssen, A.D., Lewallen, D.G., Cofield, R.H., Sperling, J.W., Sanchez-Sotelo, J., Huddleston, P.M., Dekutoski, M.B., Yaszemski, M., Currier, B., Patel, R. C-reactive protein, erythrocyte sedimentation rate and orthopedic implant infection. *PLoS One* 2010; 2: e9358-
228. Piper, K.E., Jacobson, M.J., Cofield, R.H., Sperling, J.W., Sanchez-Sotelo, J., Osmon, D.R., McDowell, A., Patrick, S., Steckelberg, J.M., Mandrekar, J.N., Fernandez, Sampedro M., Patel, R. Microbiologic diagnosis of prosthetic shoulder infection by use of implant sonication. *J Clin Microbiol*. 2009/6; 6: 1878-1884
229. Plodkowski, A.J., Hayter, C.L., Miller, T.T., Nguyen, J.T., Potter, H.G. Lamellated hyperintense synovitis: potential MR imaging sign of an infected knee arthroplasty. 2013/1; 1: 256-260
230. Pons, M., Angles, F., Sanchez, C., Matamala, A., Cuchi, E., Salavert, M., Forcada, P., Ferrer, H. Infected total hip arthroplasty--the value of intraoperative histology. *Int Orthop* 1999; 1: 34-36
231. Portillo, M.E., Salvado, M., Sorli, L., Alier, A., Martinez, S., Trampuz, A., Gomez, J., Puig, L., Horcajada, J.P. Multiplex PCR of sonication fluid accurately differentiates between prosthetic joint infection and aseptic failure. *J Infect*. 2012/12; 6: 541-548
232. Portillo, M.E., Salvado, M., Trampuz, A., Plasencia, V., Rodriguez-Villasante, M., Sorli, L., Puig, L., Horcajada, J.P. Sonication versus vortexing of implants for diagnosis of prosthetic joint infection. *J Clin Microbiol*. 2013/2; 2: 591-594
233. Poultides, L.A., Memtsoudis, S.G., Vasilakakos, T., Wanivenhaus, F., Do, H.T., Finerty, E., Alexiades, M., Sculco, T.P. Infection following simultaneous bilateral total knee arthroplasty. *J Arthroplasty* 2013/9; 8: 92-95
234. Prakasam, S., Stein, K., Lee, M.K., Rampa, S., Nalliah, R., Allareddy, V., Allareddy, V. Prevalence and predictors of complications following facial reconstruction procedures. *Int. J. Oral Maxillofac. Surg*. 2016/6; 6: 735-742
235. Puhto, A.P., Puhto, T., Syrjala, H. Short-course antibiotics for prosthetic joint infections treated with prosthesis retention. *Clin Microbiol. Infect*. 2012/11; 11: 1143-1148
236. Puig-Verdie, L., Alentorn-Geli, E., Gonzalez-Cuevas, A., Sorli, L., Salvado, M., Alier, A., Pelfort, X., Portillo, M.E., Horcajada, J.P. Implant sonication increases the diagnostic accuracy of infection in patients with delayed, but not early, orthopaedic implant failure. *Bone Joint J* 2013/2; 2: 244-249
237. Puvanesarajah, V., Jain, A., Kebaish, K., Shaffrey, C.I., Sciubba, D.M., Garza-Ramos, R., Jay, Khanna A., Hassanzadeh, H. Poor Nutrition Status and Lumbar Spine Fusion Surgery in the Elderly: Readmissions, Complications, and Mortality. *Spine (Phila. Pa. 1976.)* 2016/11/9; 0: -
238. Puvanesarajah, V., Jain, A., Qureshi, R., Carstensen, S.E., Tyger, R., Hassanzadeh, H. Elective Thoracolumbar Spine Fusion Surgery in Patients with Parkinson Disease. *World Neurosurg*. 2016/12; 0: 267-271
239. Rak, M., Barlic-Maganja, D., Kavcic, M., Trebse, R., Cor, A. Comparison of molecular and culture method in diagnosis of prosthetic joint infection. *FEMS Microbiol. Lett*. 2013/6; 1: 42-48
240. Rand, J.A., Brown, M.L. The value of indium 111 leukocyte scanning in the evaluation of painful or infected total knee arthroplasties. *Clin Orthop Relat Res* 1990/10; 259: 179-182
241. Randau, T.M., Friedrich, M.J., Wimmer, M.D., Reichert, B., Kuberra, D., Stoffel-Wagner, B., Limmer, A., Wirtz, D.C., Gravius, S. Interleukin-6 in serum and in synovial fluid enhances the differentiation between periprosthetic joint infection and aseptic loosening. *PLoS One* 2014; 2: e89045-
242. Rasouli, M.R., Maltenfort, M.G., Purtill, J.J., Hozack, W.J., Parvizi, J. Has the rate of in-hospital infections after total joint arthroplasty decreased?. *Clin Orthop Relat Res* 2013/10; 10: 3102-3111
243. Ravi, B., Croxford, R., Hollands, S., Paterson, J.M., Bogoch, E., Kreder, H., Hawker, G.A. Increased risk of complications following total joint arthroplasty in patients with rheumatoid arthritis. *Arthritis Rheumatol*. 2014/2; 2: 254-263

244. Reategui, D., Tornero, E., Popescu, D., Sastre, S., Camafort, M., Gines, G., Combalia, A., Lozano, L. Postoperative hyperglycaemia control reduces postoperative complications in patients subject to total knee arthroplasty. *Knee* 2017/1/1; 1: 128-136
245. Reategui, D., Tornero, E., Popescu, D., Sastre, S., Camafort, M., Gines, G., Combalia, A., Lozano, L. Postoperative hyperglycaemia control reduces postoperative complications in patients subject to total knee arthroplasty. *Knee* 2017/1; 1: 128-136
246. Ren, T., Ding, L., Xue, F., He, Z., Xiao, H. Risk factors for surgical site infection of pilon fractures. *Clinics (Sao Paulo)* 2015/6; 6: 419-422
247. Richards, J., Inacio, M.C., Beckett, M., Navarro, R.A., Singh, A., Dillon, M.T., Sodl, J.F., Yian, E.H. Patient and procedure-specific risk factors for deep infection after primary shoulder arthroplasty. *Clin Orthop Relat Res* 2014/9; 9: 2809-2815
248. Roberts, P., Walters, A.J., McMinn, D.J. Diagnosing infection in hip replacements. The use of fine-needle aspiration and radiometric culture. *J Bone Joint Surg Br* 1992/3; 2: 265-269
249. Rodriguez, D., Pigrau, C., Euba, G., Cobo, J., Garcia-Lechuz, J., Palomino, J., Riera, M., del Toro, M.D., Granados, A., Ariza, X. Acute haematogenous prosthetic joint infection: prospective evaluation of medical and surgical management. *Clin Microbiol. Infect.* 2010/12; 12: 1789-1795
250. Romano, C.L., D'Anchise, R., Calamita, M., Manzi, G., Romano, D., Sansone, V. Value of digital telethermography for the diagnosis of septic knee prosthesis: a prospective cohort study. *BMC Musculoskelet. Disord.* 2013; 0: 7-
251. Ronde-Oustau, C., Diesinger, Y., Jenny, J.Y., Antoni, M., Gaudias, J., Boeri, C., Sibilia, J., Lessinger, J.M. Diagnostic accuracy of intra-articular C-reactive protein assay in periprosthetic knee joint infection--a preliminary study. *Orthop Traumatol. Surg Res* 2014/4; 2: 217-220
252. Rubello, D., Casara, D., Maran, A., Avogaro, A., Tiengo, A., Muzzio, P.C. Role of anti-granulocyte Fab' fragment antibody scintigraphy (LeukoScan) in evaluating bone infection: acquisition protocol, interpretation criteria and clinical results. *Nucl. Med Commun.* 2004/1; 1: 39-47
253. Ryu, S. Y., Greenwood-Quaintance, K.E., Hanssen, A.D., Mandrekar, J.N., Patel, R. Low sensitivity of periprosthetic tissue PCR for prosthetic knee infection diagnosis. *Diagn. Microbiol. Infect. Dis* 2014/8; 4: 448-453
254. Salt, E., Wiggins, A.T., Rayens, M.K., Morris, B.J., Mannino, D., Hoellein, A., Donegan, R.P., Crofford, L.J. Moderating effects of immunosuppressive medications and risk factors for post-operative joint infection following total joint arthroplasty in patients with rheumatoid arthritis or osteoarthritis. *Semin. Arthritis Rheum.* 2017/2; 4: 423-429
255. Salvati, E.A., Robinson, R.P., Zeno, S.M., Koslin, B.L., Brause, B.D., Wilson, P.D., Jr. Infection rates after 3175 total hip and total knee replacements performed with and without a horizontal unidirectional filtered air-flow system. *J Bone Joint Surg Am* 1982/4; 4: 525-535
256. Sampedro, M.F., Huddleston, P.M., Piper, K.E., Karau, M.J., Dekutoski, M.B., Yaszemski, M.J., Currier, B.L., Mandrekar, J.N., Osmon, D.R., McDowell, A., Patrick, S., Steckelberg, J.M., Patel, R. A biofilm approach to detect bacteria on removed spinal implants. *Spine (Phila Pa 1976)* 2010/5/20; 12: 1218-1224
257. Schafer, P., Fink, B., Sandow, D., Margull, A., Berger, I., Frommelt, L. Prolonged bacterial culture to identify late periprosthetic joint infection: a promising strategy. *Clin Infect. Dis* 2008/12/1; 11: 1403-1409
258. Schairer, W.W., Nwachukwu, B.U., Mayman, D.J., Lyman, S., Jerabek, S.A. Preoperative Hip Injections Increase the Rate of Periprosthetic Infection After Total Hip Arthroplasty. *J. Arthroplasty* 2016/9; 9: 166-169
259. Schepers, T., Van Lieshout, E.M., De Vries, M.R., Van der Elst, M. Increased rates of wound complications with locking plates in distal fibular fractures. 2011/10; 10: 1125-1129
260. Scher, D.M., Pak, K., Lonner, J.H., Finkel, J.E., Zuckerman, J.D., Di Cesare, P.E. The predictive value of indium-111 leukocyte scans in the diagnosis of infected total hip, knee, or resection arthroplasties. *J Arthroplasty* 2000/4; 3: 295-300
261. Schinsky, M.F., Della Valle, C.J., Sporer, S.M., Paprosky, W.G. Perioperative testing for joint infection in patients undergoing revision total hip arthroplasty. *J Bone Joint Surg Am* 2008/9; 9: 1869-1875

262. Schnaser, E.A., Browne, J.A., Padgett, D.E., Figgie, M.P., D'Apuzzo, M.R. Perioperative Complications in Patients with Inflammatory Arthropathy Undergoing Total Knee Arthroplasty. *J. Arthroplasty* 2015/9/1; 9: 76-80
263. Schrama, J.C., Fenstad, A.M., Dale, H., Havelin, L., Hallan, G., Overgaard, S., Pedersen, A.B., Karrholm, J., Garellick, G., Pulkkinen, P., Eskelinen, A., Makela, K., Engesaeter, L.B., Fevang, B.T. Increased risk of revision for infection in rheumatoid arthritis patients with total hip replacements. *Acta Orthop* 2015; 4: 469-476
264. Segura, A.B., Munoz, A., Brulles, Y.R., Hernandez Hermoso, J.A., Diaz, M.C., Bajen Lazaro, M.T., Martin-Comin, J. What is the role of bone scintigraphy in the diagnosis of infected joint prostheses?. *Nucl. Med Commun.* 2004/5; 5: 527-532
265. Shen, H., Tang, J., Wang, Q., Jiang, Y., Zhang, X. Sonication of explanted prosthesis combined with incubation in BD bactec bottles for pathogen-based diagnosis of prosthetic joint infection. *J Clin Microbiol.* 2015/3; 3: 777-781
266. Sigmund, I.K., Holinka, J., Gamper, J., Staats, K., Bohler, C., Kubista, B., Windhager, R. Qualitative alpha-defensin test (Synovasure) for the diagnosis of periprosthetic infection in revision total joint arthroplasty. *Bone Joint J.* 2017/1; 1: 66-72
267. Simonsen, L., Buhl, A., Oersnes, T., Duus, B. White blood cell scintigraphy for differentiation of infection and aseptic loosening: a retrospective study of 76 painful hip prostheses. *Acta Orthop* 2007/10; 5: 640-647
268. Singh, J.A., Schleck, C., Harmsen, W.S., Jacob, A.K., Warner, D.O., Lewallen, D.G. Current tobacco use is associated with higher rates of implant revision and deep infection after total hip or knee arthroplasty: a prospective cohort study. *BMC Med* 2015; 1: 283-
269. Siqueira, M.B., Saleh, A., Klika, A.K., O'Rourke, C., Schmitt, S., Higuera, C.A., Barsoum, W.K. Chronic Suppression of Periprosthetic Joint Infections with Oral Antibiotics Increases Infection-Free Survivorship. *J Bone Joint Surg Am* 2015/8/5; 15: 1220-1232
270. Siqueira, M.B., Saleh, A., Klika, A.K., O'Rourke, C., Schmitt, S., Higuera, C.A., Barsoum, W.K. Chronic Suppression of Periprosthetic Joint Infections with Oral Antibiotics Increases Infection-Free Survivorship. *J Bone Joint Surg Am* 2015/8/5; 15: 1220-1232
271. Siqueira, M.B., Saleh, A., Klika, A.K., O'Rourke, C., Schmitt, S., Higuera, C.A., Barsoum, W.K. Chronic Suppression of Periprosthetic Joint Infections with Oral Antibiotics Increases Infection-Free Survivorship. *J Bone Joint Surg Am* 2015/8/5; 15: 1220-1232
272. Smith, E.B., Cai, J., Wynne, R., Maltenfort, M., Good, R.P. Performance characteristics of broth-only cultures after revision total joint arthroplasty. *Clin Orthop Relat Res* 2014/11; 11: 3285-3290
273. Soriano, A., Bori, G., Garcia-Ramiro, S., Martinez-Pastor, J.C., Miana, T., Codina, C., Macule, F., Basora, M., Martinez, J.A., Riba, J., Suso, S., Mensa, J. Timing of antibiotic prophylaxis for primary total knee arthroplasty performed during ischemia. *Clin Infect. Dis* 2008/4/1; 7: 1009-1014
274. Spangehl, M.J., Masri, B.A., O'Connell, J.X., Duncan, C.P. Prospective analysis of preoperative and intraoperative investigations for the diagnosis of infection at the sites of two hundred and two revision total hip arthroplasties. *J Bone Joint Surg Am* 1999/5; 5: 672-683
275. Stall, A., Paryavi, E., Gupta, R., Zadnik, M., Hui, E., O'Toole, R.V. Perioperative supplemental oxygen to reduce surgical site infection after open fixation of high-risk fractures: a randomized controlled pilot trial. *J Trauma Acute Care Surg* 2013/10; 4: 657-663
276. Stine, I.A., Lee, B., Zalavras, C.G., Hatch, G., III, Itamura, J.M. Management of chronic shoulder infections utilizing a fixed articulating antibiotic-loaded spacer. *J Shoulder Elbow Surg* 2010/7; 5: 739-748
277. Street, J.T., Andrew, Glennie R., Dea, N., DiPaola, C., Wang, Z., Boyd, M., Paquette, S.J., Kwon, B.K., Dvorak, M.F., Fisher, C.G. A comparison of the Wiltse versus midline approaches in degenerative conditions of the lumbar spine. *J. Neurosurg. Spine* 2016/9; 3: 332-338
278. Takemoto, R.C., Lonner, B., Andres, T., Park, J., Ricart, Hoffiz P., Bendo, J., Goldstein, J., Spivak, J., Errico, T. Appropriateness of twenty-four-hour antibiotic prophylaxis after spinal surgery in which a drain is utilized: a prospective randomized study. *Journal of Bone and Joint Surgery American Volume* 2017; 0: 979-986
279. Tattevin, P., Cremieux, A.C., Pottier, P., Hutten, D., Carbon, C. Prosthetic joint infection: when can prosthesis salvage be considered?. *Clin Infect. Dis* 1999/8; 2: 292-295

280. Tattevin, P., Cremieux, A.C., Pottier, P., Hutten, D., Carbon, C. Prosthetic joint infection: when can prosthesis salvage be considered?. *Clin Infect. Dis* 1999/8; 2: 292-295
281. Taylor, T., Beggs, I. Fine needle aspiration in infected hip replacements. *Clin Radiol* 1995/3; 3: 149-152
282. Tayton, E.R., Frampton, C., Hooper, G.J., Young, S.W. The impact of patient and surgical factors on the rate of infection after primary total knee arthroplasty: an analysis of 64,566 joints from the New Zealand Joint Registry. *Bone Joint J.* 2016/3; 3: 334-340
283. Tetreault, M.W., Wetters, N.G., Moric, M., Gross, C.E., Della Valle, C.J. Is synovial C-reactive protein a useful marker for periprosthetic joint infection?. *Clin Orthop Relat Res* 2014/12; 12: 3997-4003
284. Thakar, C., Alsousou, J., Hamilton, T.W., Willett, K. The cost and consequences of proximal femoral fractures which require further surgery following initial fixation. *J Bone Joint Surg Br* 2010/12; 12: 1669-1677
285. Tischler, E.H., Cavanaugh, P.K., Parvizi, J. Leukocyte esterase strip test: matched for musculoskeletal infection society criteria. *J Bone Joint Surg Am* 2014/11/19; 22: 1917-1920
286. Tischler, E.H., Matsen, Ko L., Chen, A.F., Maltenfort, M.G., Schroeder, J., Austin, M.S. Smoking Increases the Rate of Reoperation for Infection within 90 Days After Primary Total Joint Arthroplasty. *J. Bone Joint Surg. Am.* 2017/2/15; 4: 295-304
287. Tomas, X., Bori, G., Garcia, S., Garcia-Diez, A.I., Pomes, J., Soriano, A., Rios, J., Almela, M., Mensa, J., Gallart, X., Martinez, J.C., Riba, J. Accuracy of CT-guided joint aspiration in patients with suspected infection status post-total hip arthroplasty. *Skeletal Radiol* 2011/1; 1: 57-64
288. Tornero, E., Garcia-Ramiro, S., Martinez-Pastor, J.C., Bori, G., Bosch, J., Morata, L., Sala, M., Basora, M., Mensa, J., Soriano, A. Prophylaxis with teicoplanin and cefuroxime reduces the rate of prosthetic joint infection after primary arthroplasty. *Antimicrob. Agents Chemother.* 2015/2; 2: 831-837
289. Tornero, E., Morata, L., Martinez-Pastor, J.C., Angulo, S., Combalia, A., Bori, G., Garcia-Ramiro, S., Bosch, J., Mensa, J., Soriano, A. Importance of selection and duration of antibiotic regimen in prosthetic joint infections treated with debridement and implant retention. *J. Antimicrob. Chemother.* 2016/5; 5: 1395-1401
290. Tornero, E., Morata, L., Martinez-Pastor, J.C., Bori, G., Climent, C., Garcia-Velez, D.M., Garcia-Ramiro, S., Bosch, J., Mensa, J., Soriano, A. KLIC-score for predicting early failure in prosthetic joint infections treated with debridement, implant retention and antibiotics. *Clin Microbiol. Infect.* 2015/8; 8: 786-786
291. Tornero, E., Senneville, E., Euba, G., Petersdorf, S., Rodriguez-Pardo, D., Lakatos, B., Ferrari, M.C., Pilares, M., Bahamonde, A., Trebse, R., Benito, N., Sorli, L., del Toro, M.D., Baraiaetxaburu, J.M., Ramos, A., Riera, M., Jover-Saenz, A., Palomino, J., Ariza, J., Soriano, A. Characteristics of prosthetic joint infections due to *Enterococcus* sp. and predictors of failure: a multi-national study. *Clin Microbiol. Infect.* 2014/11; 11: 1219-1224
292. Trampuz, A., Piper, K.E., Hanssen, A.D., Osmon, D.R., Cockerill, F.R., Steckelberg, J.M., Patel, R. Sonication of explanted prosthetic components in bags for diagnosis of prosthetic joint infection is associated with risk of contamination. *J Clin Microbiol.* 2006/2; 2: 628-631
293. Trampuz, A., Piper, K.E., Jacobson, M.J., Hanssen, A.D., Unni, K.K., Osmon, D.R., Mandrekar, J.N., Cockerill, F.R., Steckelberg, J.M., Greenleaf, J.F., Patel, R. Sonication of removed hip and knee prostheses for diagnosis of infection. *N Engl. J Med* 2007/8/16; 7: 654-663
294. Triantafyllopoulos, G.K., Memtsoudis, S.G., Zhang, W., Ma, Y., Sculco, T.P., Poultsides, L.A. Same-Day Surgery Does Not Increase Deep Infection Risk in Bilateral Total Hip Arthroplasty Patients. *J. Arthroplasty* 2016/9; 9: 237-241
295. Tsai, J.C., Sheng, W.H., Lo, W.Y., Jiang, C.C., Chang, S.C. Clinical characteristics, microbiology, and outcomes of prosthetic joint infection in Taiwan. *J Microbiol. Immunol. Infect.* 2015/4; 2: 198-204
296. Tsai, J.C., Sheng, W.H., Lo, W.Y., Jiang, C.C., Chang, S.C. Clinical characteristics, microbiology, and outcomes of prosthetic joint infection in Taiwan. *J Microbiol. Immunol. Infect.* 2015/4; 2: 198-204
297. Tsuda, Y., Yasunaga, H., Horiguchi, H., Ogawa, S., Kawano, H., Tanaka, S. Association between dementia and postoperative complications after hip fracture surgery in the elderly: analysis of 87,654 patients using a national administrative database. *Arch Orthop Trauma Surg* 2015/11; 11: 1511-1517
298. van den Bekerom, M.P., Stuyck, J. The value of pre-operative aspiration in the diagnosis of an infected prosthetic knee: a retrospective study and review of literature. *Acta Orthop Belg.* 2006/8; 4: 441-447

299. van Kasteren, M.E., Mannien, J., Ott, A., Kullberg, B.J., de Boer, A.S., Gyssens, I.C. Antibiotic prophylaxis and the risk of surgical site infections following total hip arthroplasty: timely administration is the most important factor. *Clin Infect. Dis* 2007/4/1; 7: 921-927
300. Vanderstappen, C., Verhoeven, N., Stuyck, J., Bellemans, J. Intra-articular versus serum C-reactive protein analysis in suspected periprosthetic knee joint infection. *Acta Orthop Belg.* 2013/6; 3: 326-330
301. Vicente, A.G., Almoguera, M., Alonso, J.C., Heffernan, A.J., Gomez, A., Contreras, P.I., Martin-Comin, J. Diagnosis of orthopedic infection in clinical practice using Tc-99m sulesomab (antigranulocyte monoclonal antibody fragment Fab'2). *Clin Nucl. Med* 2004/12; 12: 781-785
302. Vielgut, I., Sadoghi, P., Wolf, M., Holzer, L., Leithner, A., Schwantzer, G., Poolman, R., Frankl, B., Glehr, M. Two-stage revision of prosthetic hip joint infections using antibiotic-loaded cement spacers: When is the best time to perform the second stage?. *Int Orthop* 2015/9; 9: 1731-1736
303. Villacis, D., Merriman, J.A., Yalamanchili, R., Omid, R., Itamura, J., Rick Hatch, G.F. Serum interleukin-6 as a marker of periprosthetic shoulder infection. *J Bone Joint Surg Am* 2014/1/1; 1: 41-45
304. Waikakul, S., Unnanantana, A., Vanadurongwan, V. The role of allopurinol in digital replantation. *Journal of Hand Surgery* 1999; 0: 325-327
305. Wallace, G., Judge, A., Prieto-Alhambra, D., de Vries F., Arden, N.K., Cooper, C. The effect of body mass index on the risk of post-operative complications during the 6 months following total hip replacement or total knee replacement surgery. *Osteoarthritis Cartilage* 2014/7; 7: 918-927
306. Wang, K.H., Yu, S.W., Iorio, R., Marcantonio, A.J., Kain, M.S. Long Term Treatment Results for Deep Infections of Total Knee Arthroplasty. *J Arthroplasty* 2015/9; 9: 1623-1628
307. Wang, Z., Anderson, F.A., Jr., Ward, M., Bhattacharyya, T. Surgical site infections and other postoperative complications following prophylactic anticoagulation in total joint arthroplasty. *PLoS One* 2014; 4: e91755-
308. Wasielewski, R.C., Barden, R.M., Rosenberg, A.G. Results of different surgical procedures on total knee arthroplasty infections. *J Arthroplasty* 1996/12; 8: 931-938
309. Wasielewski, R.C., Barden, R.M., Rosenberg, A.G. Results of different surgical procedures on total knee arthroplasty infections. *J Arthroplasty* 1996/12; 8: 931-938
310. Watanabe, M., Sakai, D., Matsuyama, D., Yamamoto, Y., Sato, M., Mochida, J. Risk factors for surgical site infection following spine surgery: efficacy of intraoperative saline irrigation. *J Neurosurg. Spine* 2010/5; 5: 540-546
311. Wenter, V., Albert, N.L., Brendel, M., Fendler, W.P., Cyran, C.C., Bartenstein, P., Friederichs, J., Muller, J.P., Militz, M., Hacker, M., Hungerer, S. [18F]FDG PET accurately differentiates infected and non-infected non-unions after fracture fixation. *Eur. J. Nucl. Med. Mol. Imaging* 2017/3; 3: 432-440
312. Wenter, V., Muller, J.P., Albert, N.L., Lehner, S., Fendler, W.P., Bartenstein, P., Cyran, C.C., Friederichs, J., Militz, M., Hacker, M., Hungerer, S. The diagnostic value of [F]FDG PET for the detection of chronic osteomyelitis and implant-associated infection. *Eur J Nucl. Med Mol Imaging* 2015/11/7; 0: -
313. Werner, B.C., Higgins, M.D., Pehlivan, H.C., Carothers, J.T., Browne, J.A. Super Obesity Is an Independent Risk Factor for Complications After Primary Total Hip Arthroplasty. *J. Arthroplasty* 2017/2; 2: 402-406
314. Westberg, M., Frihagen, F., Brun, O.C., Figved, W., Groggaard, B., Valland, H., Wangen, H., Snorrason, F. Effectiveness of gentamicin-containing collagen sponges for prevention of surgical site infection after hip arthroplasty: a multicenter randomized trial. *Clin Infect. Dis* 2015/6/15; 12: 1752-1759
315. Westberg, M., Snorrason, F., Frihagen, F. Preoperative waiting time increased the risk of periprosthetic infection in patients with femoral neck fracture. *Acta Orthop* 2013/4; 2: 124-129
316. Willis-Owen, C.A., Konyves, A., Martin, D.K. Factors affecting the incidence of infection in hip and knee replacement: an analysis of 5277 cases. *J Bone Joint Surg Br* 2010/8; 8: 1128-1133
317. Wimmer, M.D., Randau, T.M., Friedrich, M.J., Ploeger, M.M., Schmolder, J., Strauss, A.C., Pennekamp, P.H., Vavken, P., Gravius, S. Outcome Predictors in Prosthetic Joint Infections--Validation of a risk stratification score for Prosthetic Joint Infections in 120 cases. *Acta Orthop Belg.* 2016/3; 1: 143-148
318. Wolf, G., Aigner, R.M., Schwarz, T., Lorbach, M.P. Localization and diagnosis of septic endoprosthesis infection by using 99mTc-HMPAO labelled leucocytes. *Nucl. Med Commun.* 2003/1; 1: 23-28

319. Wolf, M., Clar, H., Friesenbichler, J., Schwantzer, G., Bernhardt, G., Gruber, G., Glehr, M., Leithner, A., Sadoghi, P. Prosthetic joint infection following total hip replacement: results of one-stage versus two-stage exchange. *Int Orthop* 2014/7; 7: 1363-1368
320. Wong, Y.C., Lee, Q.J., Wai, Y.L., Ng, W.F. Intraoperative frozen section for detecting active infection in failed hip and knee arthroplasties. *J Arthroplasty* 2005/12; 8: 1015-1020
321. Worthington, T., Dunlop, D., Casey, A., Lambert, R., Luscombe, J., Elliott, T. Serum procalcitonin, interleukin-6, soluble intercellular adhesion molecule-1 and IgG to short-chain exocellular lipoteichoic acid as predictors of infection in total joint prosthesis revision. *Br J Biomed Sci* 2010; 2: 71-76
322. Wright, N.M., Park, J., Tew, J.M., Kim, K.D., Shaffrey, M.E., Cheng, J., Choudhri, H., Krishnaney, A.A., Graham, R.S., Mendel, E., Simmons, N. Spinal Sealant System Provides Better Intraoperative Watertight Closure than Standard of Care during Spinal Surgery: A Prospective, Multi-Center, Randomized Controlled Study. 2015; 2: -
323. Wu, C., Qu, X., Liu, F., Li, H., Mao, Y., Zhu, Z. Risk factors for periprosthetic joint infection after total hip arthroplasty and total knee arthroplasty in Chinese patients. *PLoS One* 2014; 4: e95300-
324. Yano, K., Minoda, Y., Sakawa, A., Kuwano, Y., Kondo, K., Fukushima, W., Tada, K. Positive nasal culture of methicillin-resistant *Staphylococcus aureus* (MRSA) is a risk factor for surgical site infection in orthopedics. *Acta Orthop* 2009/8; 4: 486-490
325. Yapar, Z., Kibar, M., Yapar, A.F., Togrul, E., Kayaselcuk, U., Sarpel, Y. The efficacy of technetium-99m ciprofloxacin (Infecton) imaging in suspected orthopaedic infection: a comparison with sequential bone/gallium imaging. *Eur J Nucl. Med* 2001/7; 7: 822-830
326. Yi, P.H., Cross, M.B., Moric, M., Levine, B.R., Sporer, S.M., Paprosky, W.G., Jacobs, J.J., Della Valle, C.J. Do serologic and synovial tests help diagnose infection in revision hip arthroplasty with metal-on-metal bearings or corrosion?. *Clin Orthop Relat Res* 2015/2; 2: 498-505
327. Yi, P.H., Cross, M.B., Moric, M., Sporer, S.M., Berger, R.A., Della Valle, C.J. The 2013 Frank Stinchfield Award: Diagnosis of infection in the early postoperative period after total hip arthroplasty. *Clin Orthop Relat Res* 2014/2; 2: 424-429
328. Zgonis, T., Jolly, G.P., Garbalosa, J.C. The efficacy of prophylactic intravenous antibiotics in elective foot and ankle surgery. *J Foot Ankle Surg* 2004/3; 2: 97-103
329. Zhou, Z.Y., Liu, Y.K., Chen, H.L., Liu, F. Prevention of Surgical Site Infection After Ankle Surgery Using Vacuum-Assisted Closure Therapy in High-Risk Patients With Diabetes. *J Foot Ankle Surg* 2015/10/22; 0: -
330. Zimmerli, W., Widmer, A.F., Blatter, M., Frei, R., Ochsner, P.E. Role of rifampin for treatment of orthopedic implant-related staphylococcal infections: a randomized controlled trial. Foreign-Body Infection (FBI) Study Group. 1998/5/20; 19: 1537-1541

GUIDELINE DEVELOPMENT GROUP DISCLOSURES

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Disclosure Items: (n) = Respondent answered 'No' to all items indicating no conflicts. 1 = Royalties from a company or supplier; 2 = Speakers bureau/paid presentations for a company or supplier; 3A = Paid employee for a company or supplier; 3B = Paid consultant for a company or supplier; 3C = Unpaid consultant for a company or supplier; 4 = Stock or stock options in a company or supplier; 5 = Research support from a company or supplier as a PI; 6 = Other financial or material support from a company or supplier; 7 = Royalties, financial or material support from publishers; 8 = Medical/Orthopaedic publications editorial/governing board; 9 = Board member/committee appointments for a society.

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