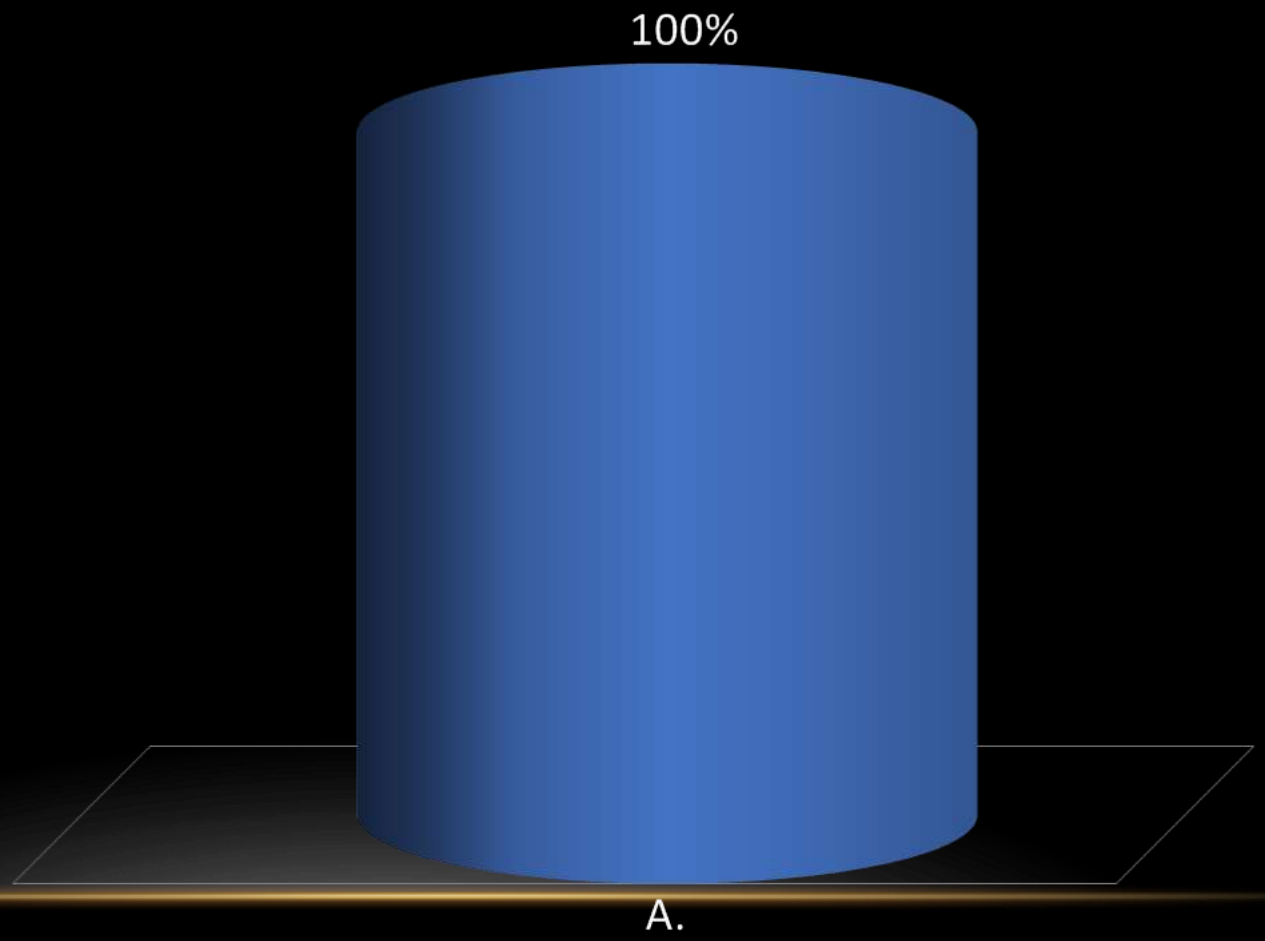
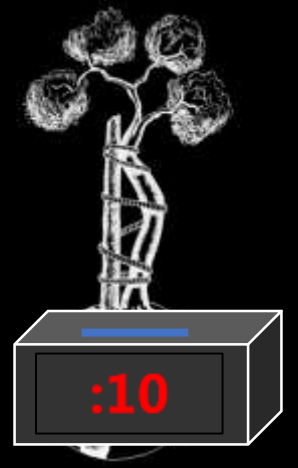
# Shoulder

# Let’s test our devices

A. Yes



# infectionconsensus2018@gmail.com

- For any corrections, comments, edits, etc. please email the above address
- The same comments can be posted on the contact page of our website

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# Prevention

# Dissent options

- If a delegate does not support a recommendation (a dissenting delegate), he /she has one of three options:
  - Vote “YES” but declare reservations.  Delegates who are willing to let a motion pass but desire to register their concerns with the group may choose “declare reservations”.  If there are significant reservations about a motion, the recommendation may be reworded.
  - Abstain (or stand aside): An abstention may be registered by a delegate who has a personal disagreement, conflict of interest, or lack of knowledge around a recommendation but is willing to let the motion pass.  Abstentions are regarded as a “non-yes” vote and the concerns of delegates “standing aside” will be addressed by modifying or better explaining the recommendation.
  - Vote “NO” (Object): If a delegate objects to a proposal, he/she should vote “no”.

# S-1 (Former S-70) What is the role of medical comorbidities as potential risk factors for PJI following primary or revision TSA?

**RESEARCHED BY:**

Morris, Brent MD, USA

King, Joseph J MD, USA

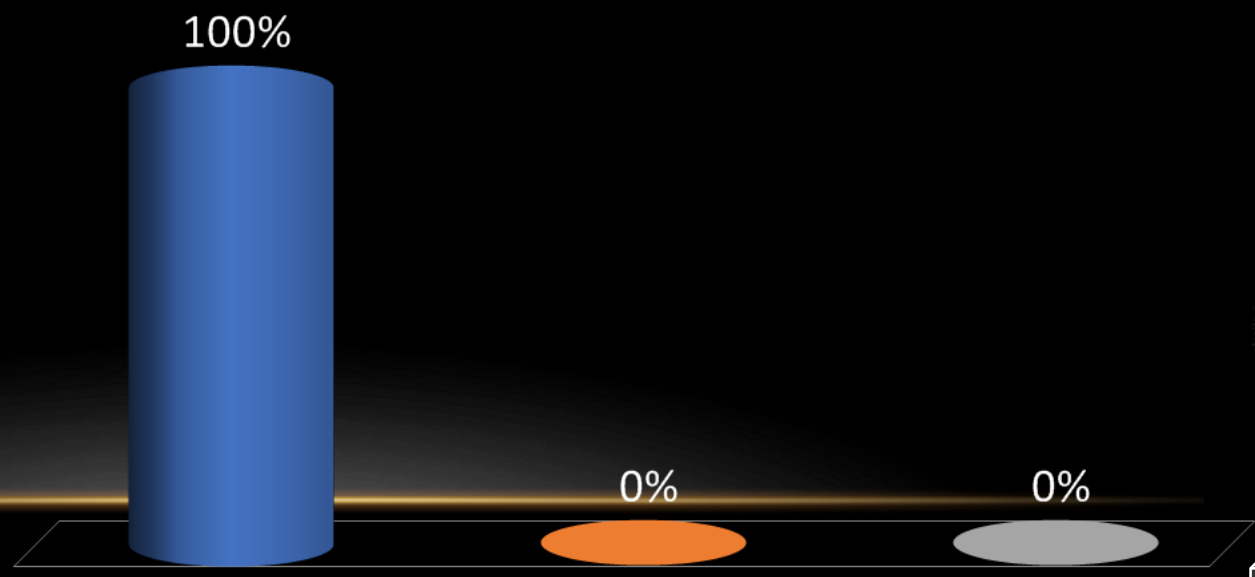
# Literature:

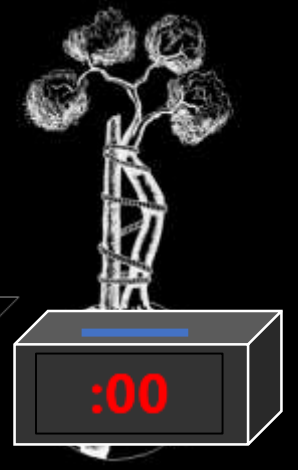
- **Prospective: 0**
- **Retrospective: 9**
- **Database: 1**
- **Meta-analysis: 0**
- **Scientific Review: 0**

**Recommendation:** Specific patient medical comorbidities and demographic factors are potential risk factors for shoulder PJI and appropriate pre-operative evaluation and peri-operative management should be standard practice.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain



# S-2 (Former S-55) What are the optimal peri-operative antibiotics for primary shoulder arthroplasty?

**RESEARCHED BY:**

Pottinger, Paul MD, USA

Tande, Aaron J MD, USA

Nelson, Sandra Bliss MD, USA

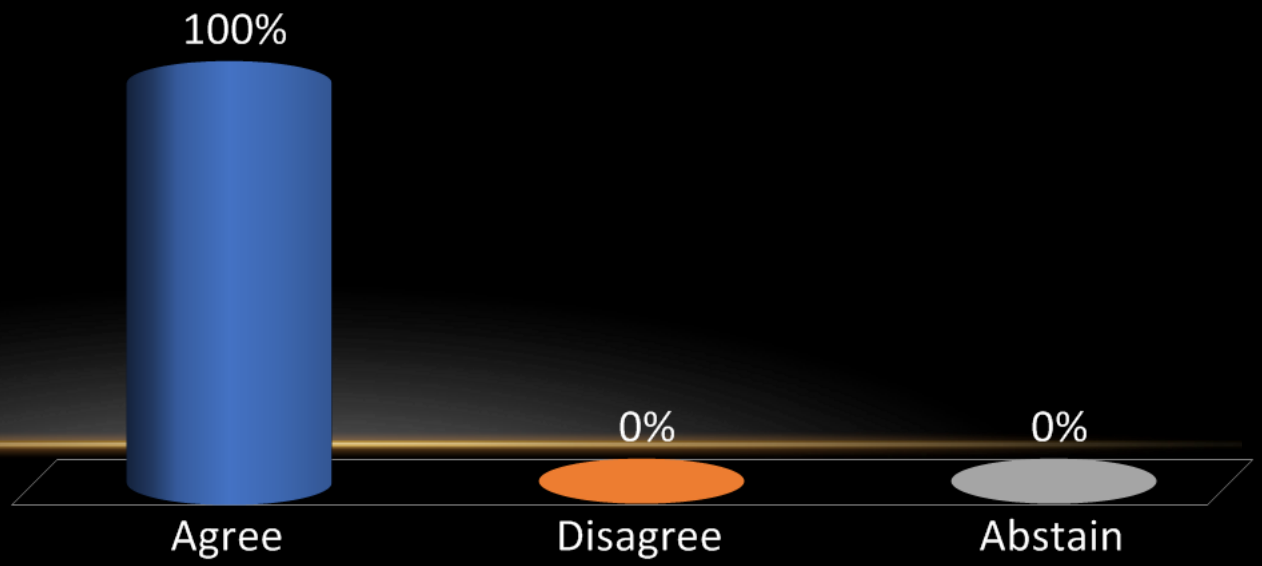
# Literature:

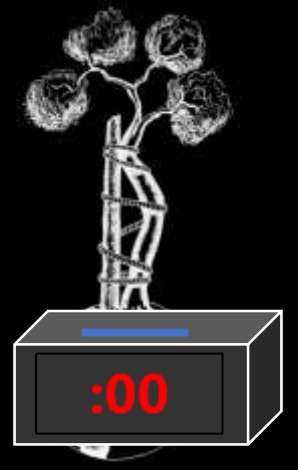
- **Prospective: 3**
- **Retrospective/Registry: 7 (2 lower ext.; 3 non-orthopedics)**
- **Database: 1**
- **Meta-analysis: 0**
- **Scientific Review: 0**

**Recommendation:** Patients undergoing primary shoulder arthroplasty should receive antibiotics that cover gram-positive and gram-negative organisms specific to the regionally encountered organisms. Peer-reviewed literature supports **cefazolin** be dosed based on body weight (see Table 1). Patients with **MRSA colonization** should receive weight-based **glycopeptide**, preferably in combination with cefazolin (see Table 1). Patients who are believed to have an intolerance to beta-lactam antibiotics should be further evaluated to determine if they can receive cefazolin. Patients with a true hypersensitivity reaction or adverse reaction that precludes the use of cefazolin should receive vancomycin or clindamycin.

Level of Evidence: Consensus

A. Agree
B. Disagree
C. Abstain



# S-3 (Former S-54) What are the optimal peri-operative antibiotics for patients undergoing revision shoulder arthroplasty?

**RESEARCHED BY:**

Pottinger, Paul MD, USA

Tande, Aaron J MD, USA

Calixto, Luis F MD, Colombia

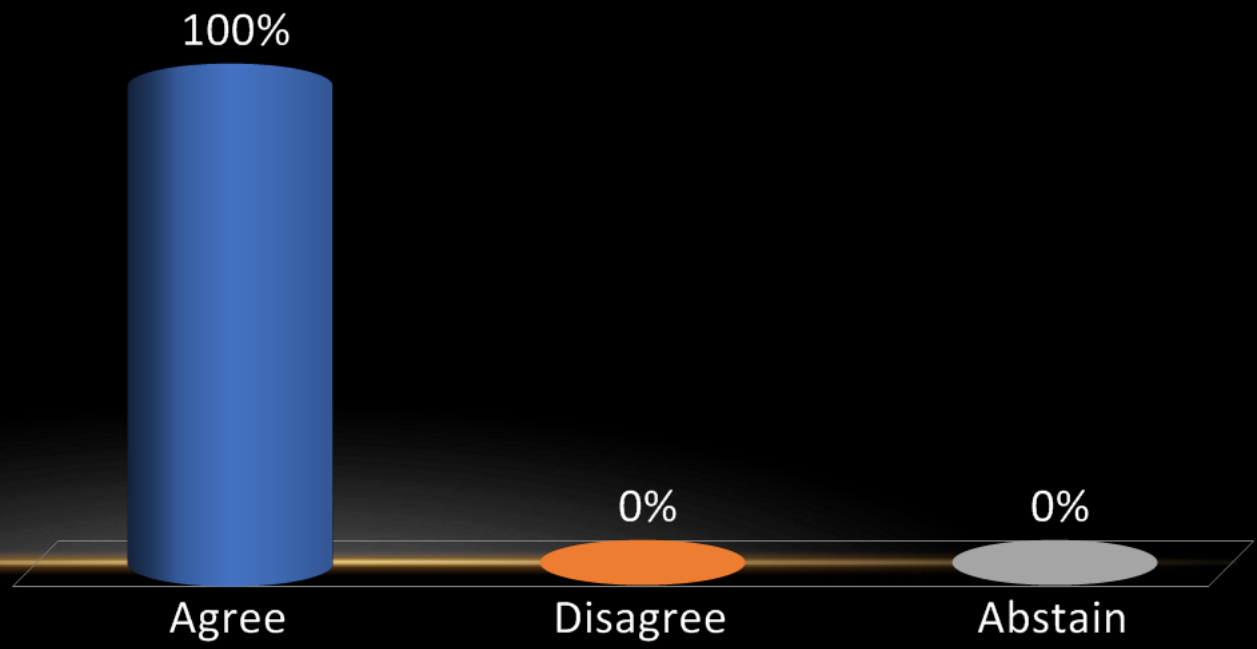
# Literature:

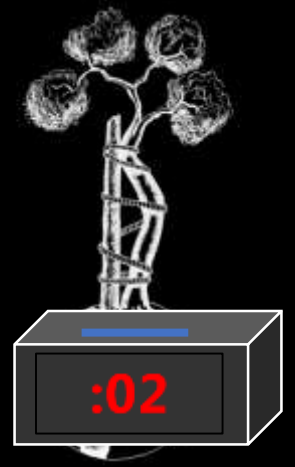
- **Prospective: 3**
- **Retrospective/Registry: 7 (2 lower ext.; 2 non-orthopedic)**
- **Database: 0**
- **Meta-analysis: 0**
- **Scientific Review: 0**
- **Consensus: 1**

**Recommendation:** Patients undergoing revision shoulder arthroplasty should receive prophylactic antibiotics as discussed in question XX. As addressed in question XX, if there is suspicion for preexisting infection during surgery, consider oral amoxicillin or first-generation cephalosporin (or oral doxycycline if beta-lactam allergic) until cultures are finalized.

**Level of Evidence:** Consensus

A. Agree
B. Disagree
C. Abstain



# S-4 (Former S-1) Are there peri-operative antibiotics that should be used for patients who have specific preoperative risk factors (e.g. patient sex and comorbidities) for shoulder PJI?

**RESEARCHED BY:**

Pottinger, Paul MD, USA

Tande, Aaron J MD, USA

Nelson, Sandra Bliss MD, USA

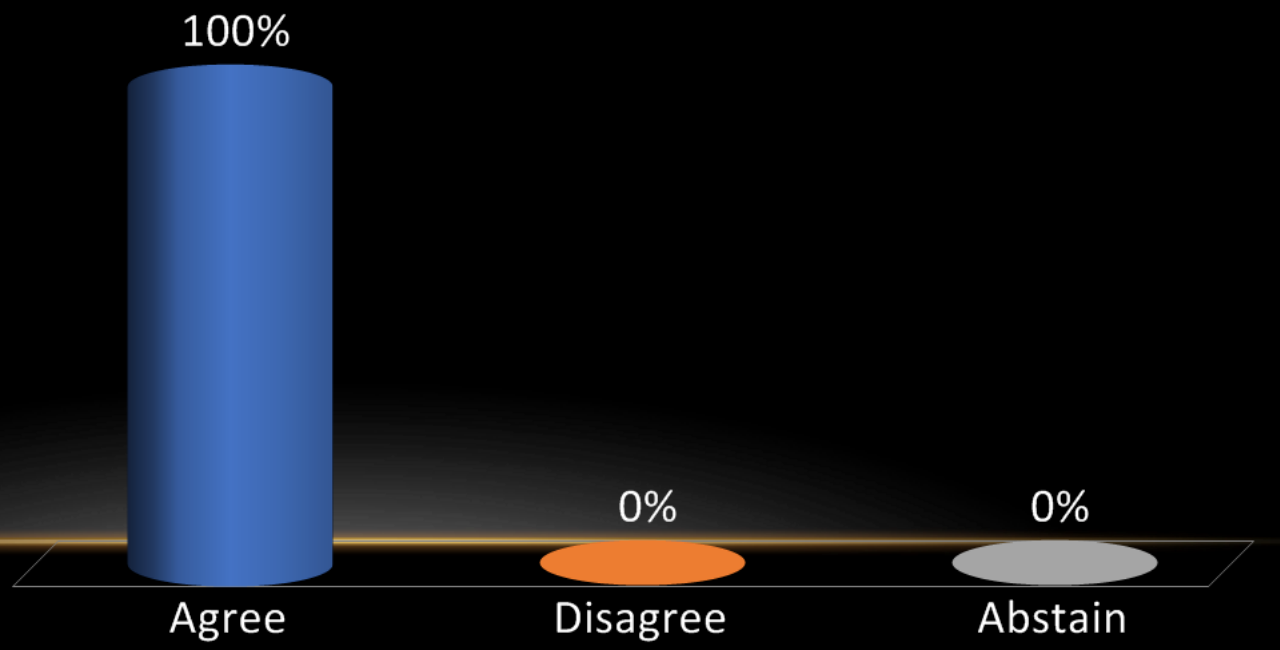
# Literature:

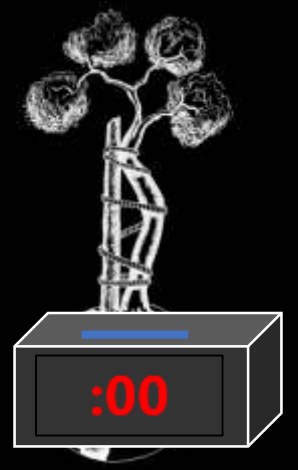
- **Prospective: 4**
- **Retrospective/Registry: 3 (2 lower ext.; 1 non-orthopedic)**
- **Database: 0**
- **Meta-analysis: 0**
- **Scientific Review: 0**
- **Consensus: 0**

**Recommendation:** While risk of infection may be affected by demographics and comorbidities, outside of known MRSA colonization or true allergy there are not patient-specific factors that justify a change in prophylaxis recommendations. Patients with MRSA colonization should receive a glycopeptide, in addition to standard prophylaxis.

**Level of Evidence:** Consensus

A. Agree
B. Disagree
C. Abstain



# S-5 (Former S-61) What is the optimal duration of peri-operative antibiotics following primary or revision shoulder arthroplasty?

**RESEARCHED BY:**

King, Joseph J MD, USA

Morris, Brent MD, USA

Lachiewicz, Anne MD, USA

# Literature:

- **Prospective: 10 (2 lower ext.; 4 non-orthopedic)**
- **Retrospective/Registry: 3**
- **Database: 0**
- **Meta-analysis: 0**
- **Systematic Review: 3 (1 lower extremity; 1 non-orthopedic)**
- **Consensus/Expert: 4 (1 lower extremity; 2 non-orthopedic)**

No literature directly addresses this proposed question.

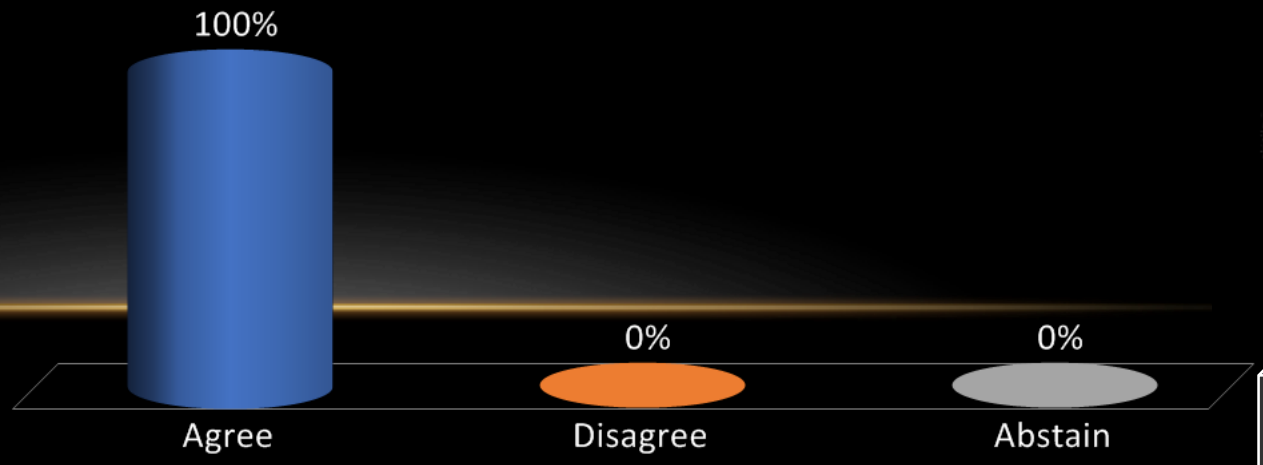
## Recommendation:

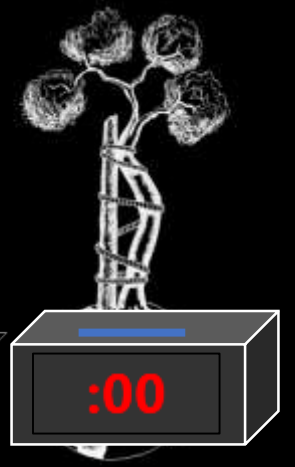
Primary: Prophylactic intravenous antibiotics should be given within 1 hour prior to incision to decrease the risk of infection. Intravenous antibiotics may be continued for 24 hours postoperatively.

Revision: Intravenous antibiotics should be given within 1 hour prior to incision. While controversial, the current evidence suggests that prophylactic antibiotics should not be routinely held until tissue for culture is obtained (see question S-17). Intravenous antibiotics should only be continued for 24 hours postoperatively, unless there is a concern for periprosthetic infection. Antibiotics can be continued up until final culture results are obtained in revision cases if there is some suspicion of infection while awaiting the final culture results.

## Level of Evidence: Moderate

A. Agree
B. Disagree
C. Abstain



# S-6 (Former S-36) Is there a role for topical skin treatments prior to primary or revision shoulder arthroplasty?

**RESEARCHED BY:**


Clark, Ben MD, Australia

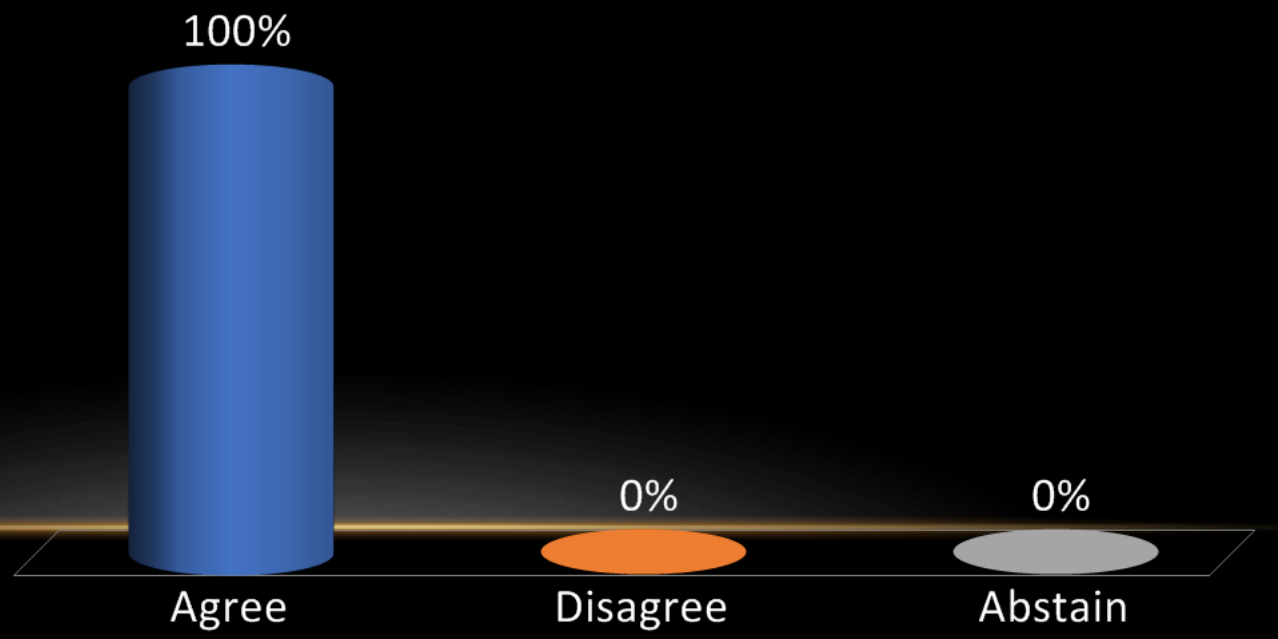
# Literature:

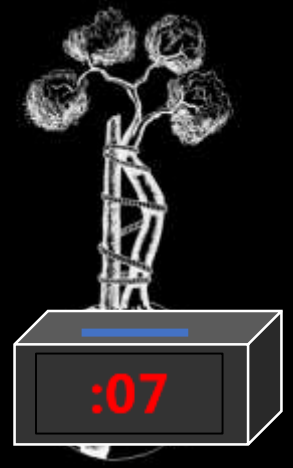
- **Prospective: 8**
- **Retrospective/Registry: 2**
- **Database: 0**
- **Meta-analysis: 1 (1 non-orthopedic)**
- **Systematic Review: 0**
- **Consensus/Expert: 4 (1 non-orthopedic)**

**Recommendation:** At this time, there is no evidence for or against the use of topical skin treatments to reduce the rate of shoulder PJI.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-7 (Former S-64) What Is the optimal perioperative surgical skin prep for primary or revision shoulder arthroplasty?

**RESEARCHED BY:**

Klein, Jason MD, USA

Morrey, Mark MD, USA

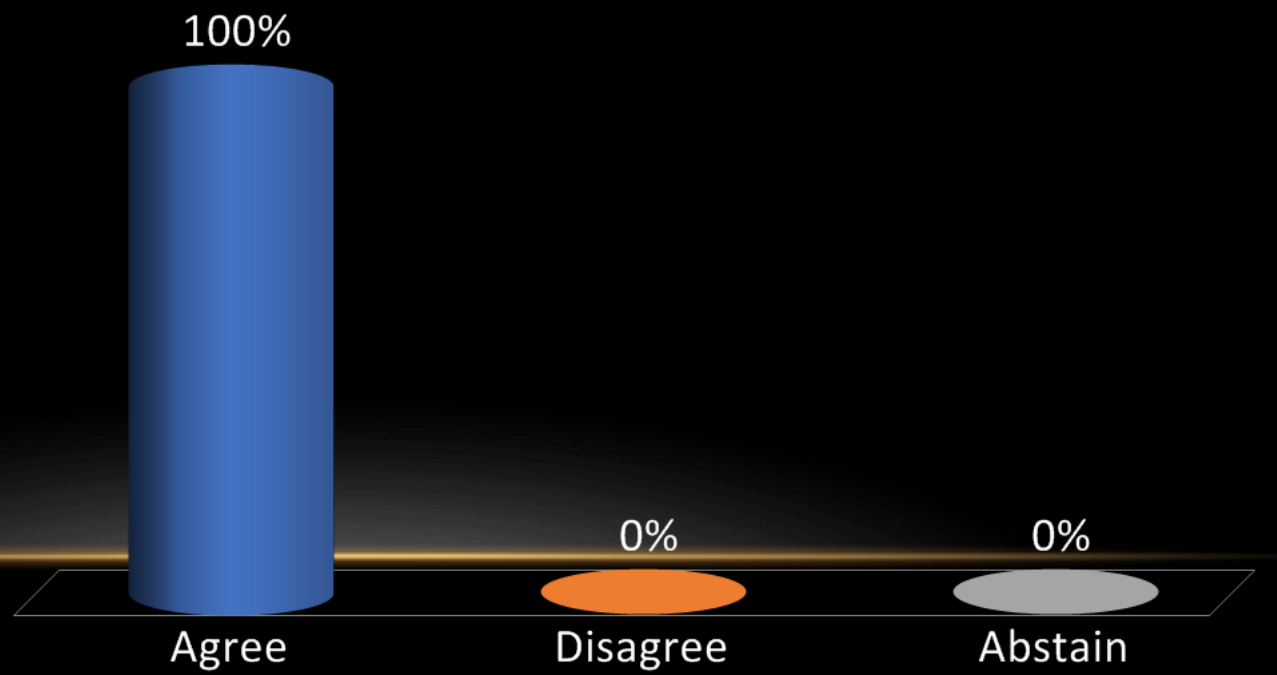
# Literature:

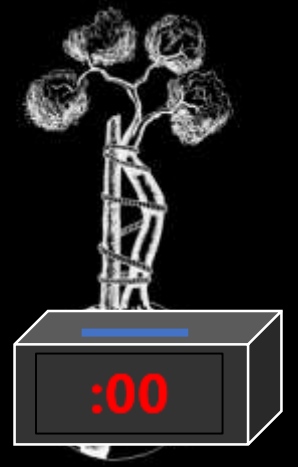
- The recommendation for chlorhexidine/alcohol skin prep is moderate based on **one level-1 randomized controlled trial** on skin prep and **one level-1 study** on skin washes prior to shoulder surgery. The major drawback to both studies was that they were not specific for arthroplasty and included patients undergoing arthroscopy.
- The recommendation for benzoyl peroxide (BPO) wash prior to arthroplasty is moderate based on **one level-1, one level-3, one level-4, 6 high-quality basic science studies on the isolation of Cutibacterium acnes during shoulder surgery, and 50 years of clinical study** supporting the bactericidal effect of BPO on *Cutibacterium acnes* without the development of resistance.

**Recommendation:** The best available evidence supports 2% chlorhexidine gluconate and 70% isopropyl alcohol for surgical skin prep for shoulder arthroplasty.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain



# S-8 (Former S-46) Should the subcutaneous and dermal tissues be disinfected during shoulder arthroplasty?

**RESEARCHED BY:**

Falworth, Mark MD, UK

Somerson, Jeremy MD, USA

# Literature:

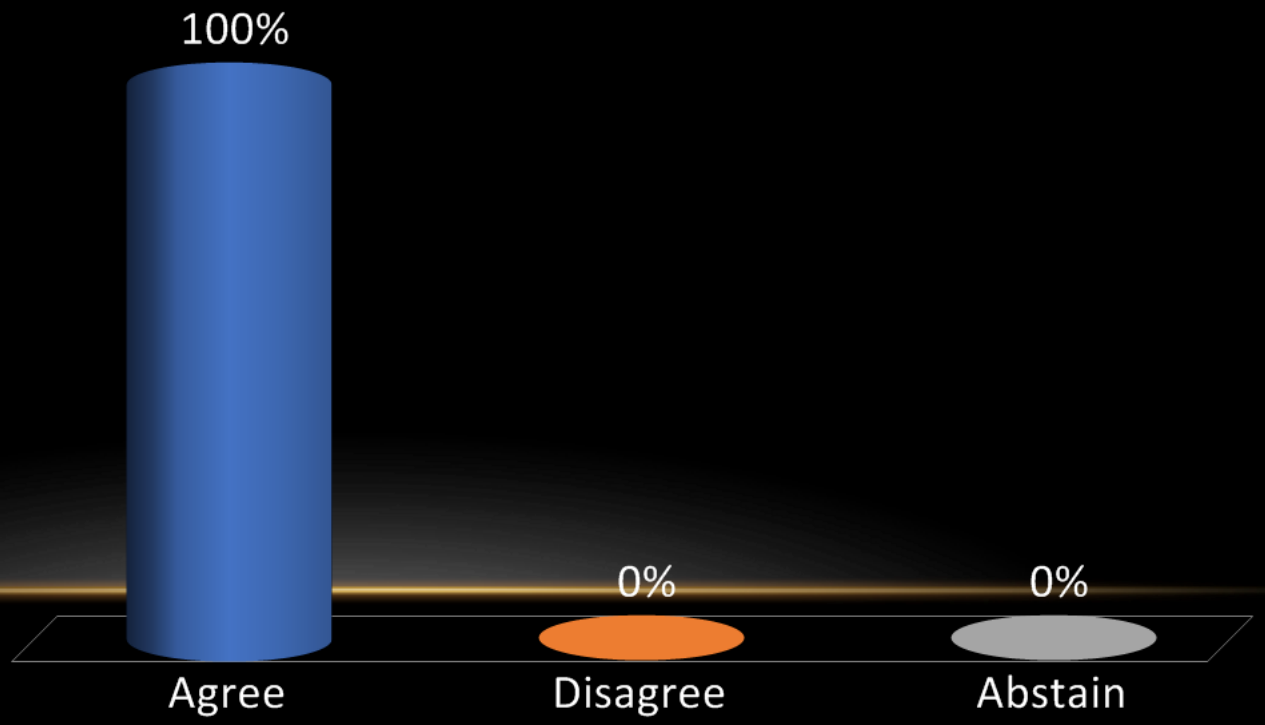
- **Prospective: 1**
- **Retrospective/Registry: 5 (2 lower ext.; 1 spine)**
- **Database: 0**
- **Meta-analysis: 0**
- **Systematic Review: 0**
- **Consensus/Expert: 1 (non-orthopedic)**

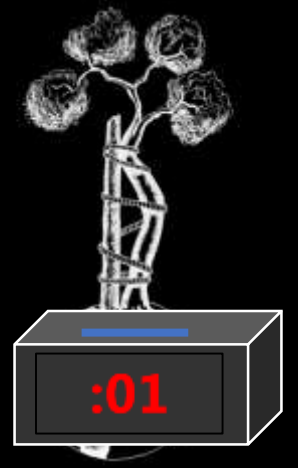
No literature directly addresses this proposed question.

**Recommendation:** There is insufficient evidence for or against disinfection of the subcutaneous and dermal tissues during shoulder arthroplasty.

**Level of Evidence:** No Evidence

A. Agree
B. Disagree
C. Abstain



# S-9 (Former S-69) What is the role of tranexamic acid (TXA) during primary or revision shoulder arthroplasty in decreasing the risk of PJI?

**RESEARCHED BY:**


McFarland, Edward MD, USA

Mora, Josa M MD, Spain

# Literature:

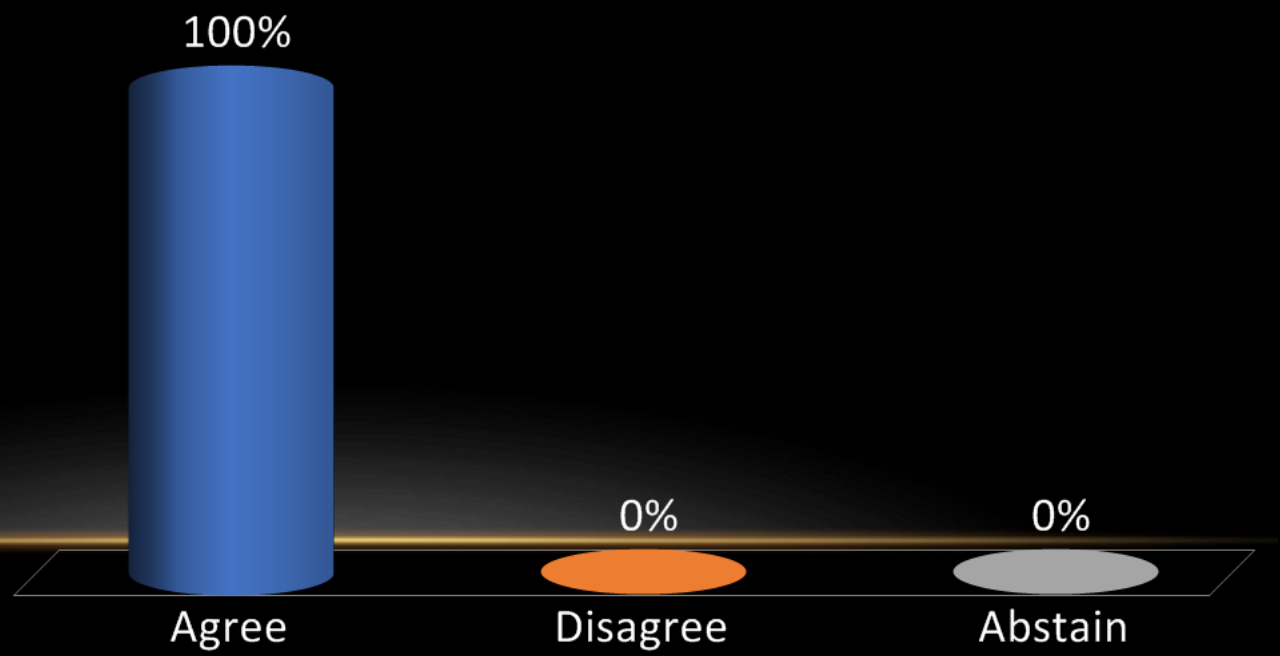
- **Prospective: 9 (1 lower ext.)**
- **Retrospective/Registry: 6**
- **Database: 4**
- **Meta-analysis: 1 (of 4 RCT above)**
- **Systematic Review: 2**
- **Consensus/Expert: 3 (non-orthopedic)**

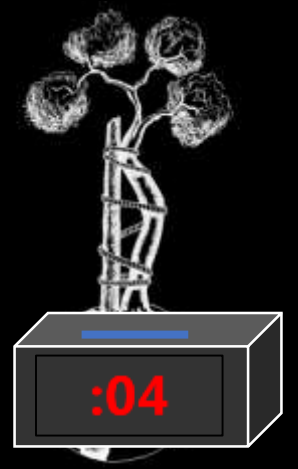
No literature directly evaluates TXA use with infection.

**Recommendation:** There is no evidence to support routine use of TXA in patients undergoing shoulder arthroplasty for the prophylaxis of PJI.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-10 (Former S-2) Do surgical drains influence the risk of infection in patients undergoing primary or revision shoulder arthroplasty?

**RESEARCHED BY:**

Kelly, Jim MD, USA

Sabesan, Vani MD, USA

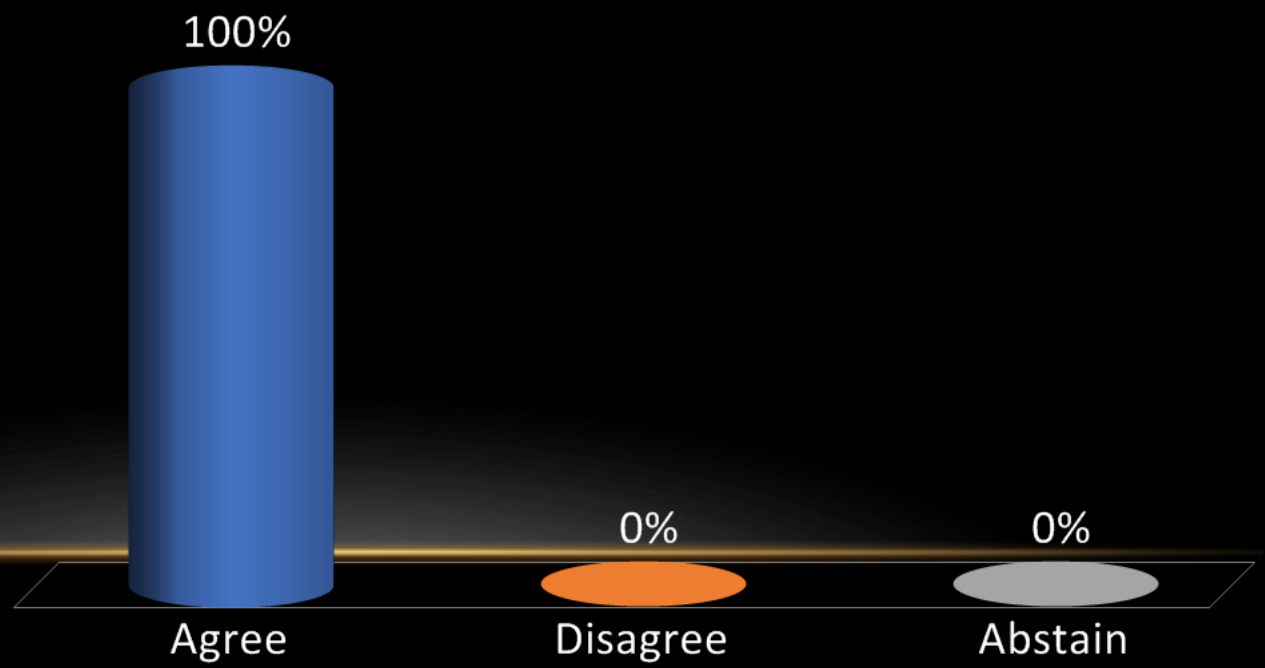
# Literature:

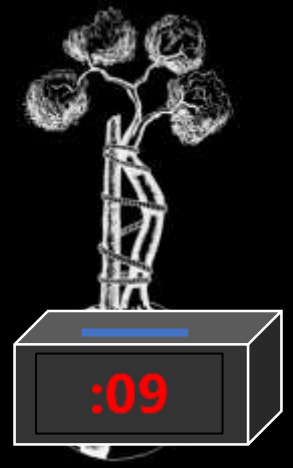
- **Prospective: 1 (included non-arthroplasty shoulder procedures)**
- **Retrospective/Registry: 1**
- **Database: 0**
- **Meta-analysis: 1 (not arthroplasty specific)**
- **Systematic Review: 0**
- **Consensus/Expert: 0**

**Recommendation:** There is no evidence to support routine use of closed-suction drains in patients undergoing shoulder arthroplasty for the prevention of PJI.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-11 (Former S-3) Does previous shoulder surgery (arthroscopic or open non-arthroplasty) increase the risk of PJI?

**RESEARCHED BY:**

Frankle, Mark MD, USA

Hsu, Jason MD, USA

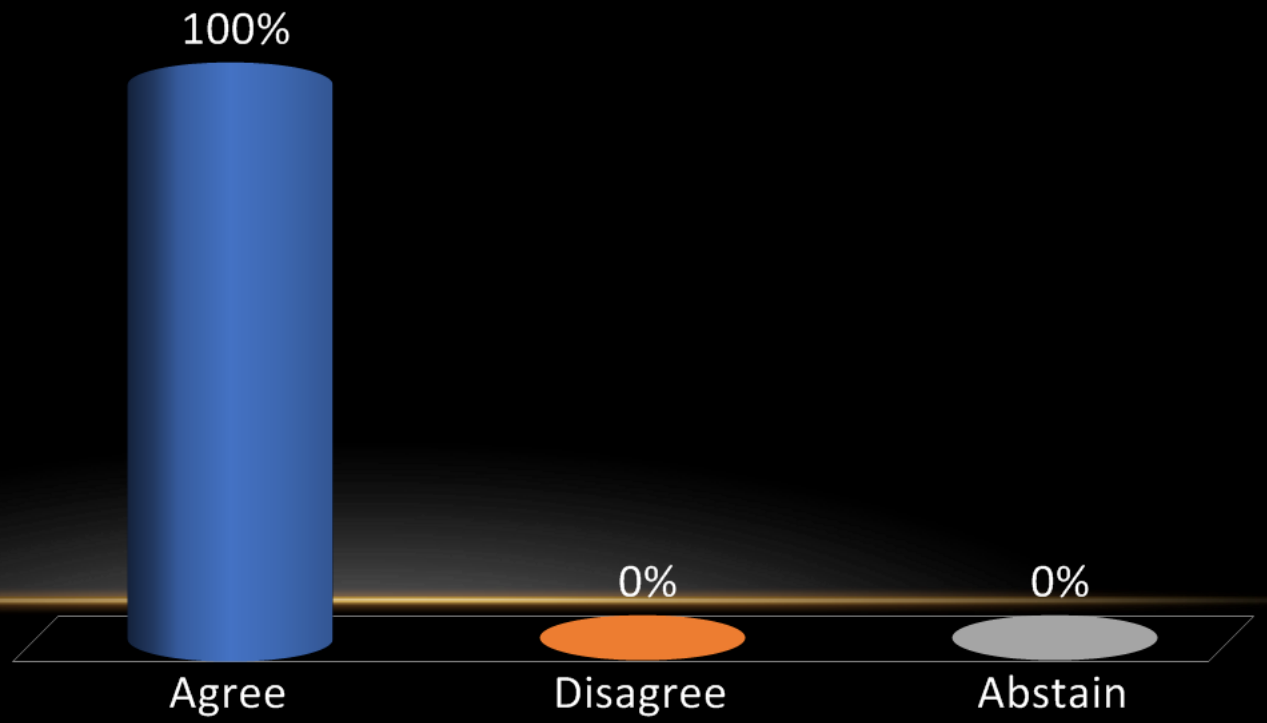
# Literature:

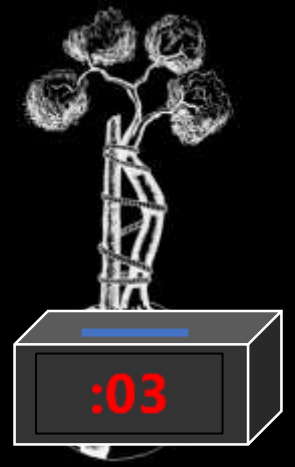
- **Prospective: 7**
- **Retrospective/Registry: 5 (2 directly assessing the question)**
- **Database: 0**
- **Meta-analysis: 0**
- **Systematic Review: 0**
- **Consensus/Expert: 0**

Recommendation: Previous ipsilateral non-arthroplasty shoulder surgery likely increases the risk of shoulder PJI.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-12 (Former S-4) Does prior corticosteroid injection increase the risk of PJI after primary or revision shoulder arthroplasty?

**RESEARCHED BY:**

Frankle, Mark MD, USA

Hsu, Jason MD, USA

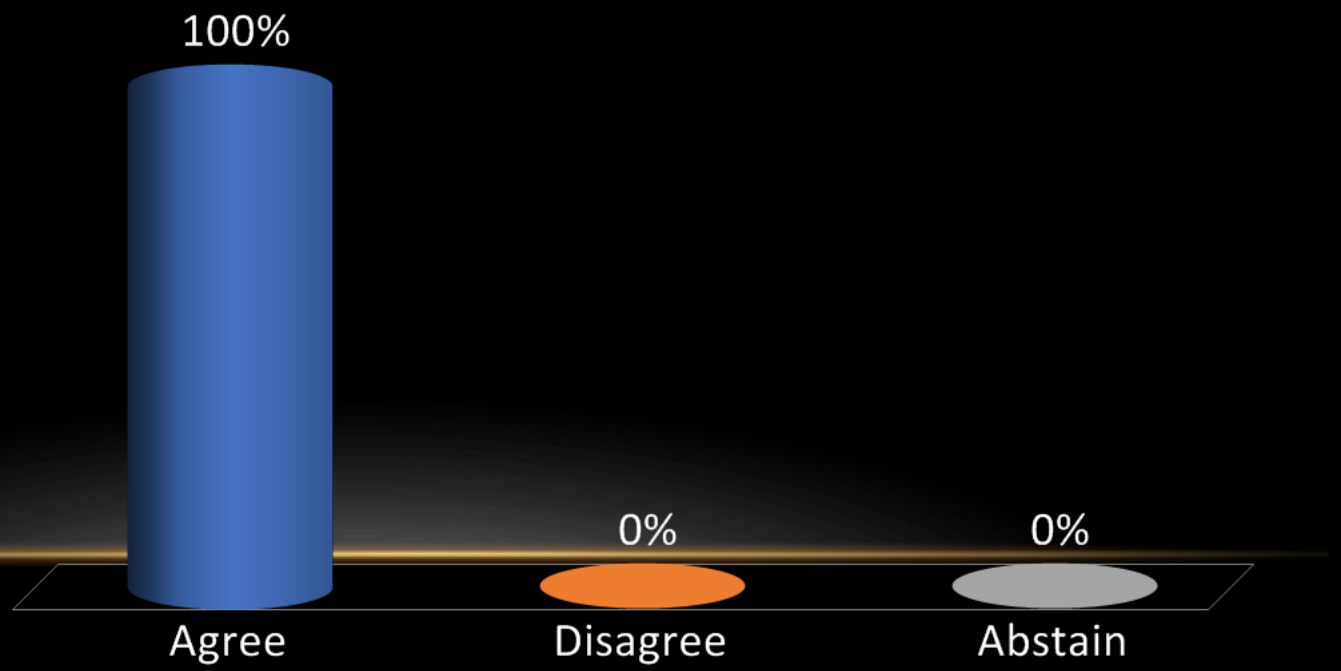
# Literature:

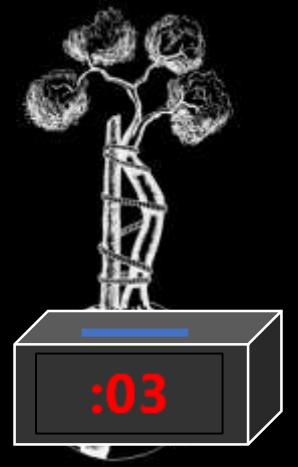
- Prospective: 5
- Retrospective/Registry: 4
  - 1 directly assessing question
  - 2 lower extremity
- Database: 3
  - 1 directly assessing question
  - 2 lower extremity
- Meta-analysis: 0
- Systematic Review: 1 (1 lower extremity)
- Consensus/Expert: 0

Recommendation: An increased number of corticosteroid injections and a shorter interval between corticosteroid injection and shoulder arthroplasty may increase the risk for surgical site infection or shoulder PJI.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-13 (Former S-24) Is there a role for pre-operative skin scrub (home scrubs and washes) prior to primary or revision shoulder arthroplasty?

**RESEARCHED BY:**


Clark, Ben MD, Australia

Sabesan, Vani MD, USA

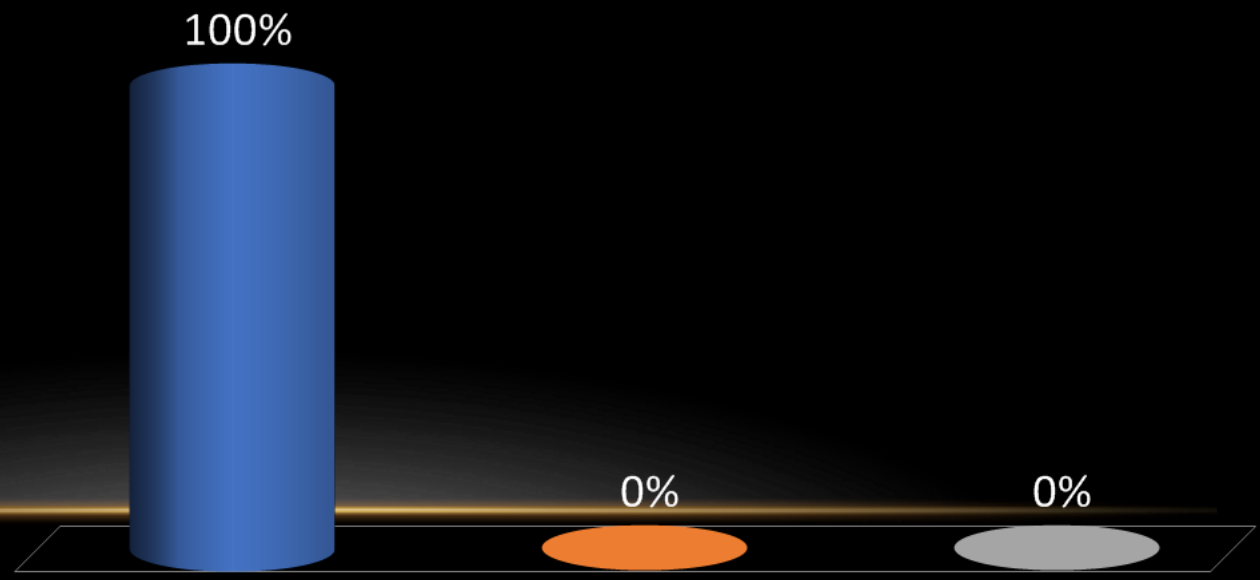
# Literature:

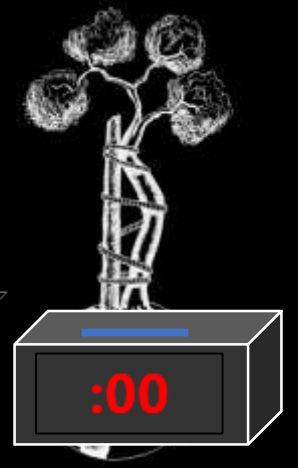
- **Prospective: 4**
  - **1 directly assesses question**
  - **1 non-orthopedic**
  - **2 lower extremity**
- **Retrospective/Registry: 1 (lower extremity)**
- **Database:**
- **Meta-analysis: 0**
- **Systematic Review:  0**
- **Consensus/Expert: 3 (non-orthopedic)**

Recommendation: Chlorhexidine gluconate (CHG) showers or cleansing wipes with at least 2 applications decreases the incidence of positive skin cultures prior to shoulder surgery. Pending further research, this protocol may provide a benefit.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-14 (Former S-38) Should antibiotic-impregnated cement used during shoulder arthroplasty (primary and revision)?

**RESEARCHED BY:**

Falworth, Mark MD, UK

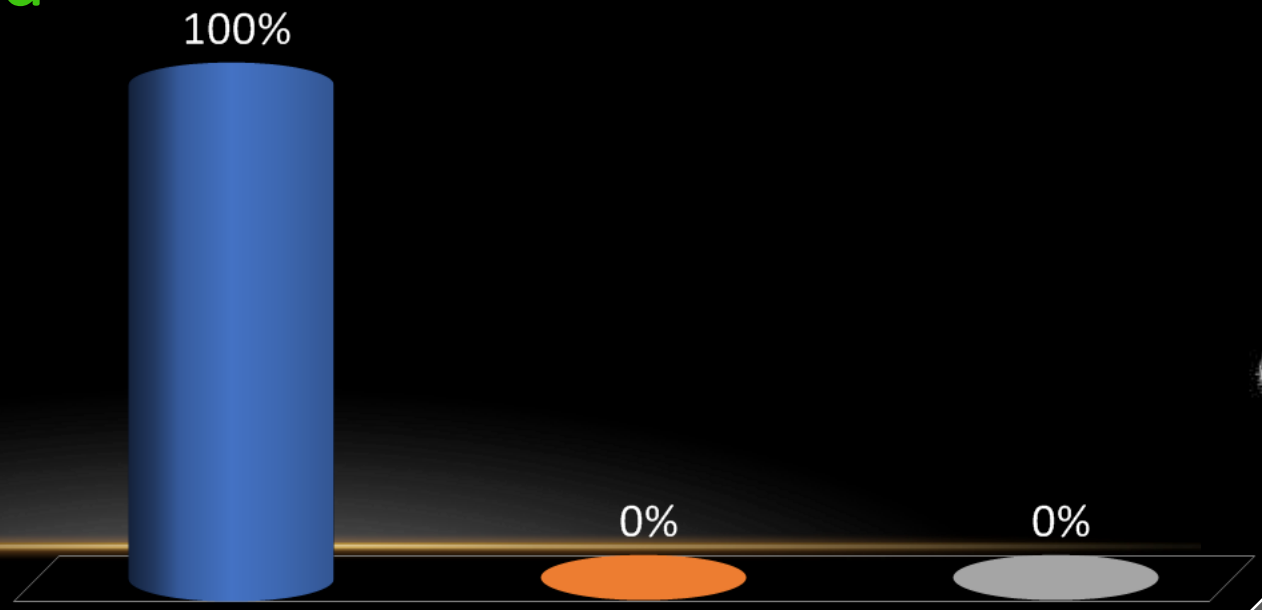
# Literature:

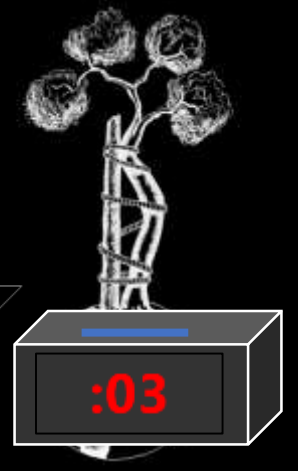
- **Prospective:**
- **Retrospective/Registry: 4**
  - **2 lower extremity**
- **Database:**
- **Meta-analysis: 0**
- **Systematic Review:  0**
- **Consensus/Expert: 1**

**Recommendation:** There is insufficient evidence to determine whether antibiotic-impregnated cement should be used during primary or revision shoulder arthroplasty.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-15 (Former S-73) What is the role of topical intrawound antiseptics (dilute betadine lavage, acetic acid, or antibiotics added to the irrigation solution) and antibiotic powder (such as vancomycin) during primary or revision shoulder arthroplasty?

**RESEARCHED BY:**

Yian, Edward MD, USA

Namdari, Surena MD, USA

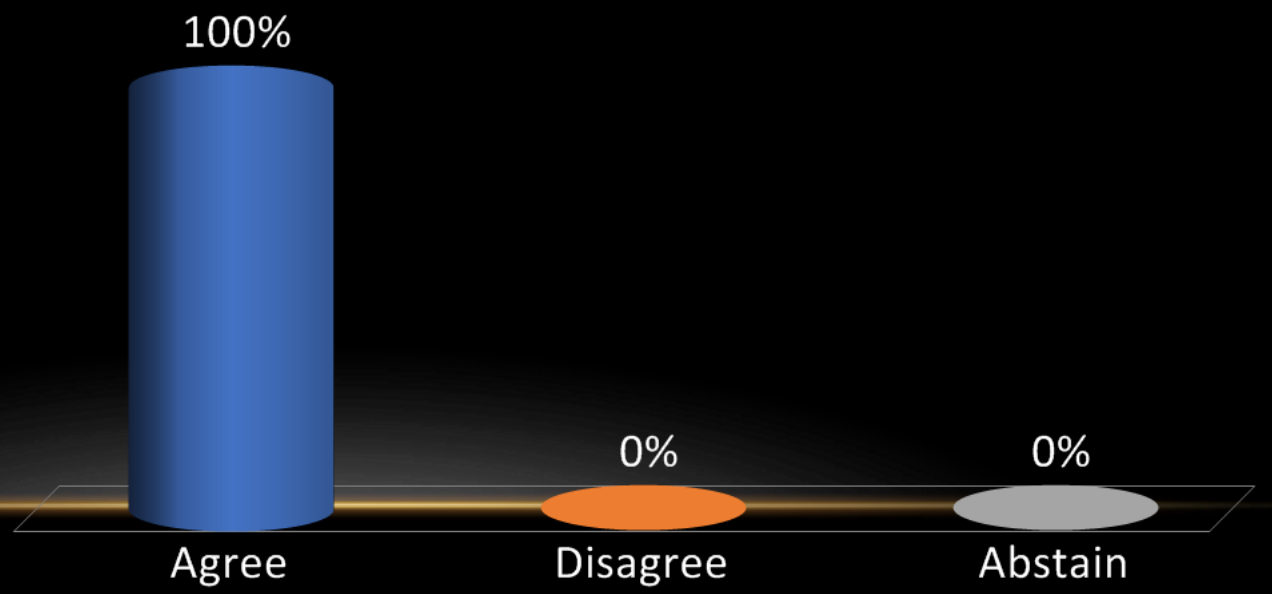
# Literature:

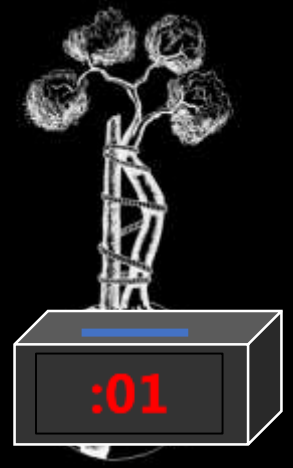
- **Prospective: 2 (spine)**
- **Retrospective/Registry: 4**
  - **2 spine**
  - **1 lower extremity**
- **Database: 0**
- **Meta-analysis: 0**
- **Systematic Review:  1 (1 spine)**
- **Consensus/Expert: 0**
- **Basic Science: 1**

Recommendation: Dilute povidine-iodine and/or vancomycin powder may have a role in patients considered at high-risk for PJI after primary or revision shoulder arthroplasty based on data extrapolated from other orthopedic specialties.

Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-16 (Former S-19) Is there a role for post-operative (pending culture results) antibiotics after revision shoulder arthroplasty without suspicion for infection?

**RESEARCHED BY:**

Peel, Trisha N MD, Australia

Yian, Edward MD, USA

Namdari, Surena MD, USA

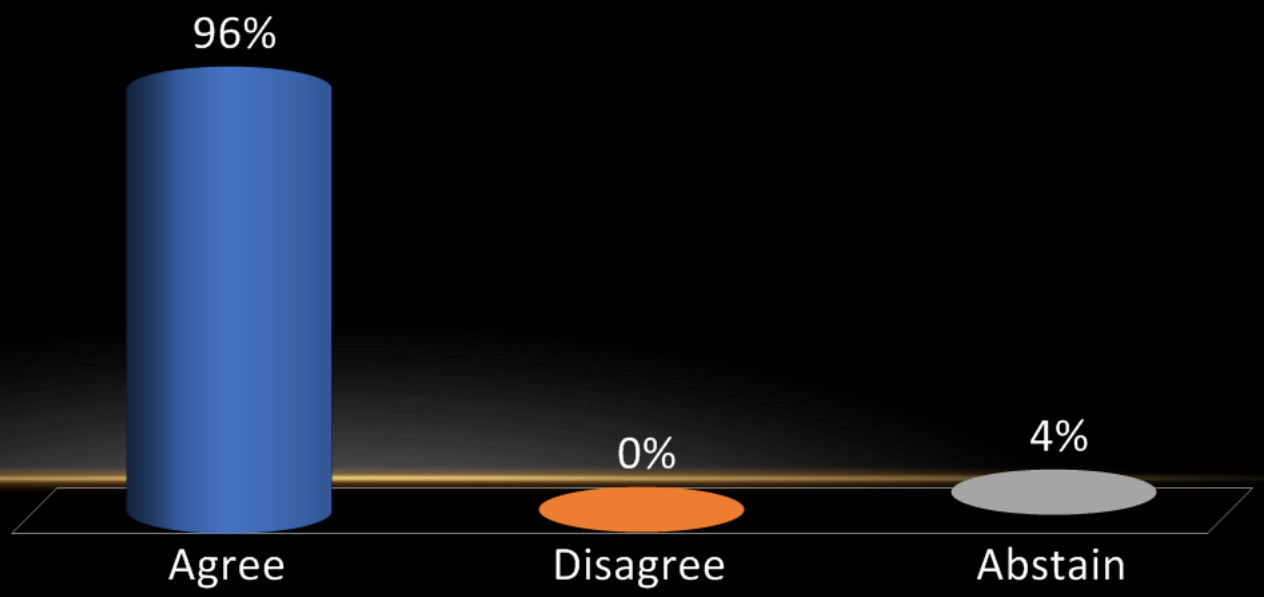
# Literature:

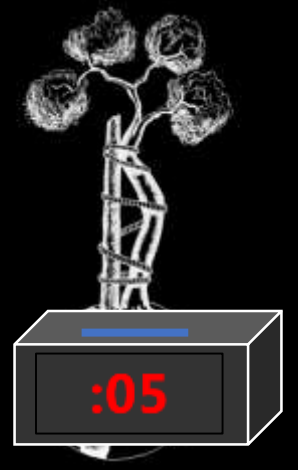
- **Prospective: 2 (1 lower extremity)**
- **Retrospective/Registry:  6**
- **Database: 0**
- **Meta-analysis: 0**
- **Systematic Review:  1**
- **Consensus/Expert: 3 (2 non-orthopedic)**

**Recommendation:** In revision shoulder arthroplasty without clinical suspicion for infection, prolonged antibiotics are not routinely required.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# Diagnostic

# S-17 (Former S-43) Should pre-operative antibiotics be held until after cultures are obtained in revision shoulder arthroplasty?

**RESEARCHED BY:**

Cil, Akin MD, USA

Tashjian, Robert MD, USA

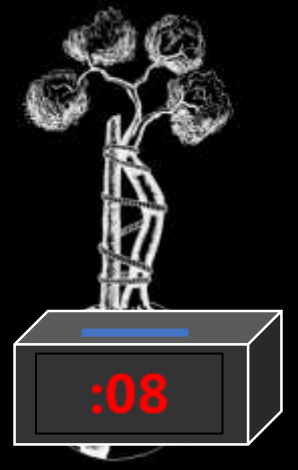
# Literature:

- **Prospective: 4 (2 lower extremity)**
- **Retrospective/Registry: 9 (1 lower extremity)**
- **Database: 0**
- **Meta-analysis: 1 (lower extremity)**
- **Systematic Review:  0**
- **Consensus/Expert: 3 (1 lower extremity)**

**Recommendation:** Recent studies have shown that pre-operative antibiotic prophylaxis does not adversely affect intraoperative culture results. We do not recommend routinely holding pre-operative antibiotics in revision shoulder arthroplasty.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain

# S-18 (Former S-6) Does the sampling technique (number of samples, tissue versus fluid versus implant, anatomic locations) affect the results for culture of specimens obtained in the evaluation of shoulder PJI?

**RESEARCHED BY:**

Zmistowski, Benjamin MD, USA

Zuckerman, Joseph MD, USA

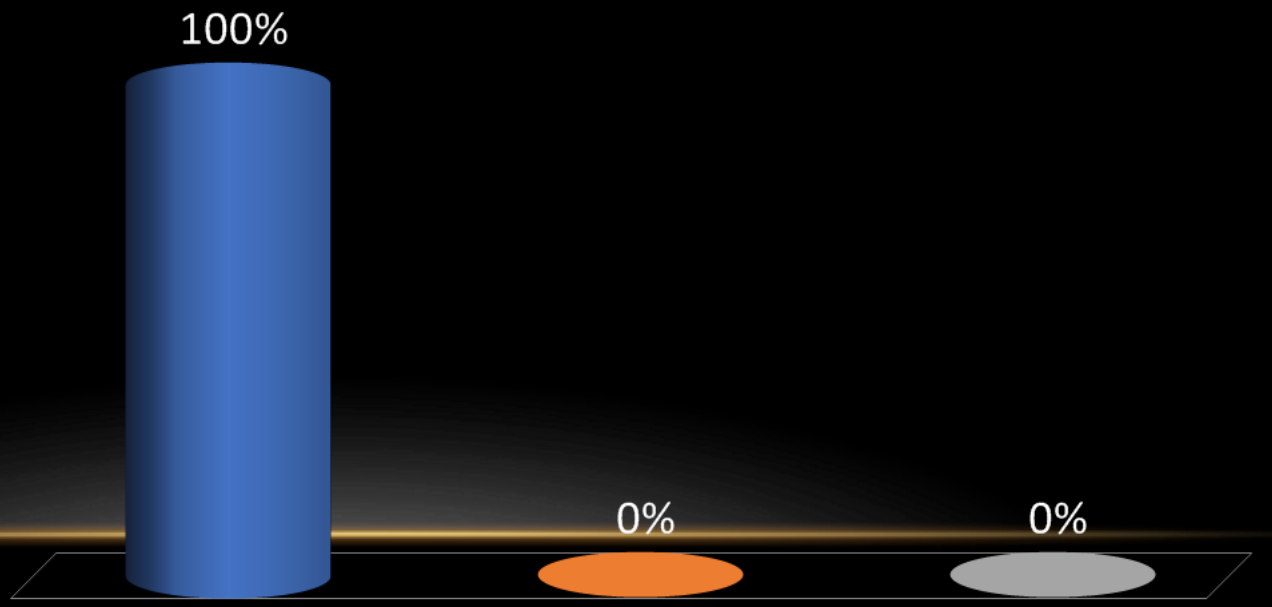
# Literature:

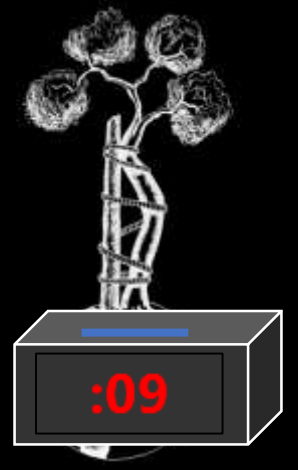
- **Prospective: 8**
  - **3 lower extremity**
- **Retrospective/Registry: 9**
- **Database: 0**
- **Meta-analysis: 0**
- **Systematic Review:  1**
- **Consensus/Expert: 1**

**Recommendation:** We recommend five deep tissue specimens for culture be obtained from various surgical sites (e.g. capsule, humeral canal, and peri-prosthetic membranes in the proximal humerus and glenoid). Use of swabs is discouraged. Fresh instruments should be used to obtain and place samples directly into sterile containers. Fluid sampling may be beneficial but has lower yield compared to tissue.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-19 (Former S-14) Is there a role for obtaining tissue cultures when performing an irrigation and debridement for hematoma after shoulder (primary or revision) arthroplasty?

**RESEARCHED BY:**

Abboud, Joseph MD, USA  Duquin, Thomas MD, USA  Henry, Michael MD, USA

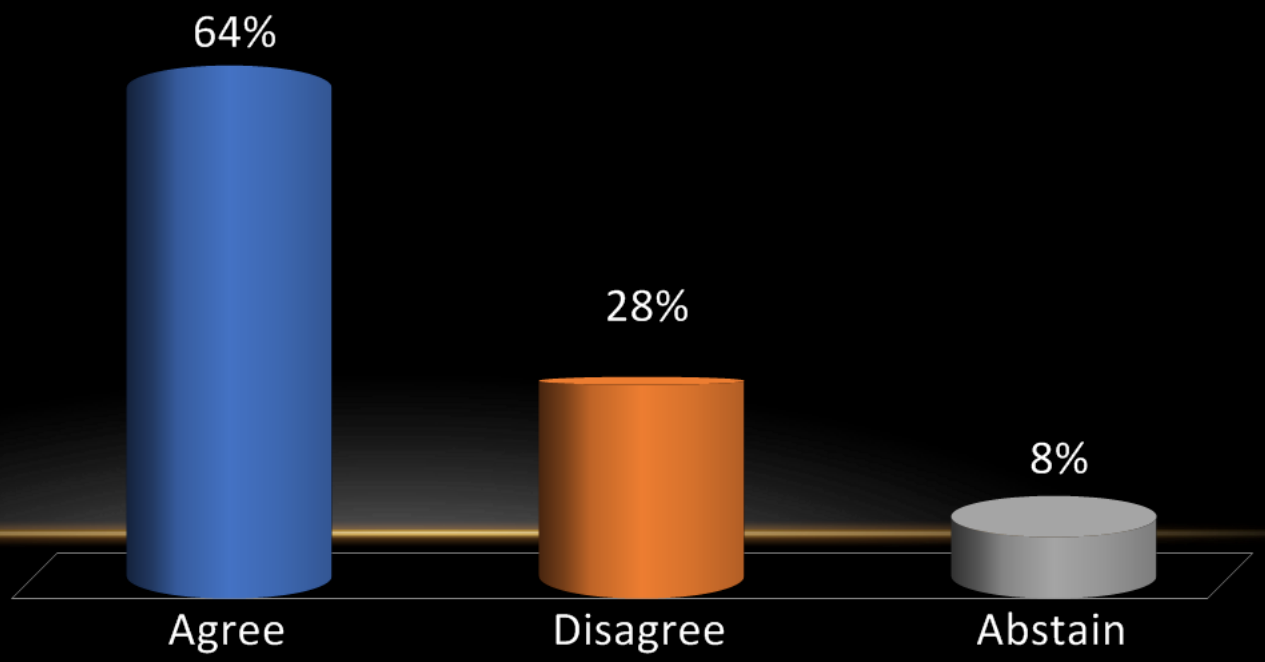
# Literature:

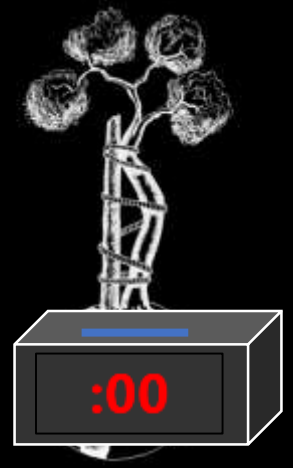
- **Prospective: 0**
- **Retrospective/Registry: 16**
  - **1 directly assessing infection and hematoma**
  - **3 lower extremity**
- **Database: 2**
- **Meta-analysis: 0**
- **Systematic Review:  3**
- **Consensus/Expert: 3**

**Recommendation:** Deep tissue samples should be routinely obtained and sent for culture when performing an irrigation and debridement (I&D) for hematoma after shoulder (primary or revision) arthroplasty.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-20 (Former S-47) Should tissue cultures be obtained in primary shoulder arthroplasty cases with history of prior surgery (arthroscopic, open, ORIF, or another non-arthroplasty surgery)?

**RESEARCHED BY:**

Choon, David MD, Malaisia

McFarland, Edward MD, USA

Gerber, Christian MD, Switzerland

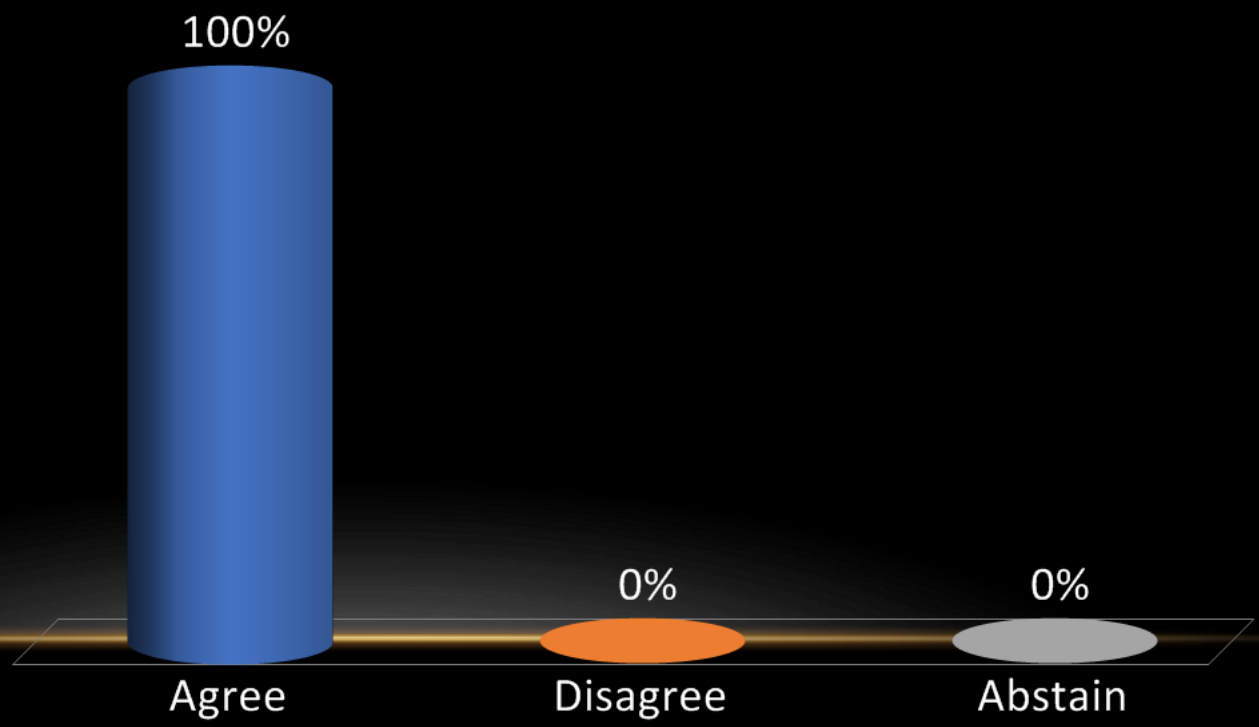
# Literature:

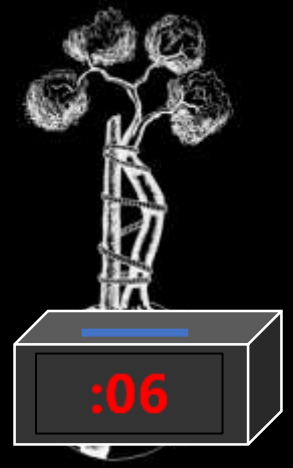
- **Prospective: 4**
- **Retrospective/Registry: 10**
  - **1 non-arthroplasty case-series**
- **Database: 1**
- **Meta-analysis: 0**
- **Systematic Review:  0**
- **Consensus/Expert: 1**

**Recommendation:** Obtaining tissue samples for culture in patients with history of prior non-arthroplasty surgery may be indicated in select cases.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-21 (Former S-48) Should tissue samples be obtained for culture in all revision shoulder arthroplasties?

**RESEARCHED BY:**

Falworth, Mark MD, UK

McFarland, Edward MD, USA

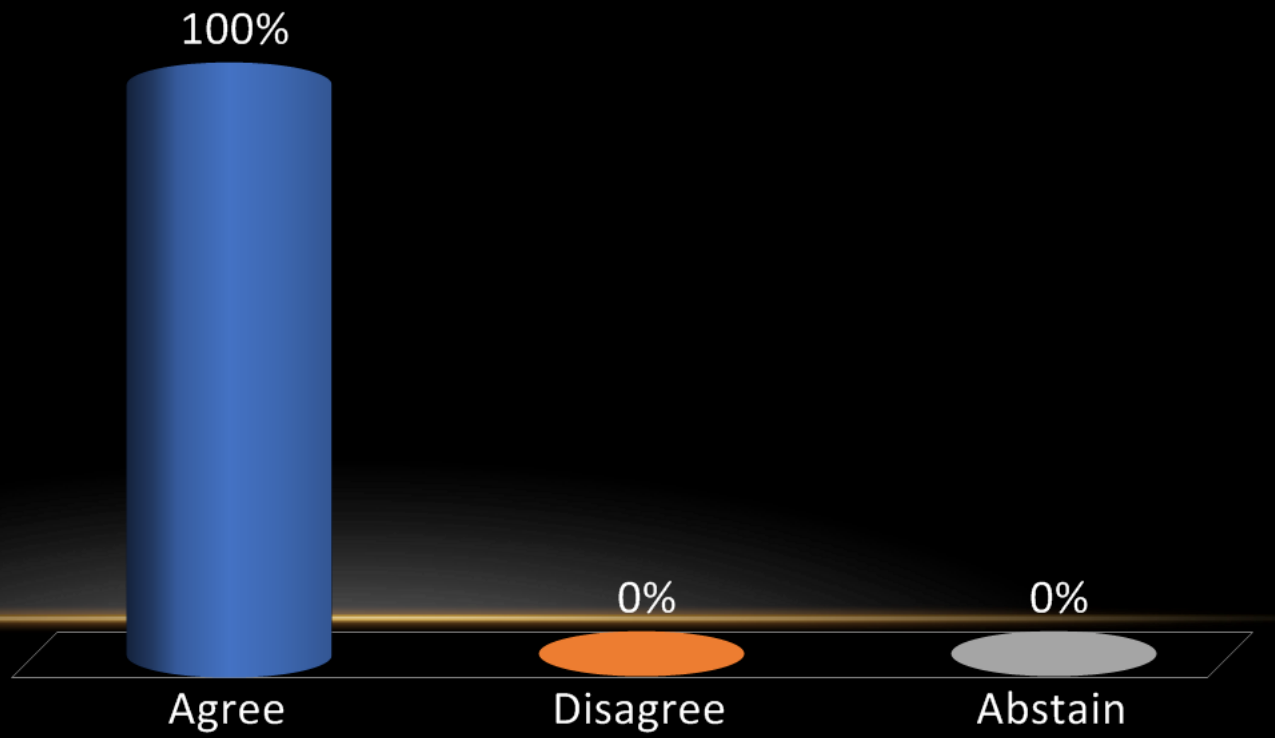
# Literature:

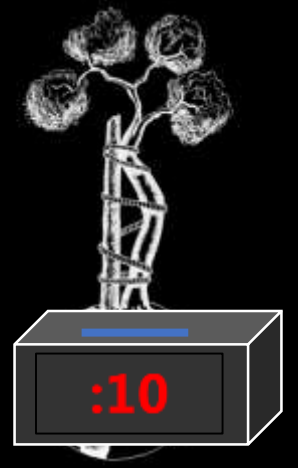
- **Prospective: 2**
  - **1 lower extremity**
- **Retrospective/Registry: 6**
- **Database: 0**
- **Meta-analysis: 0**
- **Systematic Review: 0**
- **Consensus/Expert: 3**

**Recommendation:** Tissue samples should be obtained for culture in all revision shoulder arthroplasties when there is suspicion for infection.

**Level of Evidence:** Consensus

A. Agree
B. Disagree
C. Abstain



# S-22 (Former S-60) What is the optimal culture technique (e.g. culture medium, days of incubation) in evaluating patients for shoulder PJI?

**RESEARCHED BY:**

Matsen, Frederick MD, USA

Scarborough, Matthew MD, UK

Green, Andrew MD, USA

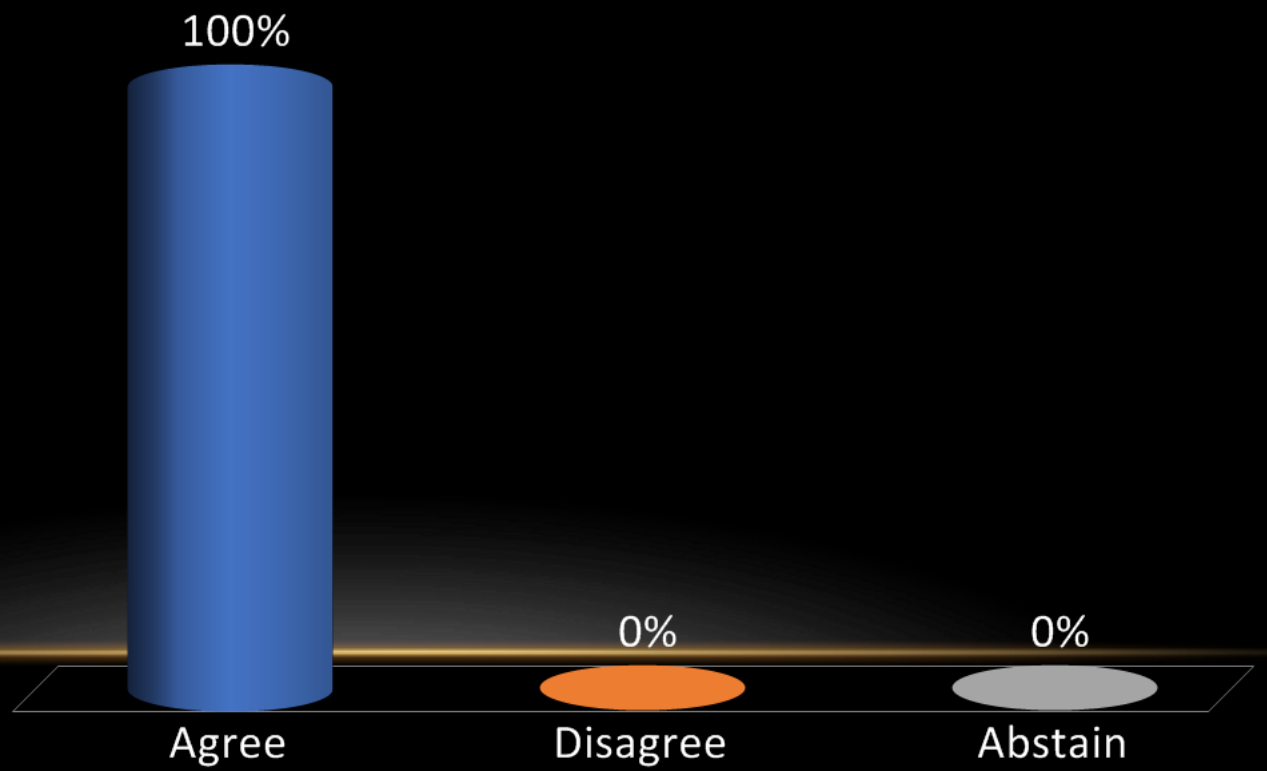
# Literature:

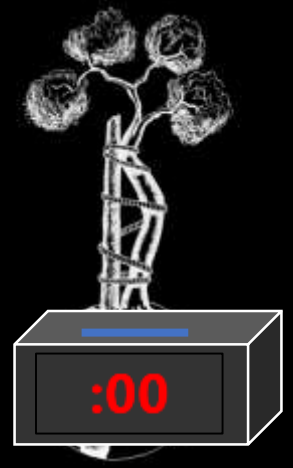
- **Prospective: 5**
  - **4 lower extremity**
  - **1 pediatrics**
- **Retrospective/Registry: 7**
  - **3 lower extremity**
- **Database: 0**
- **Meta-analysis: 0**
- **Systematic Review:  0**
- **Consensus/Expert: 2**

**Recommendation:** Current evidence suggests that culture of tissue samples for the diagnosis of shoulder PJI is best performed using both aerobic and anaerobic conditions. For solid culture media, diagnostic accuracy may be improved by using enrichment media. Fourteen days is the most common culture duration cited.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-23 (Former S-44) Should *Cutibacterium acnes* (formerly known as *Propionibacterium acnes*) isolated in samples from the shoulder be sub-typed?

**RESEARCHED BY:**

Bozhkova, Svetlana MD, Russia

King, Joseph J MD, USA

Morris, Brent MD, USA

# Literature:

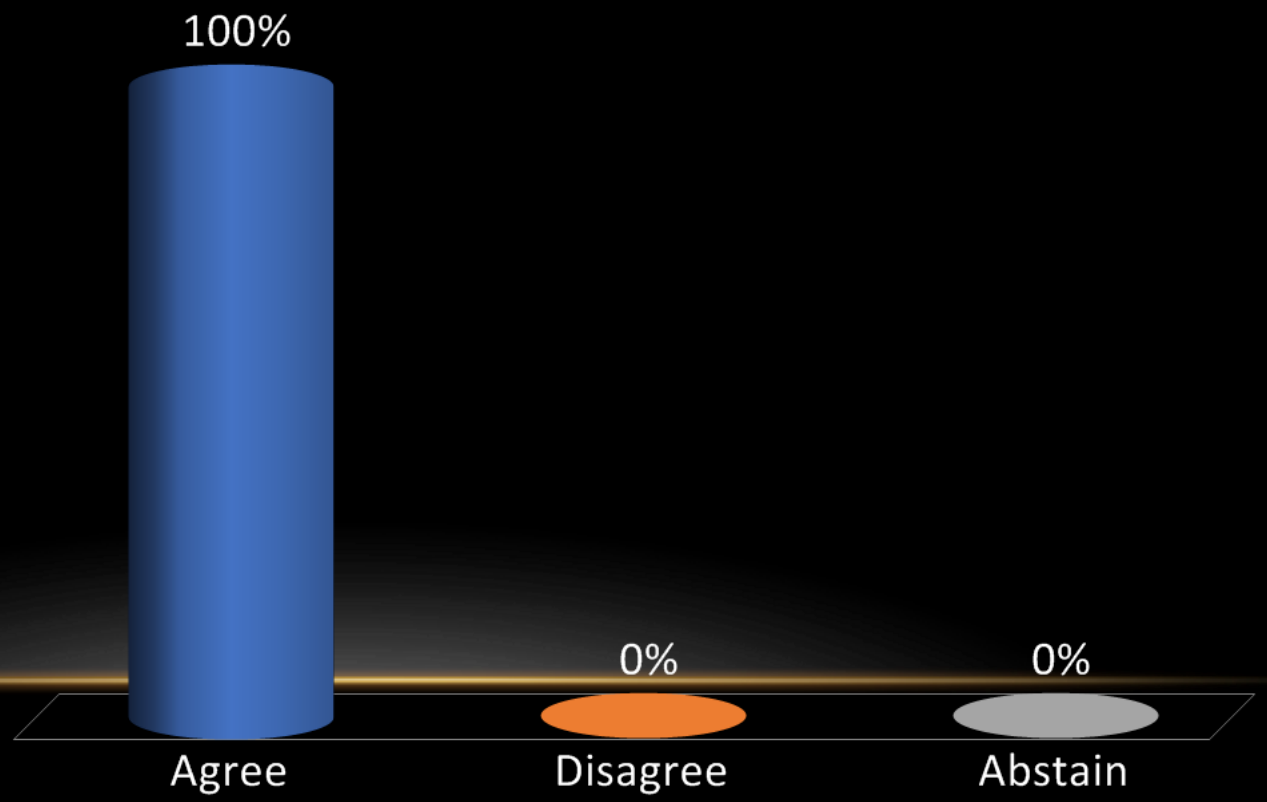
- Systematic review:
  - Shoulder-specific : 9 (do not directly address question)
  - Systematic review: 1
  - Non-shoulder specific: 2
  - Basic science: 2

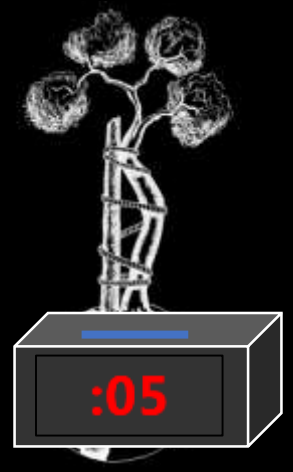
  - “these techniques should be reserved for research purposes”

**Recommendation:** Cutibacterium acnes isolated in samples from the shoulder should not be routinely sub-typed.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-24 (Former S-65) What is the treatment (if any) for unexpected positive cultures (UPC) in revision shoulder arthroplasty without clinical or radiographic signs of infection?

**RESEARCHED BY:**

Garrigues, Grant E MD, USA

Torrens, Carlos MD, Spain

Willems, Jaap MD, Netherlands

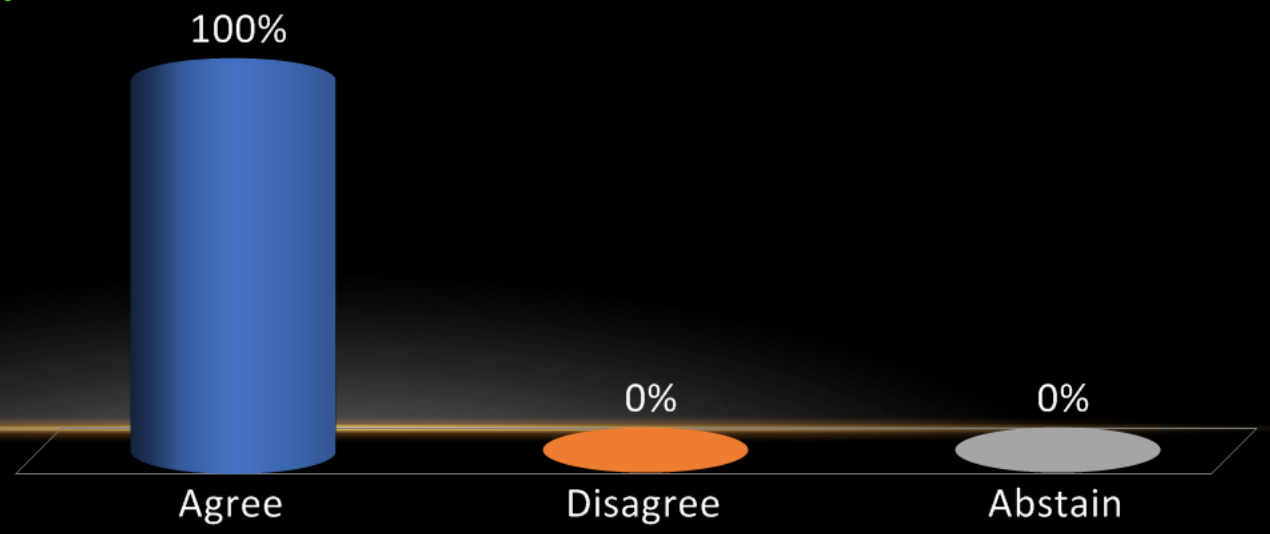
# Literature:

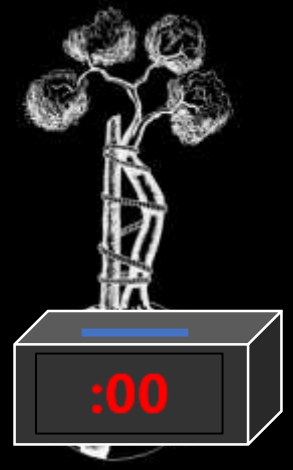
- Systematic review:
  - 8 articles met inclusion and exclusion criteria
  - 268 patients
  - “Only [6 papers] describe the author’s treatment protocol but these do not allow for definitive conclusions to be drawn regarding the effect of each treatment type on outcomes, if any were reported”

**Recommendation:** Unknown. Few publications offer protocols for addressing  unexpected positive cultures. Of these, the most common options include antibiotics, re-operation, and withholding any treatment. The lack of comparative data on outcomes of these therapy regimens makes it difficult to conclusively determine optimal management.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-25 (Former S-74) What is the relevance of unexpected positive cultures in revision shoulder arthroplasty without clinical or radiographic signs of infection?

**RESEARCHED BY:**

Garrigues, Grant E MD, USA

Torrens, Carlos MD, Spain

Willems, Jaap MD, Netherlands

# Literature:

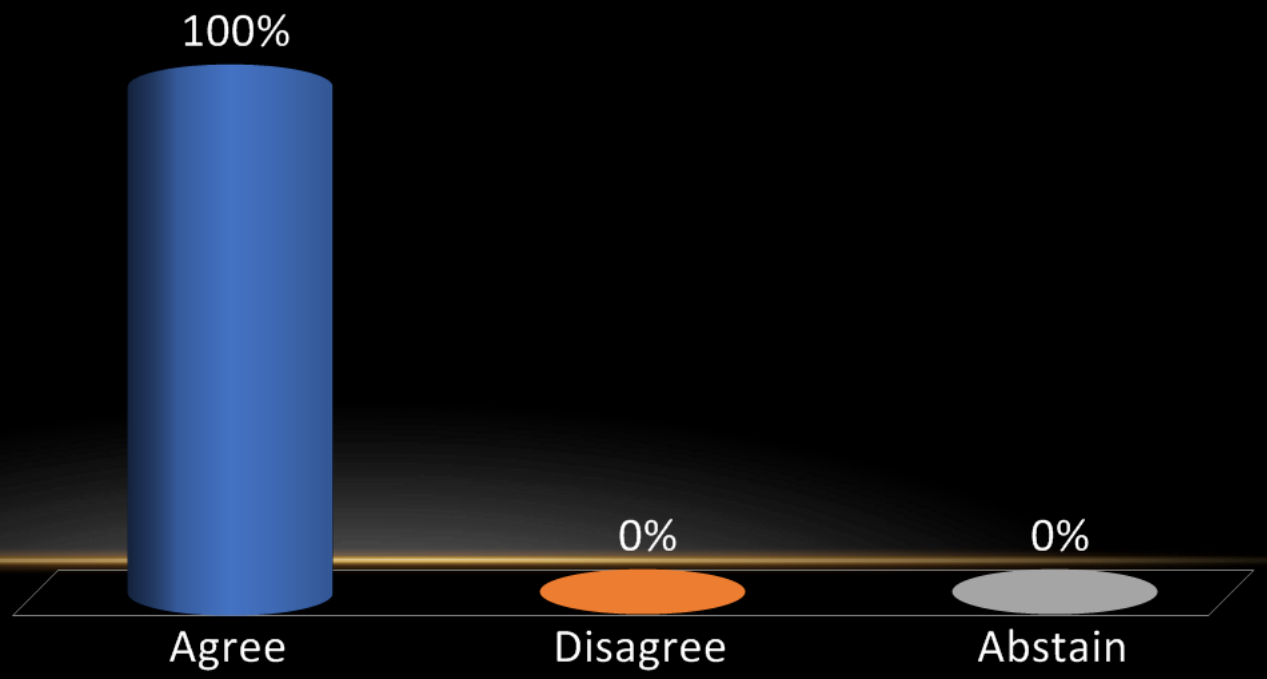
- Systematic review:
  - 15 articles included
  - 1,354 shoulder arthroplasty revisions
    - 22.5% had positive cultures
    - 53.8% were *P. acnes*

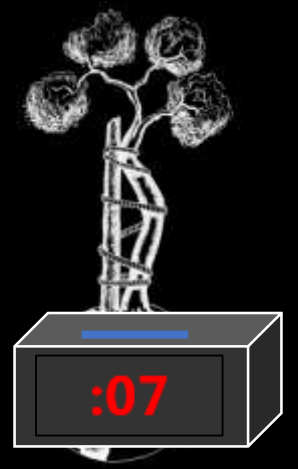
  - *"*Few studies fully meet the defined inclusion and exclusion criteria and little consistency exists on the definitions of "unexpected" or even what constitutes a 'true positive' culture.
  - Therefore, it is exceedingly challenging to compare studies reporting these rates."

**Recommendation:** The relevance of unexpected positive cultures is unknown.

**Level of Evidence:** Limited

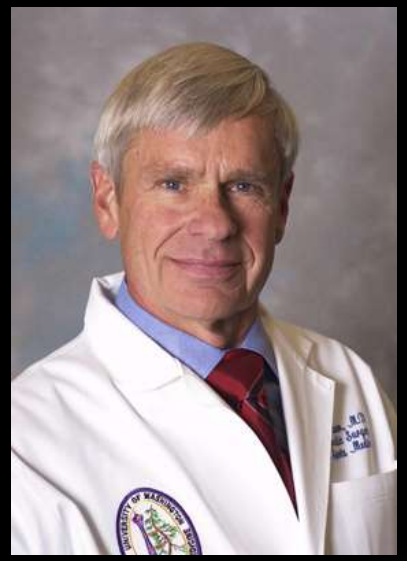
A. Agree
B. Disagree
C. Abstain



# S-26 (Former S-66) What is the relevance of positive cultures in the evaluation for shoulder PJI? What defines a clinically relevant positive culture result(s) versus a culture contaminant?

**RESEARCHED BY:**



Matsen, Frederick MD, USA

Green, Andrew MD, USA

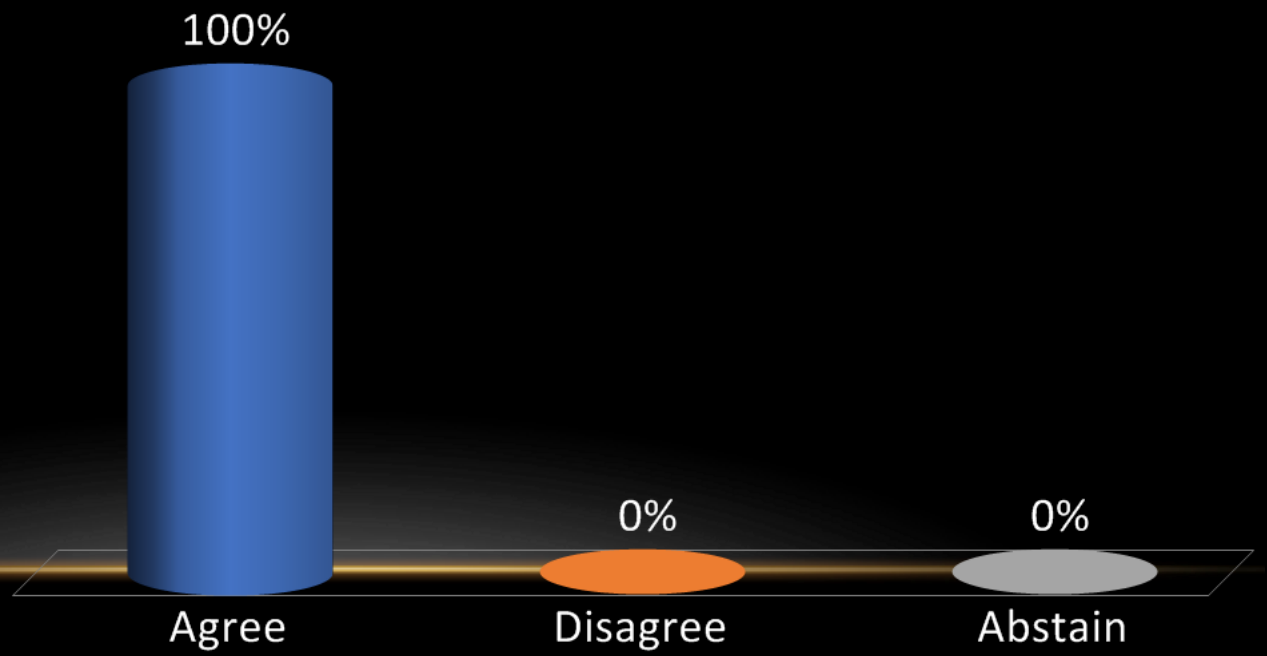
# Literature:

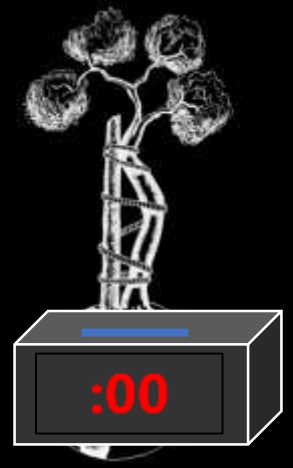
- Literature review:
  - Prospective: 7
  - Retrospective: 3

**Recommendation:** Positive cultures in a patient with painful or failed shoulder prosthesis should be considered and treated appropriately based upon the clinical context and diagnostic criteria.

**Level of Evidence:** Moderate

A. Agree
B. Disagree
C. Abstain



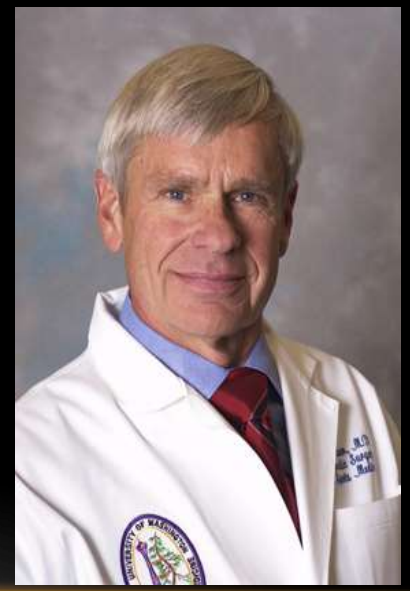



# S-27 (Former S-72) What is the role of quantitative evaluation (e.g. density of bacteria, cuti [propi] score) of positive cultures from the shoulder?

**RESEARCHED BY:**

Portillo, Maria Eugenia MD, Spain

Green, Andrew MD, USA



Matsen, Frederick MD, USA

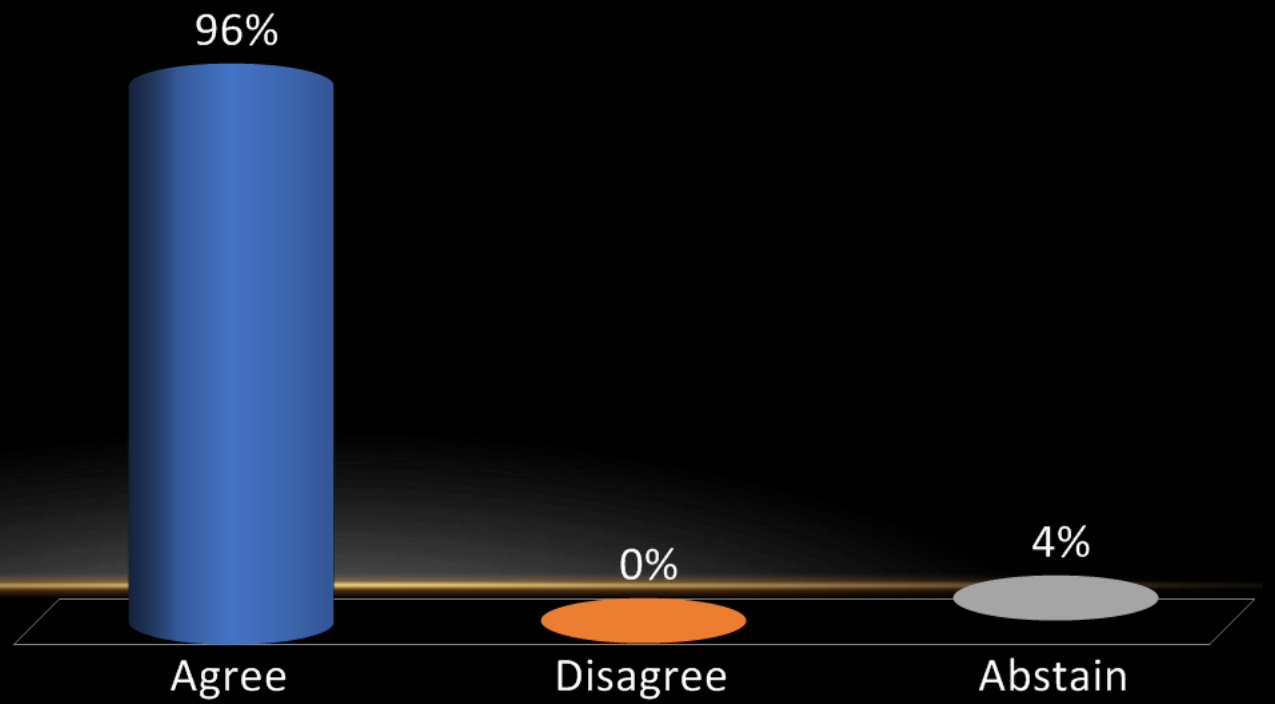
# Literature:

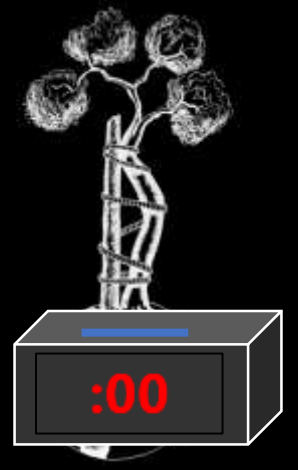
- Systematic review:
  - 127 full-text articles reviewed
  - 11 pertinent articles included
    - 7 prospective (1 lower extremity)
    - 2 retrospective (lower extremity)
    - 1 basic science
    - 1 review article

**Recommendation:** Semi-quantitative and quantitative reporting of bacterial culture results may have clinical utility for the diagnosis of shoulder PJI and may be used to interpret the relevance of positive cultures.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-28 (Former S-67) What is the role for peri-prosthetic frozen section and permanent histology in evaluation of a shoulder arthroplasty for PJI?

**RESEARCHED BY:**

Zmistowski, Benjamin MD, USA

Zuckerman, Joseph MD, USA

# Literature:

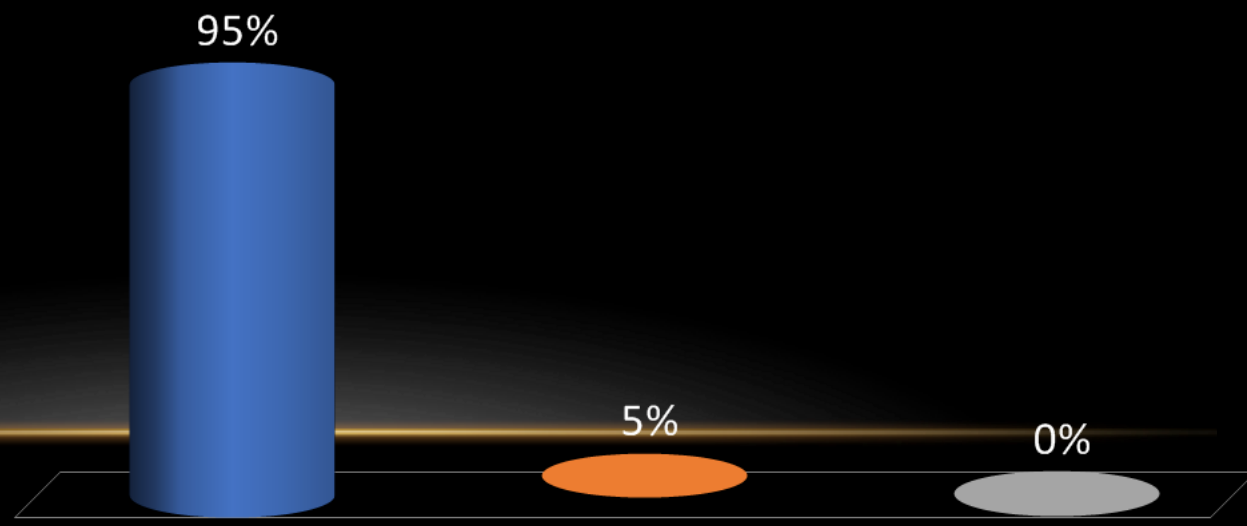
- Systematic review:
  - Two retrospective shoulder-specific analyses of frozen section

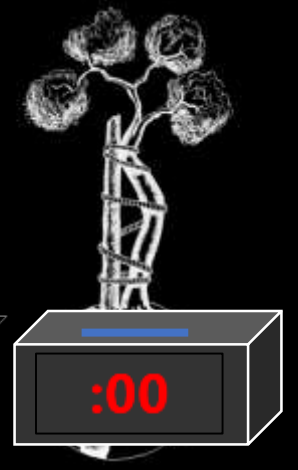
  - Topolski MS, Chin PYK, Sperling JW, Cofield RH. Revision shoulder arthroplasty with positive intraoperative cultures: the value of preoperative studies and intraoperative histology. J. Shoulder Elbow Surg. 2006 Aug;15(4):402–406
  - Grosso MJ, Frangiamore SJ, Ricchetti ET, Bauer TW, Iannotti JP. Sensitivity of frozen section histology for identifying Propionibacterium acnes infections in revision shoulder arthroplasty. J. Bone Joint Surg. Am. 2014 Mar 19;96(6):442–447.

**Recommendation:** Frozen sections or histology, reviewed by an experienced pathologist, may be useful in revision shoulder arthroplasty to evaluate for periprosthetic joint infection (PJI). The detection of infection with less virulent organisms, which make up a significant percentage of shoulder PJI, may be less reliable.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-29 (Former S-5) Does the sampling technique (number of samples, anatomic locations) of the tissue obtained in the evaluation for shoulder PJI affect the result of frozen section and permanent histology?

**RESEARCHED BY:**

Zmistowski, Benjamin MD, USA

Zuckerman, Joseph MD, USA

Virk, Mandeep MD, USA

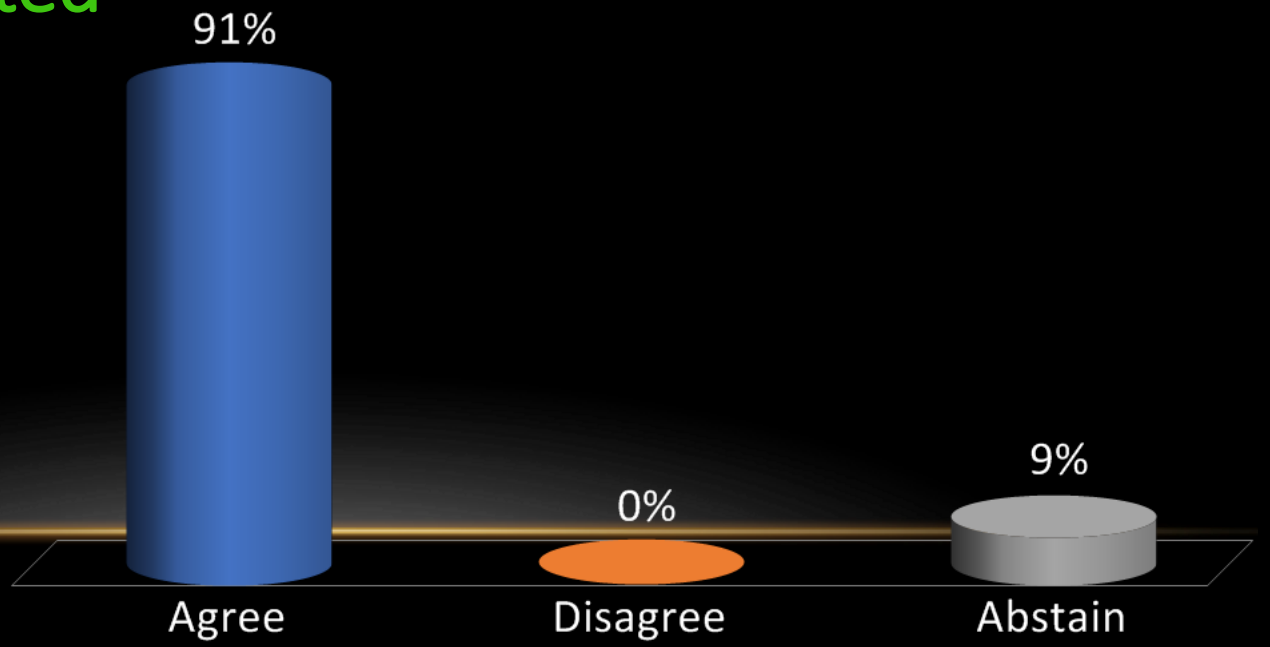
# Literature:

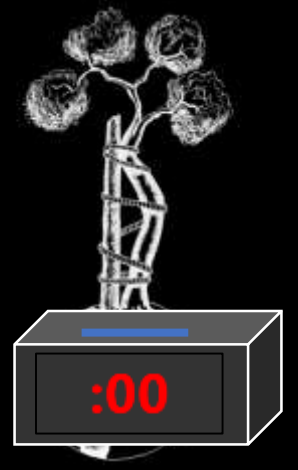
- Systematic review:
  - 25 non-specific analysis described where samples were collected from without direct analysis.
  - Two lower extremity arthroplasty provided direct analysis of sampling technique
    - 1 retrospective
    - 1 prospective

**Recommendation:** Obtaining samples from multiple locations—most importantly from the prosthetic interface membranes—may optimize accuracy if performing frozen section or permanent histology as part of a work-up for periprosthetic shoulder infection

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-30(Former S-16) Is there a role for Polymerase chain reaction / next generation sequencing technique in the diagnosis of shoulder PJI?

**RESEARCHED BY:**

Chen, Antonia MD, USA

Namdari, Surena MD, USA

Khazzam, Michael MD, USA

# Literature:

- Systematic review:
  - 12 studies evaluated
  - No pertinent studies

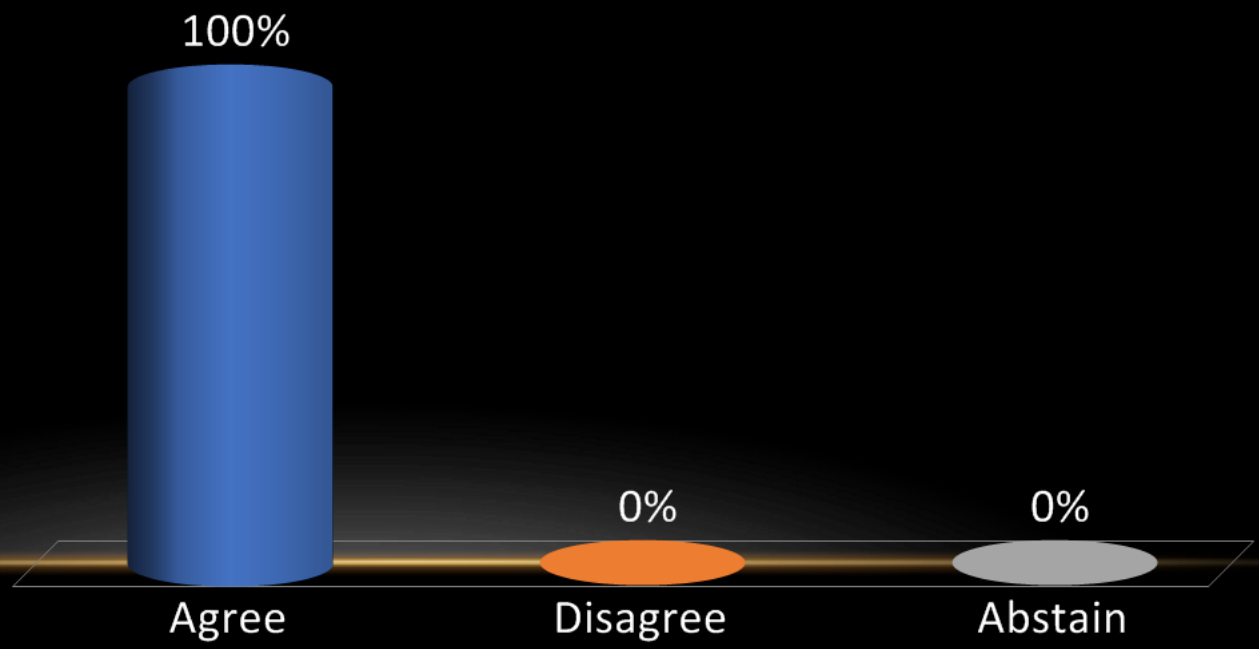
  - Cited:
    - Shoulder: 1 prospective, 1 unpublished data
    - Lower extremity: 1 prospective

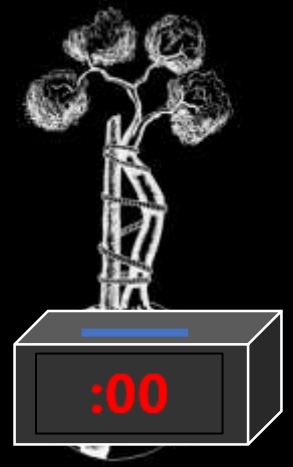
  - Consensus

**Recommendation:** There is not sufficient data to support the use of polymerase chain reaction (PCR) or next generation sequencing (NGS) in diagnosis of shoulder PJI.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-31(Former S-20) Is there a role for preoperative joint aspiration in the evaluation of a shoulder arthroplasty for PJI?

**RESEARCHED BY:**

Levy, Jonathon MD, USA

Hasan, Samer S MD, USA

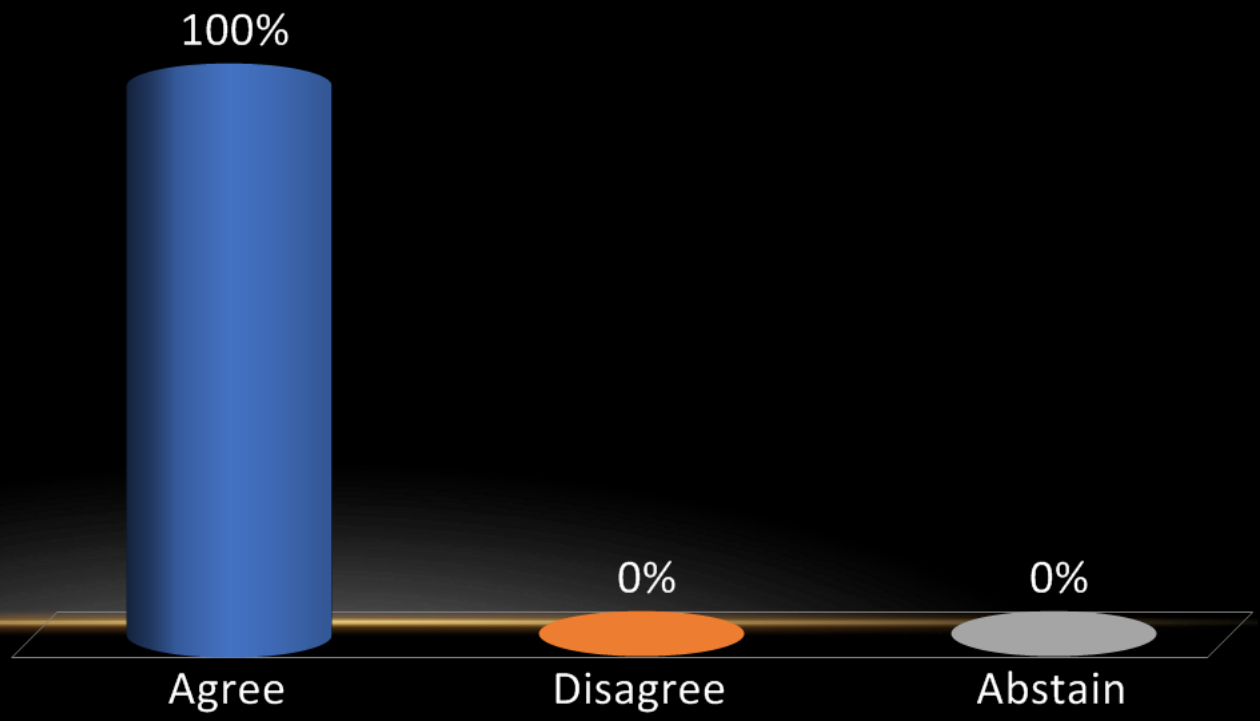
# Literature:

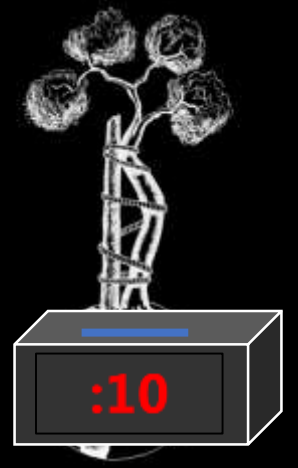
- Literature review: (shoulder only)
  - 11 retrospective,
  - 1 systematic review,
  - 1 expert opinion

**Recommendation:** Glenohumeral joint aspiration has a role as part of the investigation for shoulder PJI.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-32(Former S-22) Is there a role for pre-operative open or arthroscopic tissue biopsy in the evaluation prior to initial revision shoulder arthroplasty?

**RESEARCHED BY:**


Cvetanovich, Gregory MD, USA

Romeo, Anthony MD, USA

# Literature:

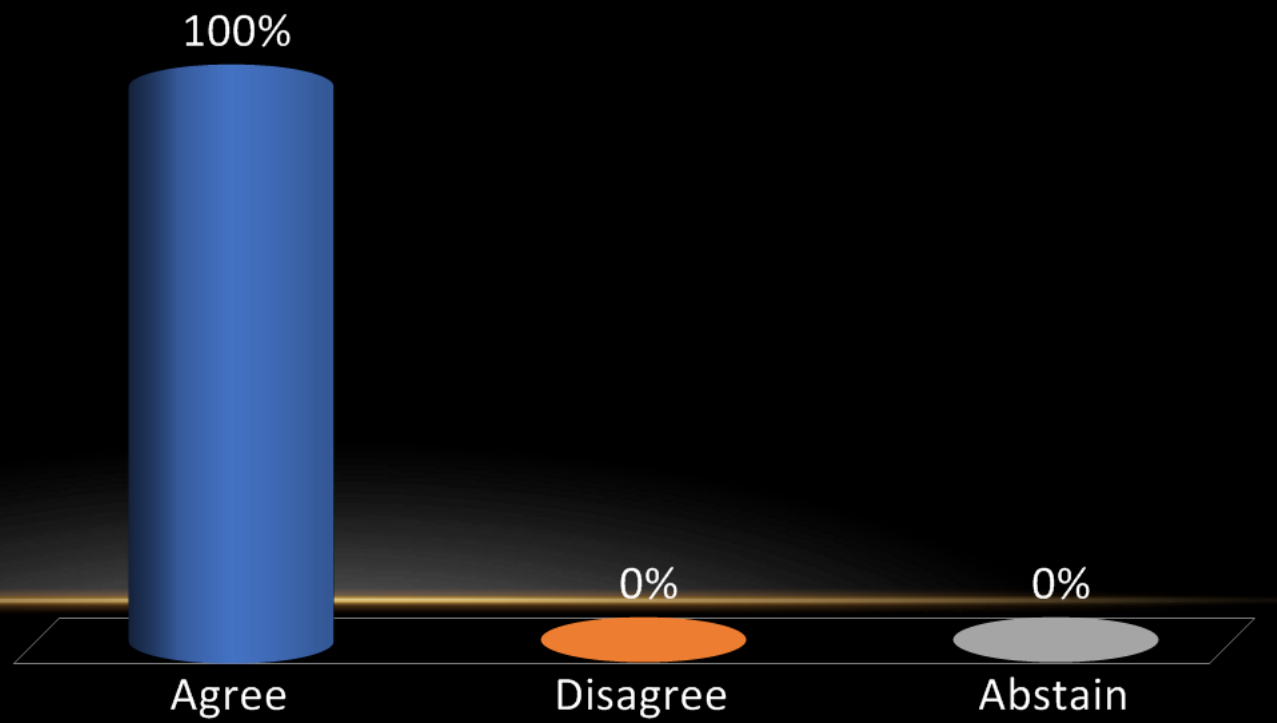
- Systematic review:
  - 3 relevant articles (shoulder-specific)
  - 2 retrospective
  - 1 case report

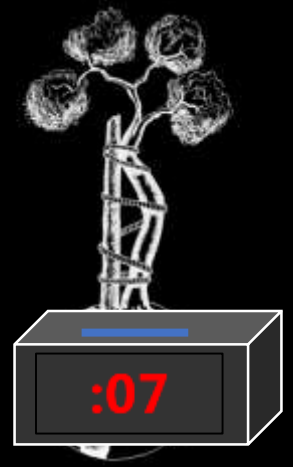

- Dilisio MF, Miller LR, Warner JJP, Higgins LD. Arthroscopic tissue culture for the evaluation of periprosthetic shoulder infection. J Bone Joint Surg Am. 2014 Dec 3;96(23):1952–1958. doi:10.2106/JBJS.M.01512
- Morman M, Fowler RL, Sanofsky B, Sanosky B, Higgins LD. Arthroscopic tissue biopsy for evaluation of infection before revision arthroplasty. J Shoulder Elbow Surg. 2011 Apr;20(3):e15–22. doi:10.1016/j.jse.2010.11.015
- Tashjian RZ, Granger EK, Zhang Y. Utility of prerevision tissue biopsy sample to predict revision shoulder arthroplasty culture results in at-risk patients. J Shoulder Elbow Surg. 2017 Feb;26(2):197–203. doi:10.1016/j.jse.2016.07.019


**Recommendation:** Arthroscopic or open biopsy prior to initial revision shoulder arthroplasty can aid in the diagnosis of suspected shoulder PJI.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-33(Former S-28) Is there a role for serum D-dimer in the evaluation of PJI following shoulder arthroplasty?

**RESEARCHED BY:**

Ekelund, Anders MD, Sweden

Romeo, Anthony MD, USA

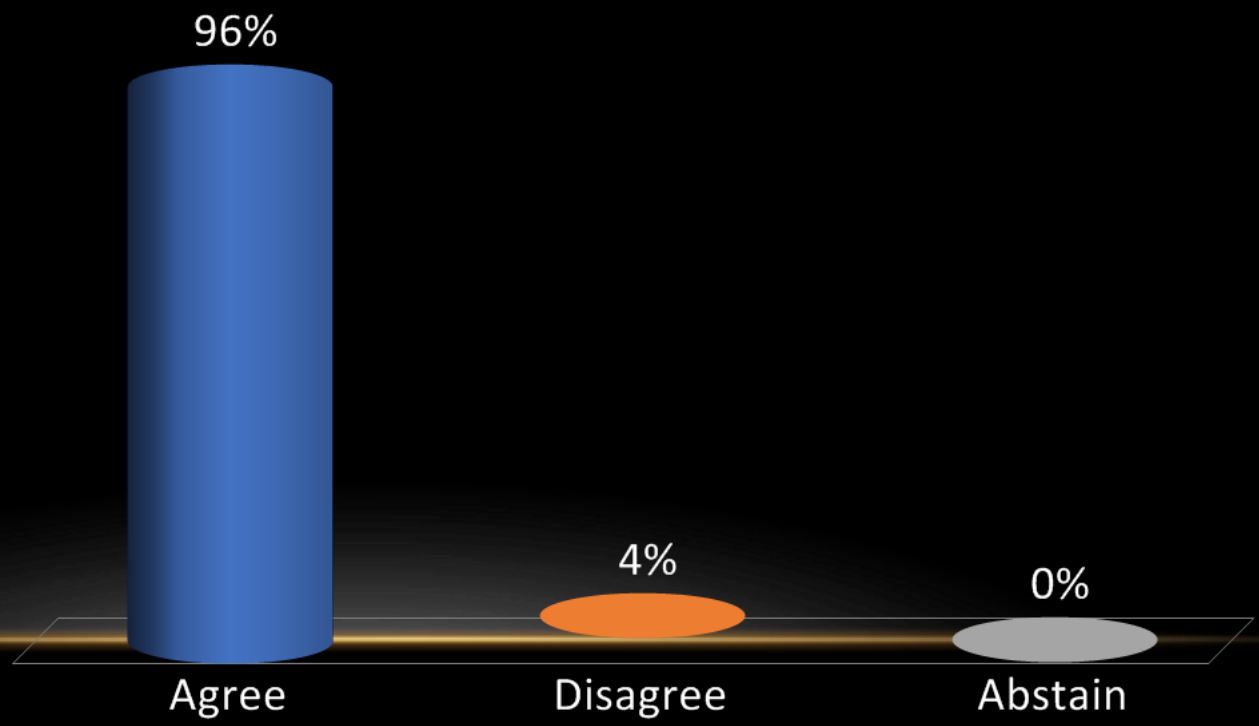
# Literature:

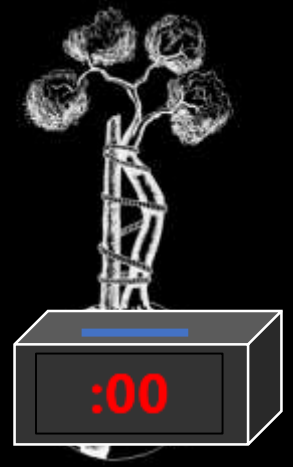
- Systematic review:
  - 1 lower extremity arthroplasty (d-dimer specific)
  - 1 non-orthopedic

**Recommendation:** Unknown. There is currently only limited evidence related to the evaluation of hip and knee PJI and no study to date evaluating its use in shoulder PJI.

**Level of Evidence:** No evidence

A. Agree
B. Disagree
C. Abstain



# S-34(Former S-30) Is there a role for synovial cytokines in the diagnosis of shoulder PJI?

**RESEARCHED BY:**


Cortes Jimenez, Luis MD, Colombia

Sabesan, Vani MD, USA

Williams, Gerrald MD, USA

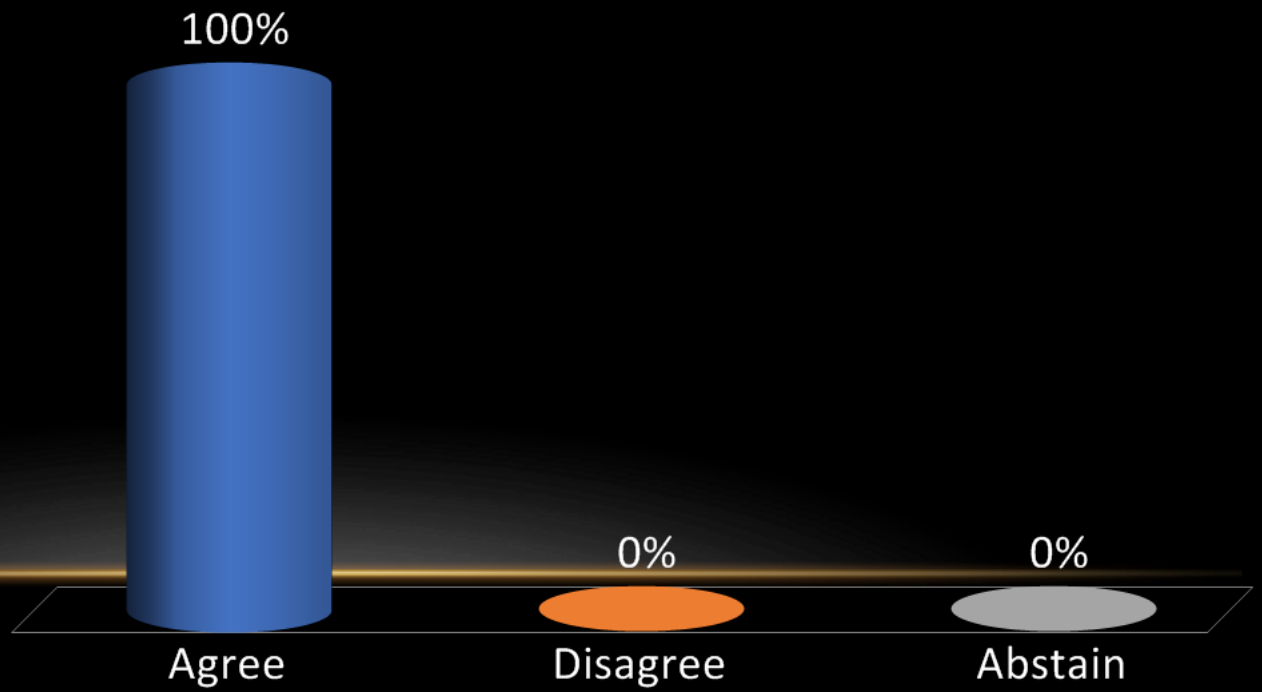
# Literature:

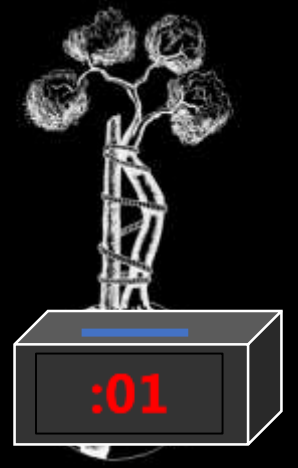
- Systematic review:
  - 18 articles including 13 lower extremity arthroplasty
    - 4 systematic review
    - 4 expert opinion
    - 5 prospective
  - Shoulder: 1 level two, 2 level 3, 1 level 4, 1 level 5

**Recommendation:** While not yet widely available, evaluation of cytokine levels in synovial fluid shows promise in clarifying the probability of shoulder PJI. See questions #XX for discussion of specific cytokine evaluations.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-35(Former S-31) Is there a role for synovial fluid alpha-defensin in the diagnosis of shoulder PJI?

**RESEARCHED BY:**


Cortes Jimenez, Luis MD,
Colombia

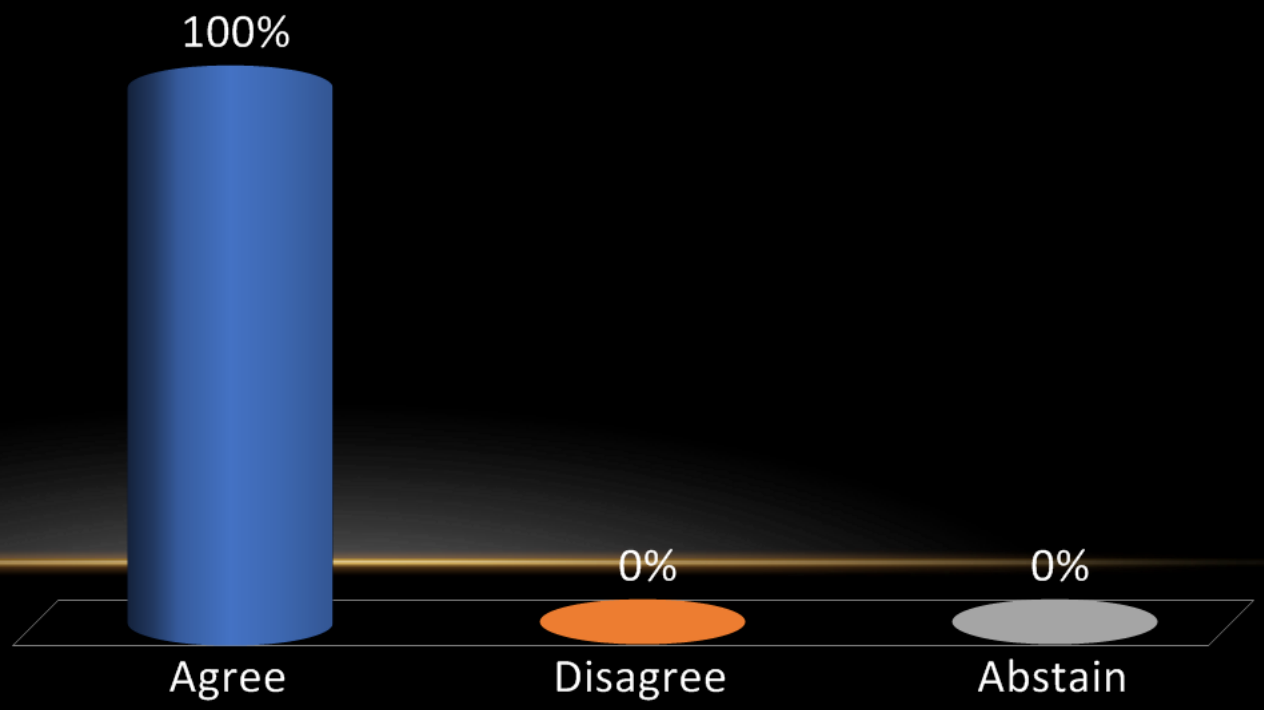
# Literature:

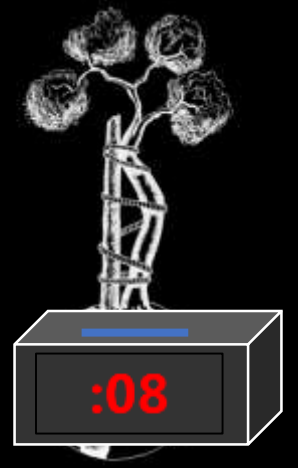
- Systematic review:
  - Lower extremity: 13 prospective analyses, 1 systematic review, 1 expert opinion
  - Shoulder: 1 prospective

**Recommendation:** Synovial alpha-defensin may aid in the diagnosis of shoulder PJI.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-36(Former S-32) Is there a role for synovial fluid leukocyte esterase strip testing in the diagnosis of shoulder PJI?

**RESEARCHED BY:**

Iannoti, Joseph MD,
USA

Naula, Victor MD,
Equador

Richetti, Eric MD,
USA

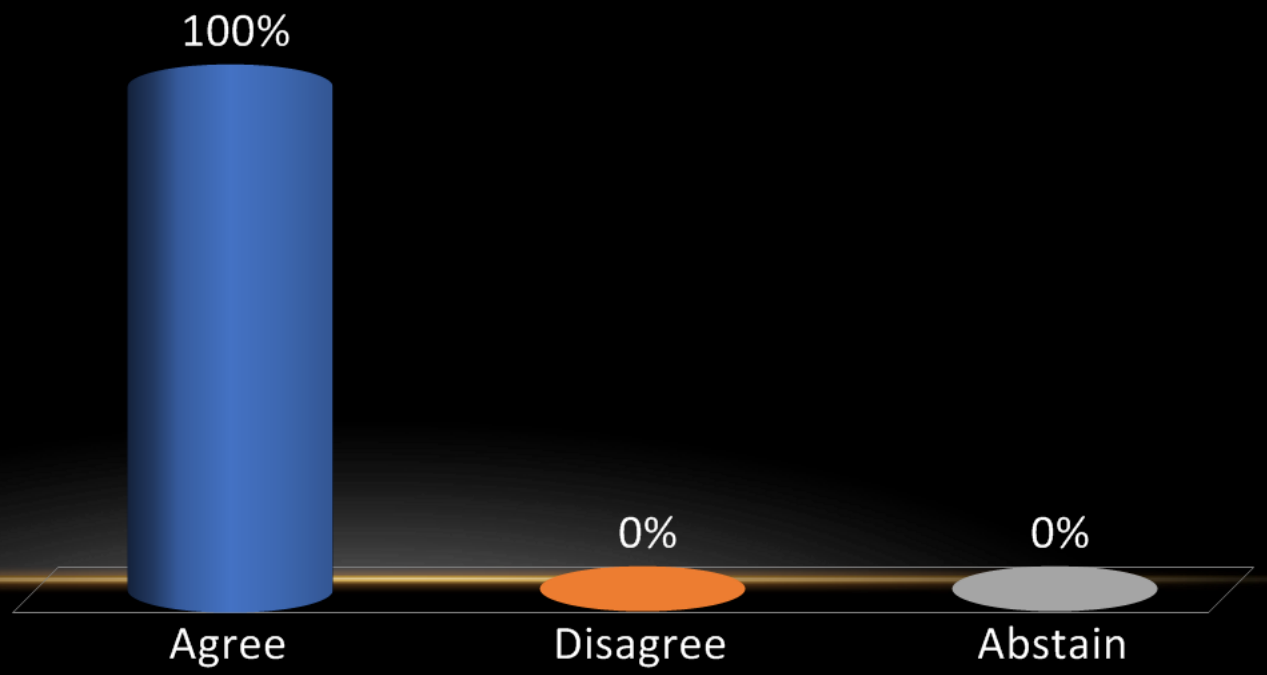
# Literature:

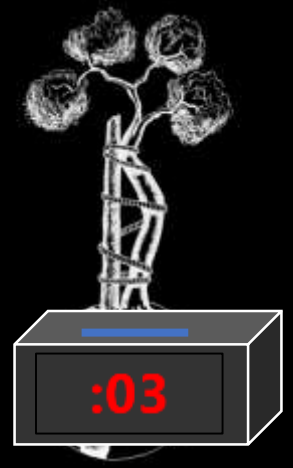
- Systematic review:
  - Shoulder: 1 prospective
  - Lower extremity: 2 systematic review, 1 retrospective, 1 meta-analysis

**Recommendation:** Given the current evidence, there is no role for synovial fluid leukocyte esterase (LE) strip testing in the diagnosis of shoulder PJI.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-37(Former S-33) Is there a role for synovial fluid TNF-alpha and IL-2 in the diagnosis of shoulder PJI?

**RESEARCHED BY:**

Iannoti, Joseph MD,
USA

Naula, Victor MD,
Equador

Richetti, Eric MD,
USA

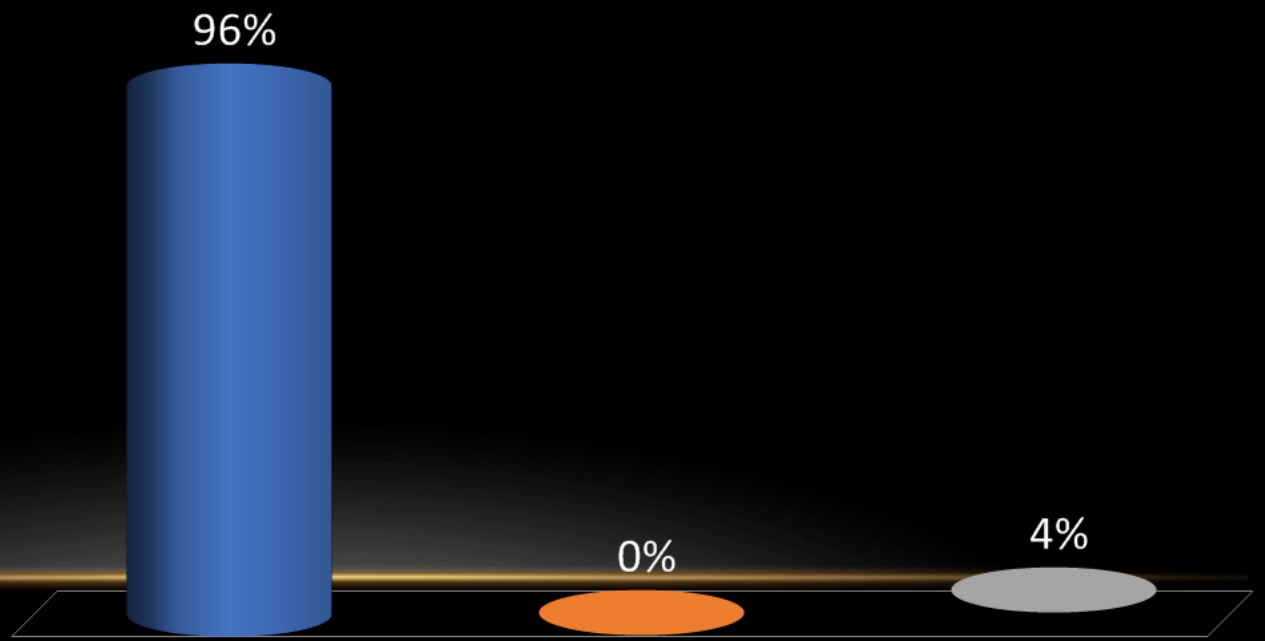
# Literature:

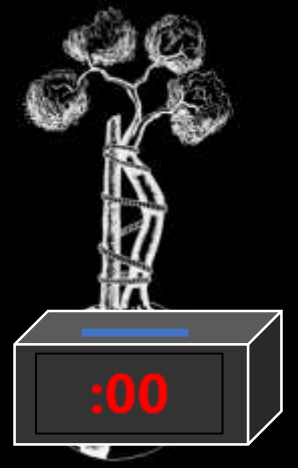
- Literature review:
  - Lower extremity: 2 meta-analyses
  - Shoulder: 1 prospective

**Recommendation:** There is a potential role for synovial fluid TNF-α and IL-2 in the diagnosis of shoulder PJI when interpreted in combination with other synovial fluid markers. TNF-α and IL-2 may not be as useful individually.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-38(Former S-34) Is there a role for synovial fluid WBC count and differential in the diagnosis of shoulder PJI?

**RESEARCHED BY:**


Cortes Jimenez, Luis MD,
Colombia

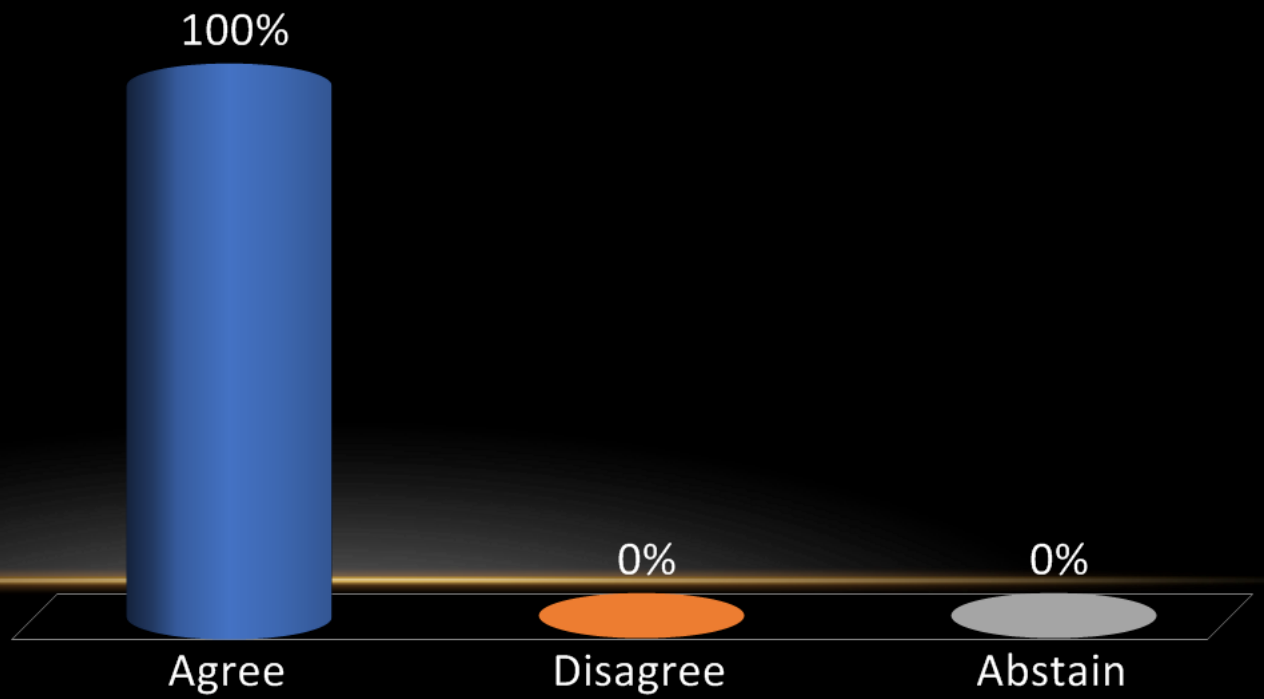
# Literature:

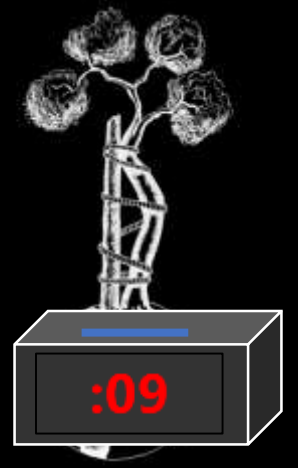
- Systematic Review:
  - Shoulder:  2 expert opinion, 2 retrospective
  - Lower extremity: 4 expert opinion, 2 meta-analyses, 6 retrospective

**Recommendation:** There may be a role; but synovial fluid cell count and differential currently lacks diagnostic thresholds from shoulder-specific literature.

**Level of Evidence:** Limited

A. Agree
B. Disagree
C. Abstain



# S-39(Former S-35) Is there a role for (a) synovial or (b) serum IL-6 in the diagnosis of shoulder PJI?

**RESEARCHED BY:**

Iannoti, Joseph MD,
USA

Naula, Victor MD,
Equador

Richetti, Eric MD,
USA

# Literature:

- Systematic review:
  - Synovial fluid IL-6:
    - 2 prospective (shoulder-specific)
    - 2 meta-analyses (lower extremity)
  - Serum IL-6
    - 2 meta-analyses (lower extremity)
    - 2 prospective (shoulder-specific)

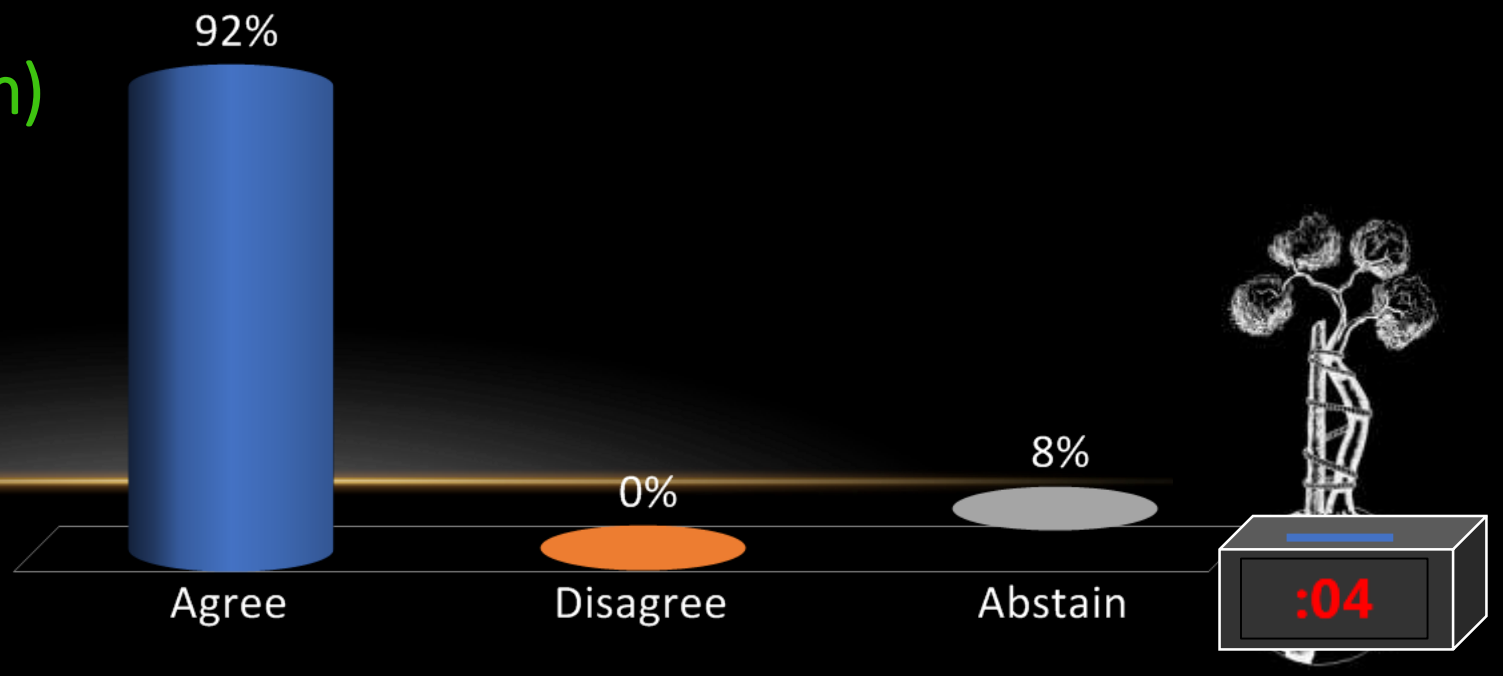
## Recommendation:

a) There is a potential role for synovial fluid IL-6 in the diagnosis of shoulder PJI, both as an individual marker and when interpreted in combination with other synovial fluid markers.

b) Although its specificity is high, serum IL-6 does not appear to provide additional information beyond the more redably available serum markers (ESR, CRP, WBC).

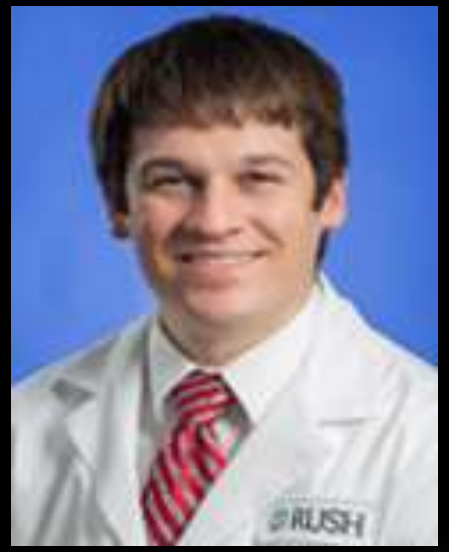
## Level of Evidence: Moderate (both)

A. Agree
B. Disagree
C. Abstain



# S-40(Former S-29) Is there a role for sonication of retrieved shoulder implants in the diagnosis of shoulder PJI?

**RESEARCHED BY:**




Cvetanovich, Gregory MD,
USA

Romeo, Anthony, MD,
USA

# Literature:

- Systematic review:
  - 2 shoulder specific studies
  - Varied definitions of PJI

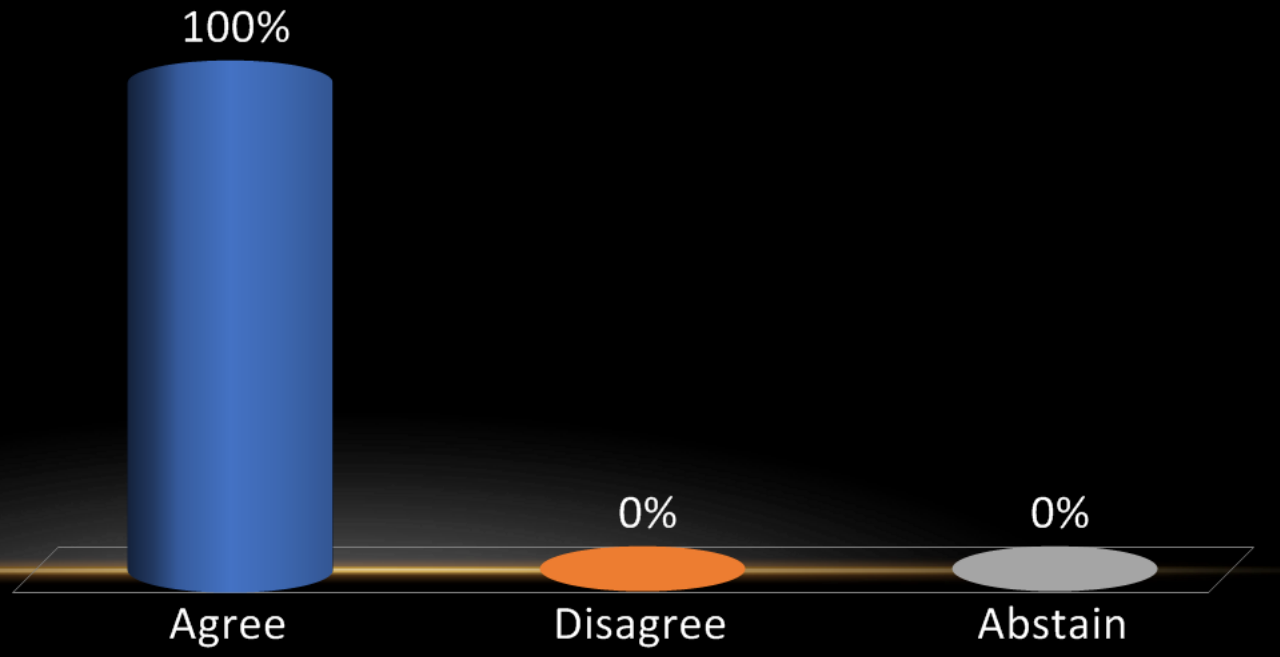

- Piper KE, Jacobson MJ, Cofield RH, Sperling JW, Sanchez-Sotelo J, Osmon DR, et al. Microbiologic diagnosis of prosthetic shoulder infection by use of implant sonication. Journal of Clinical Microbiology. 2009 Jun;47(6):1878–1884. doi:10.1128/JCM.01686-08
- Grosso MJ, Frangiamore SJ, Yakubek G, Bauer TW, Iannotti JP, Ricchetti ET. Performance of implant sonication culture for the diagnosis of periprosthetic shoulder infection. J Shoulder Elbow Surg. 2017 Oct 13;27(2):211–216. doi:10.1016/j.jse.2017.08.008

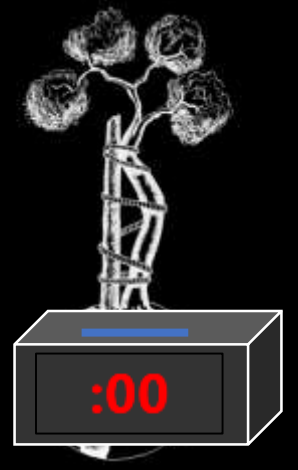

## Recommendation:

There is currently no evidence to support routine sonication of the retrieved shoulder implant in the diagnosis of shoulder PJI.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-41(Former S-68) What is the role for serum ESR, CRP, or WBC count in the evaluation of a shoulder arthroplasty for PJI?

**RESEARCHED BY:**

Cil, Akin MD, USA

Page, Richard, MD, Australia

# Literature:

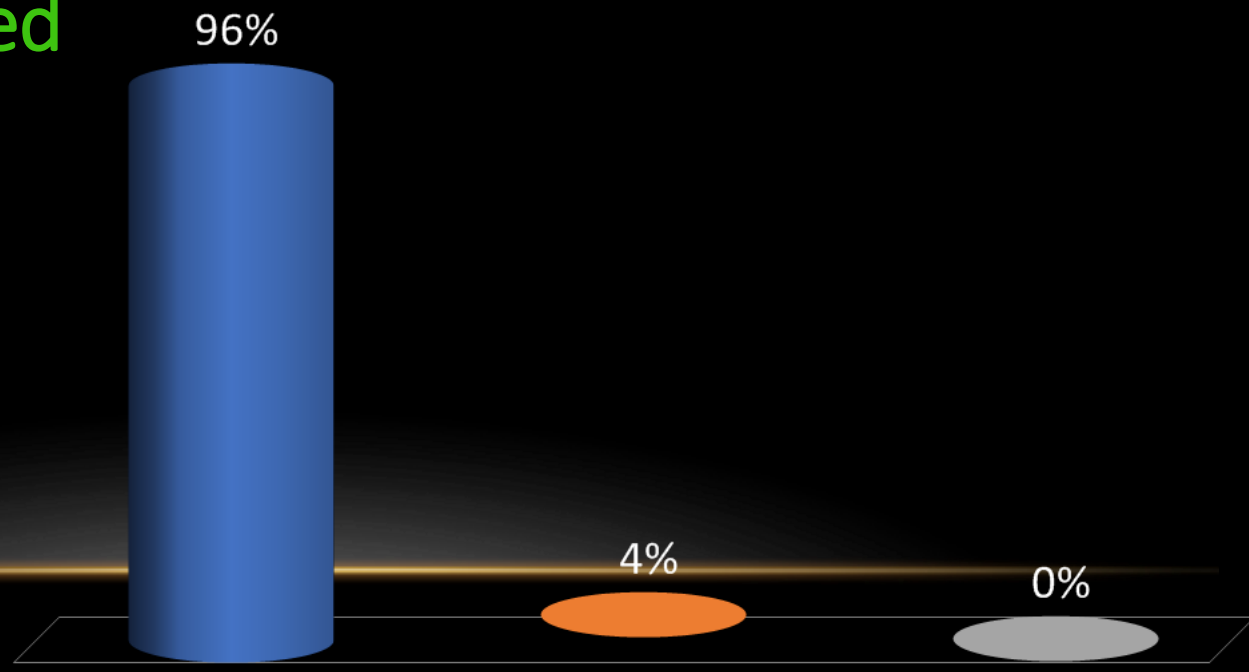
- Systematic review:
  - 13 retrospective / consensus shoulder-specific papers
    - Chalmers PN, Sumner S, Romeo AA, Tashjian RZ. Do elevated inflammatory markers associate with infection in revision shoulder arthroplasty? Journal of Shoulder and Elbow Arthroplasty 2018; 2:1–5 doi: 10.1177/2471549217750465
    - Piper KE, Fernandez-Sampedro M, Steckelberg KE, Mandrekar JN, Karau MJ, Steckelberg JM, et al. C-reactive protein, erythrocyte sedimentation rate and orthopedic implant infection.
  - 5 lower extremity papers

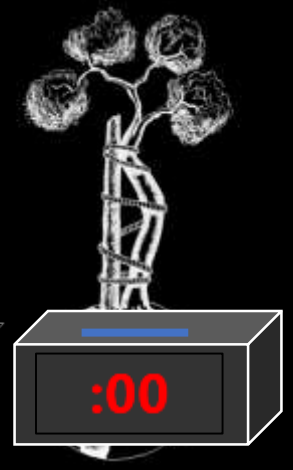
## Recommendation:

Serum ESR, CRP, or WBC count have poor sensitivity for the diagnosis of shoulder PJI. Although they should be obtained as part of a standard work up for infection, normal values do not rule out infection.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-42(Former S-75) What radiographic findings are concerning for shoulder PJI?

**RESEARCHED BY:**

Levy, Ofer MD, UK

Keener, Jay MD, USA

Jacquot, Adrien MD, France

# Literature:

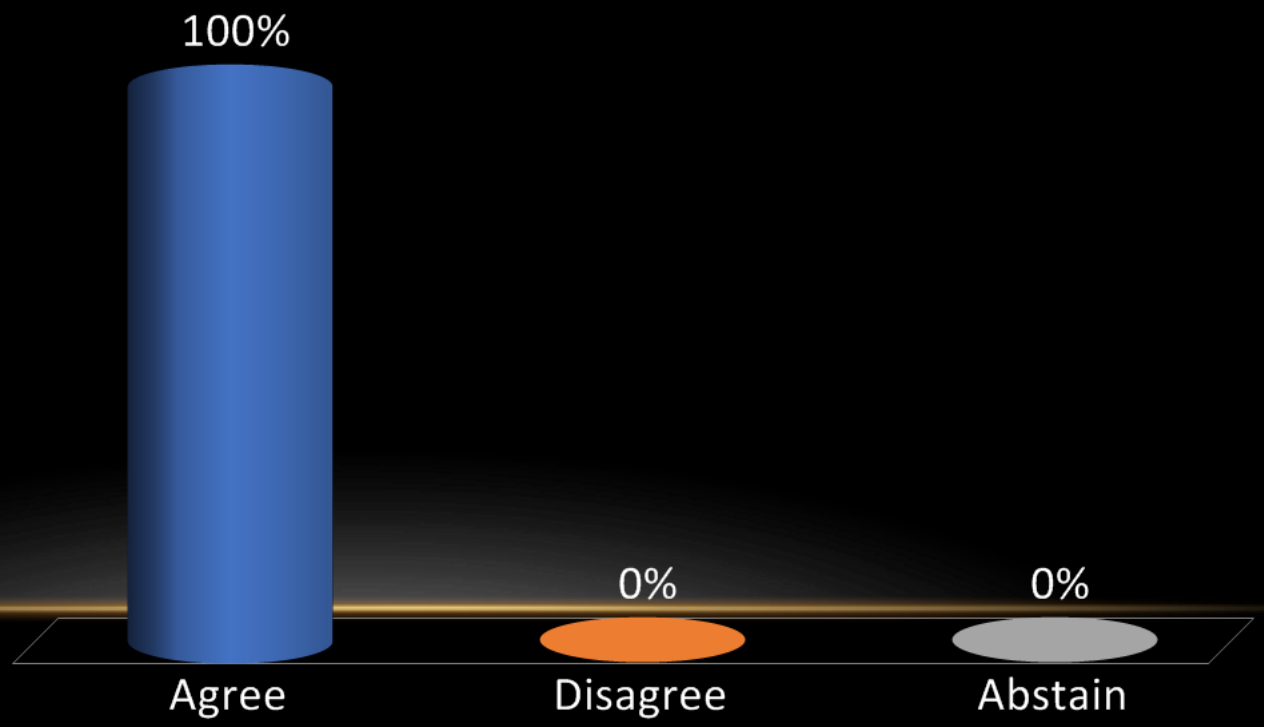
- Systematic review:
  - Plain radiograph: 4 retrospective + 2 lower extremity
  - CT: 1 lower extremity
  - MRI: 2 non-shoulder (not related to infection()
  - Nuclear imaging: 1 shoulder + 15 non-shoulder papers

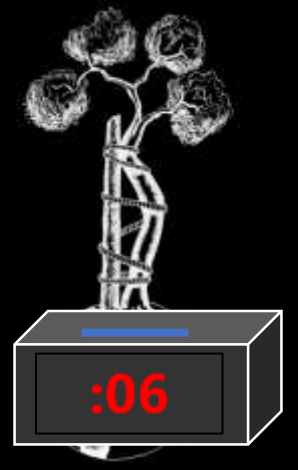
## Recommendation:

Radiographic findings concerning for shoulder PJI include component loosening or migration, radiolucent lines, osteolysis, endosteal scalloping, and new bone formation.  Specifically, humeral loosening should significantly raise the suspicion for shoulder PJI.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-43(Former S-56) What clinical signs (e.g. gross wound changes [swelling, erythema, or drainage]) are concerning for shoulder PJI?

**RESEARCHED BY:**

Keener, Jay MD, USA

Levy, Ofer MD, UK

Jacquot, Adrien MD, France

# Literature:

- Systematic review:
  - 570 citations
  - 25 papers reviewed
    - 9 series did not give any information about clinical signs
    - In the 16 others, the clinical description was incomplete in most of the cases

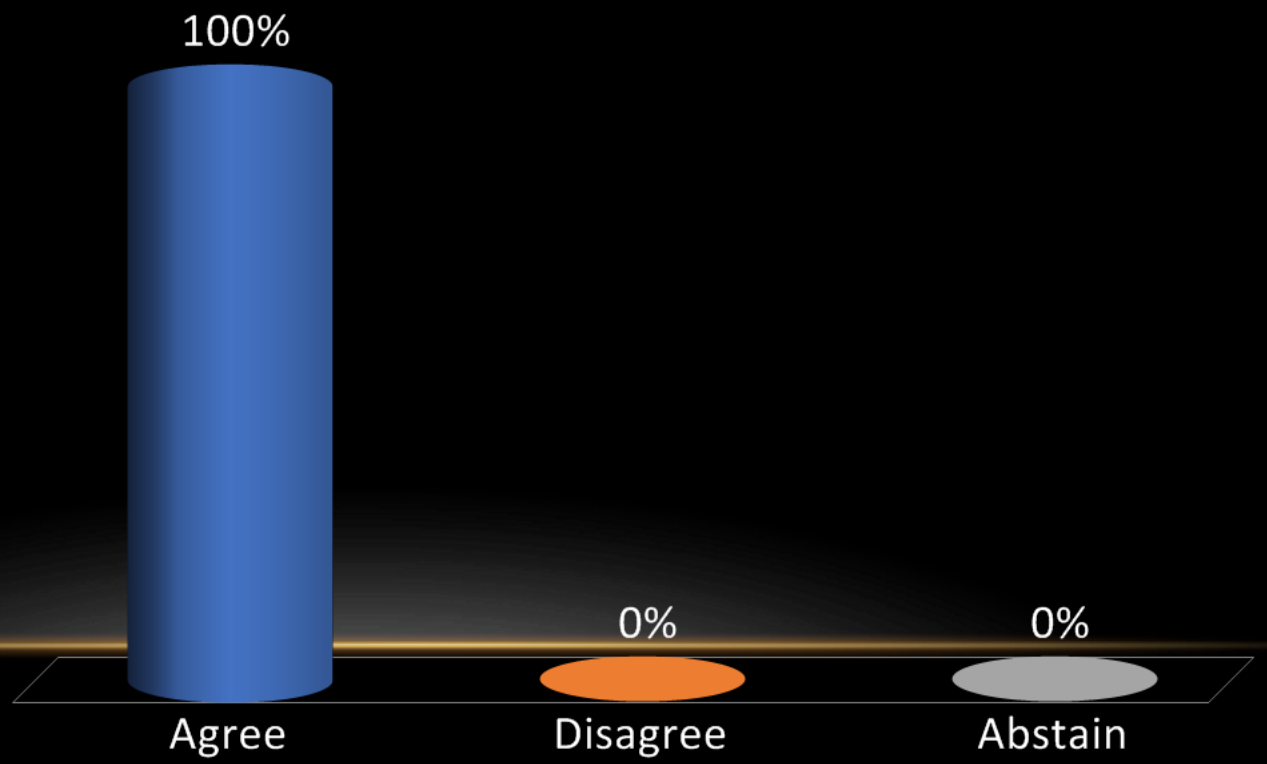
  - Fistula: 11/25 papers reported (264 shoulders) → 110 cases (41.7%)
  - Tissue inflammation: 7 papers (187 shoulders) → 71 cases
  - Fever: 4 papers (132 shoulders) → 14 had fever
  - Pain and function: 10 studies (276 shoulders) → 250 had pain

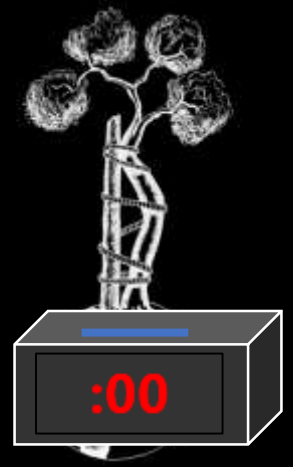
## Recommendation:

The presence of a sinus tract is the only clinical sign that can be considered highly specific for shoulder PJI. Other clinical signs of shoulder PJI include unexpected wound drainage.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-44(Former S-57) What intraoperative findings ~~(e.g. purulence, synovial fluid analysis, histology, gross biofilm, culture results)~~ are concerning for shoulder PJI?

**RESEARCHED BY:**

Keener, Jay MD, USA

Levy, Ofer MD, UK

Jacquot, Adrien MD, France

# Literature:

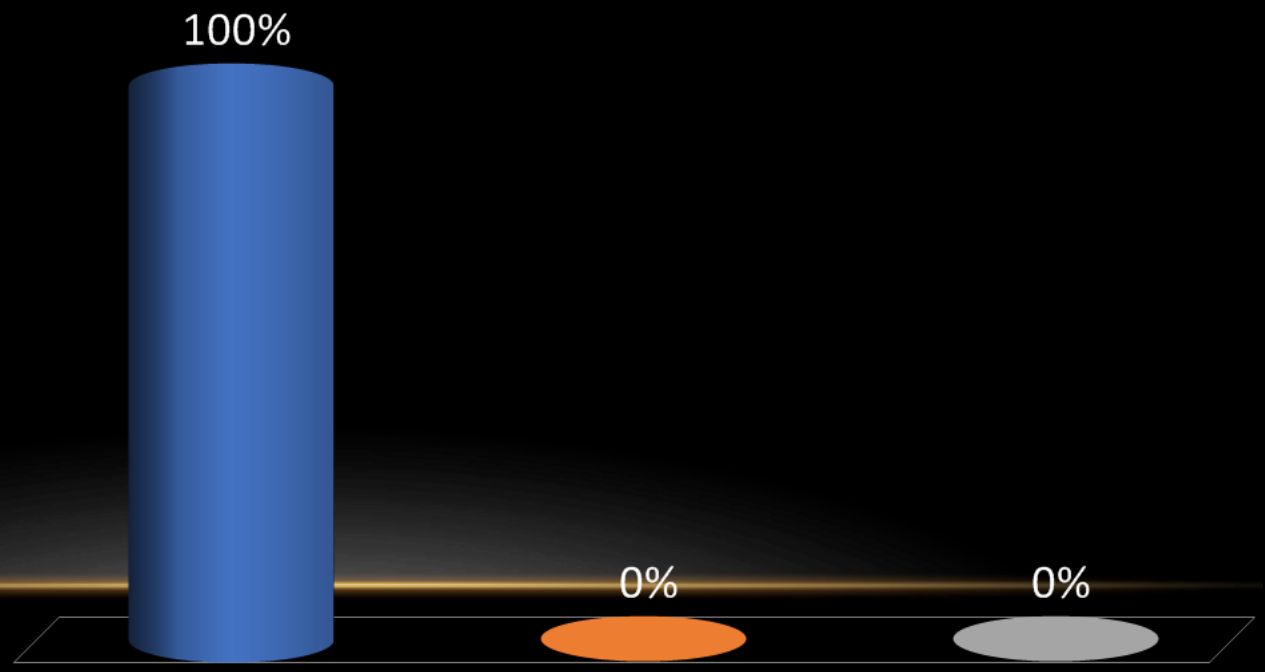
- Systematic review
  - Synovial Fluid analysis: 3 retrospective reviews + 2 lower extremity arthroplasty
  - Alpha-defensin: 1 prospective analysis + 2 lower extremity arthroplasty
  - Histology:  4 retrospective
  - Gross biofilm: 2 retrospective
  - Culture analysis: 1 prospective + 6 retrospective + 2 lower extremity
  - Implant sonication: 1 retrospective + 3 lower extremity

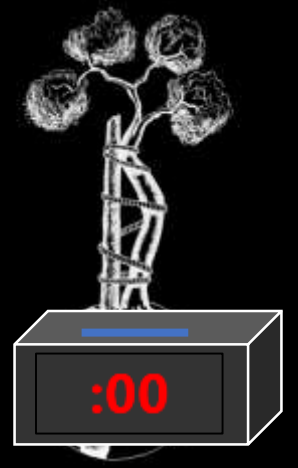
## Recommendation:

The presence of humeral stem loosening and cloudy synovial fluid should raise suspicion for shoulder PJI. Gross purulence (without a mechanical or rheumatologic explanation) or the presence of a sinus tract, communicating with the implant, are pathognomonic for periprosthetic shoulder infection.

## Level of Evidence: Consensus

A. Agree
B. Disagree
C. Abstain



# S-45(Former S-50) What are the diagnostic criteria of shoulder PJI? Are there subcategories depending on the timing of presentation (acute post-op vs subacute vs chronic occult)?

**RESEARCHED BY:**

All Members

# Definition of Shoulder PJI

**DEFINITE PJI**

Meeting one of the following criteria is diagnostic of periprosthetic shoulder infection:

- A sinus tract communicating with the prosthesis is present.
- Gross intra-articular pus
- Two positive cultures with phenotypically-identical virulent organisms

**EVALUATION scoring**

Weighted values for all positive tests performed as part of the diagnostic evaluation of a failed shoulder arthroplasty are summed.

- 6 or greater with identified organism = probable PJI
- 6 or greater *without* identified organism = possible PJI
- 6 or less
  - single positive culture virulent organism = possible PJI
  - two positive cultures non-virulent organism = possible PJI
  - negative cultures or only single positive culture for low virulent organism = PJI unlikely

| Proposed Minor Criteria | Proposed Weight |
|---|---|
| Unexpected wound drainage | 4 |
| Single Positive Tissue Culture (virulent organism) | 3 |
| Single Positive Tissue Culture (non-virulent organism) | 1 |
| Second Positive Tissue Culture (identical non-virulent pathogen) | 3 |
| Humeral loosening | 3 |
| Positive frozen section (Five PMN in 5 high-power fields) | 3 |
| Positive Pre-operative Aspirate Culture (low or high-virulent) | 3 |
| Elevated Synovial Neutrophil Percentage (>80%) | 2 |
| Elevated Synovial WBC (>3000 cells / microliter) | 2 |
| Elevated ESR (>30 mm/hr)* | 2 |
| Elevated CRP (>10 mg/L)* | 2 |
| Elevated synovial alpha-defensin | 2 |
| Cloudy fluid | 2 |

- *beyond six weeks from recent surgery.

# Case Scenario #1

- Painful shoulder arthroplasty:
  - Positive aspirate culture (C. acnes) --> 3
  - 1/5 intraoperative cultures positive (C. acnes) --> 1
  - Humeral loosening --> 3

  - Total = 7 (Probable PJI)

# Case Scenario #2

- Painful shoulder arthroplasty:
  - No aspirate done
  - Persistant drainage --> 4
  - 2/5 intraoperative cultures positive (C. acnes) --> 1 + 3 -> 4

  - Total = 8 (Probable PJI)

# Case Scenario #3

- Painful shoulder arthroplasty:
  - Dry aspirate
  - 2/5 intraoperative cultures positive (MSSA)
  - Elevated ESR
  - Elevated CRP

  - Total = 10 (Definite PJI)

# Case Scenario #4

- Painful shoulder arthroplasty:
  - Well-fixed components
  - 2/5 intraoperative cultures positive (C. acnes) --> 1 + 3 = 4
  - All other tests negative

  - Total = 4 (Possible PJI)

# Case Scenario #5

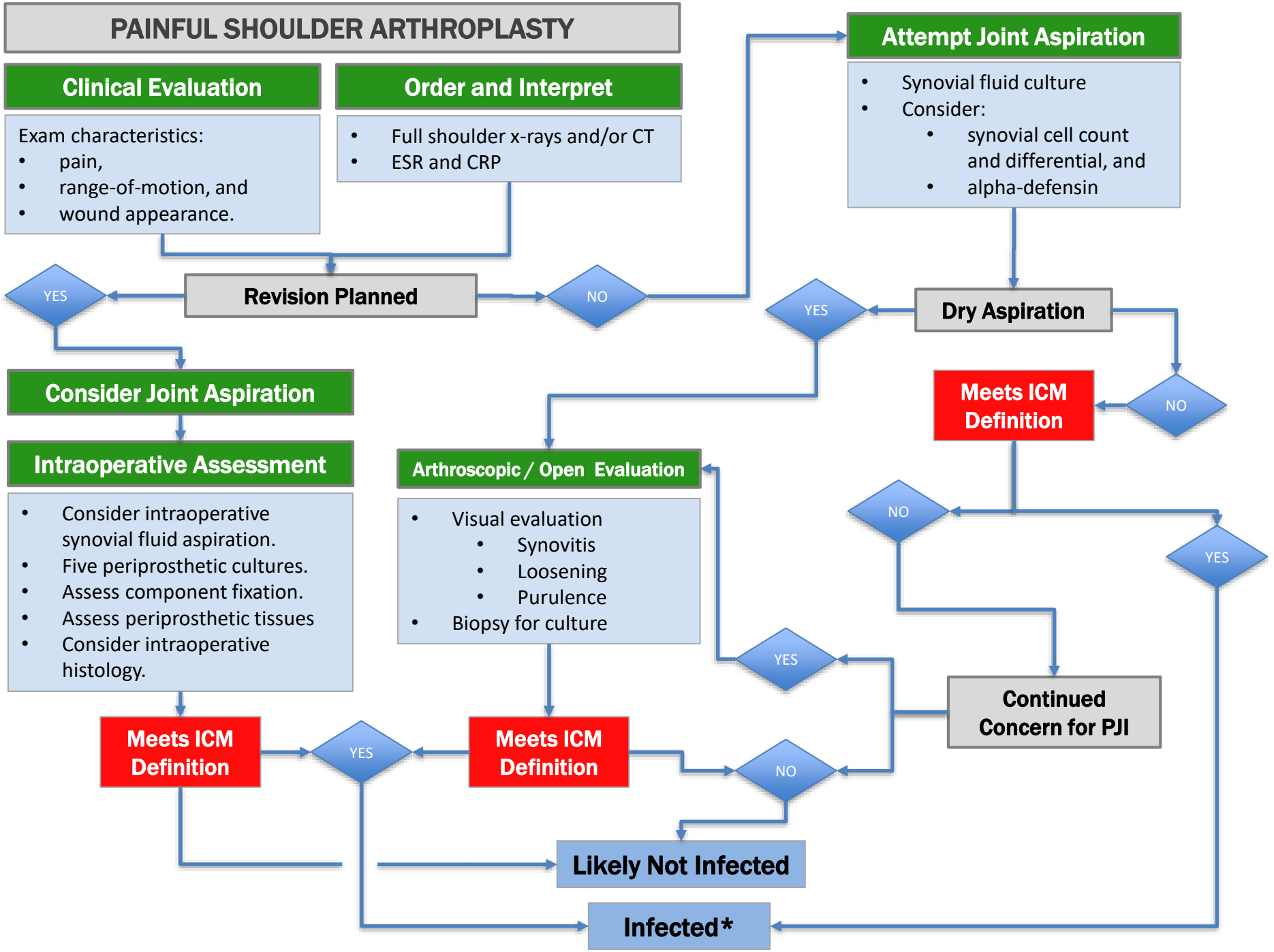
- Painful shoulder arthroplasty:
  - Persistent wound drainage → 4
  - 1/5 intraoperative cultures positive (C. acnes) --> 1
  - All other tests negative

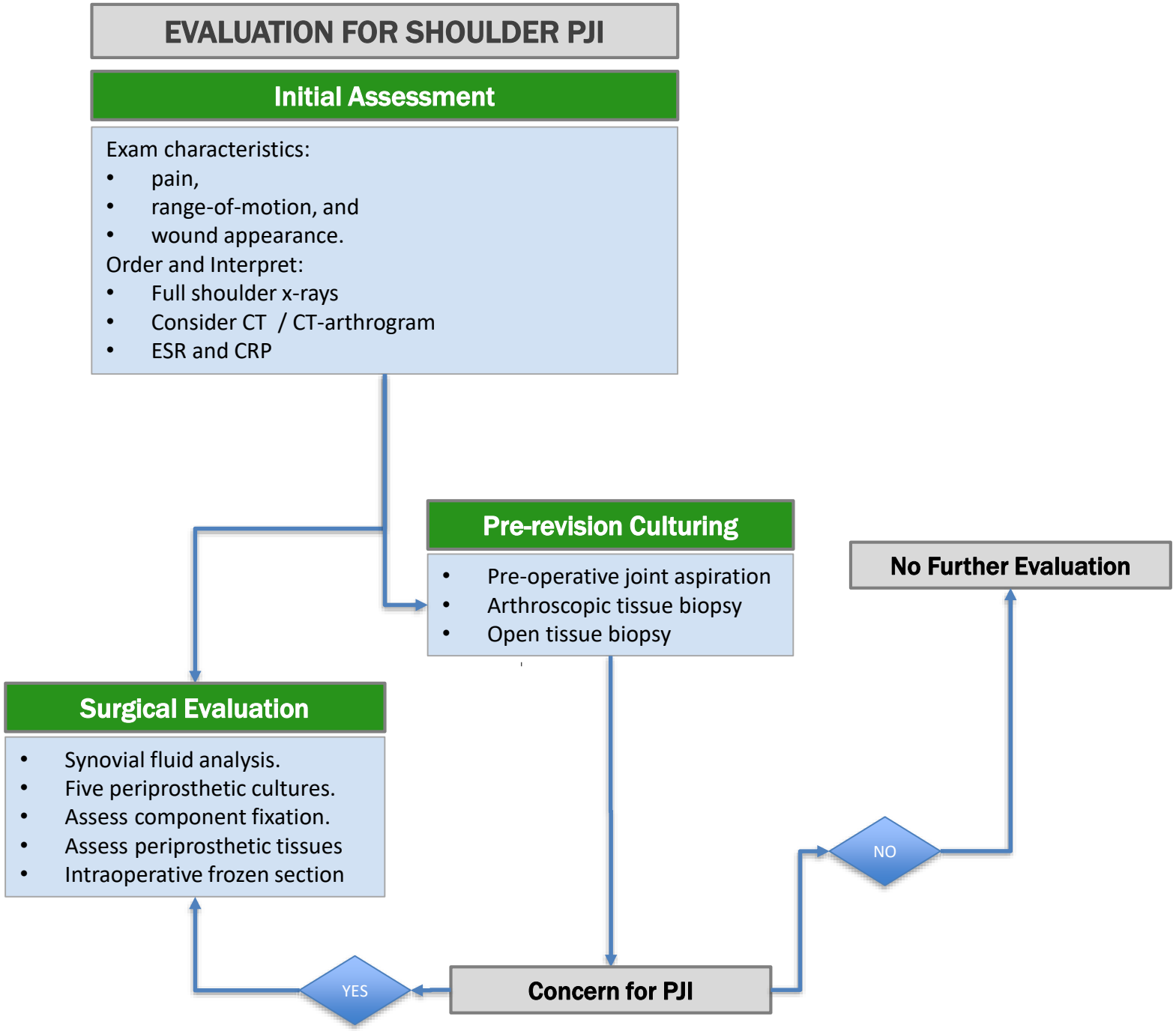
  - Total = 5 (Unlikely PJI)

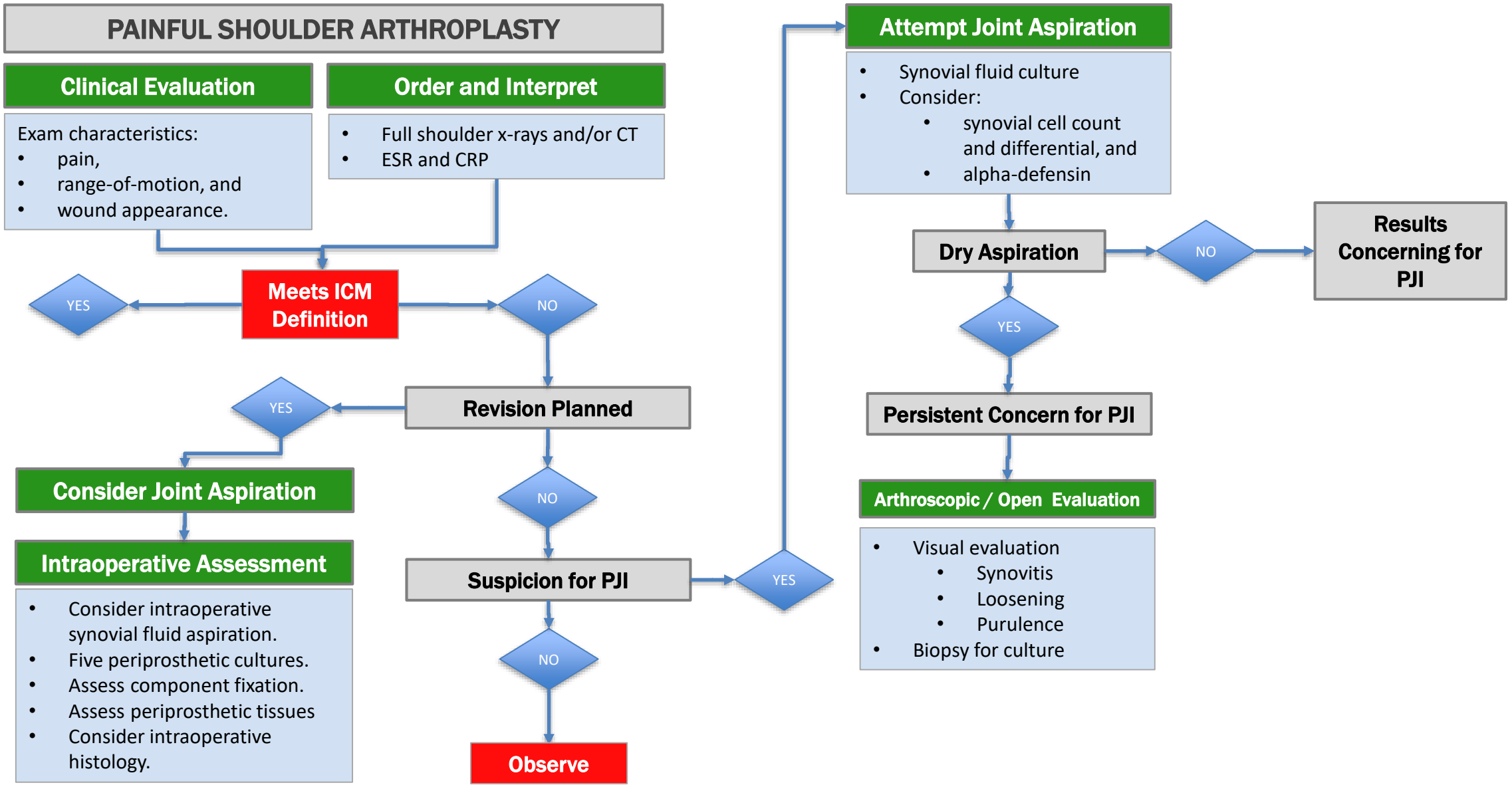
# Case Scenario #6

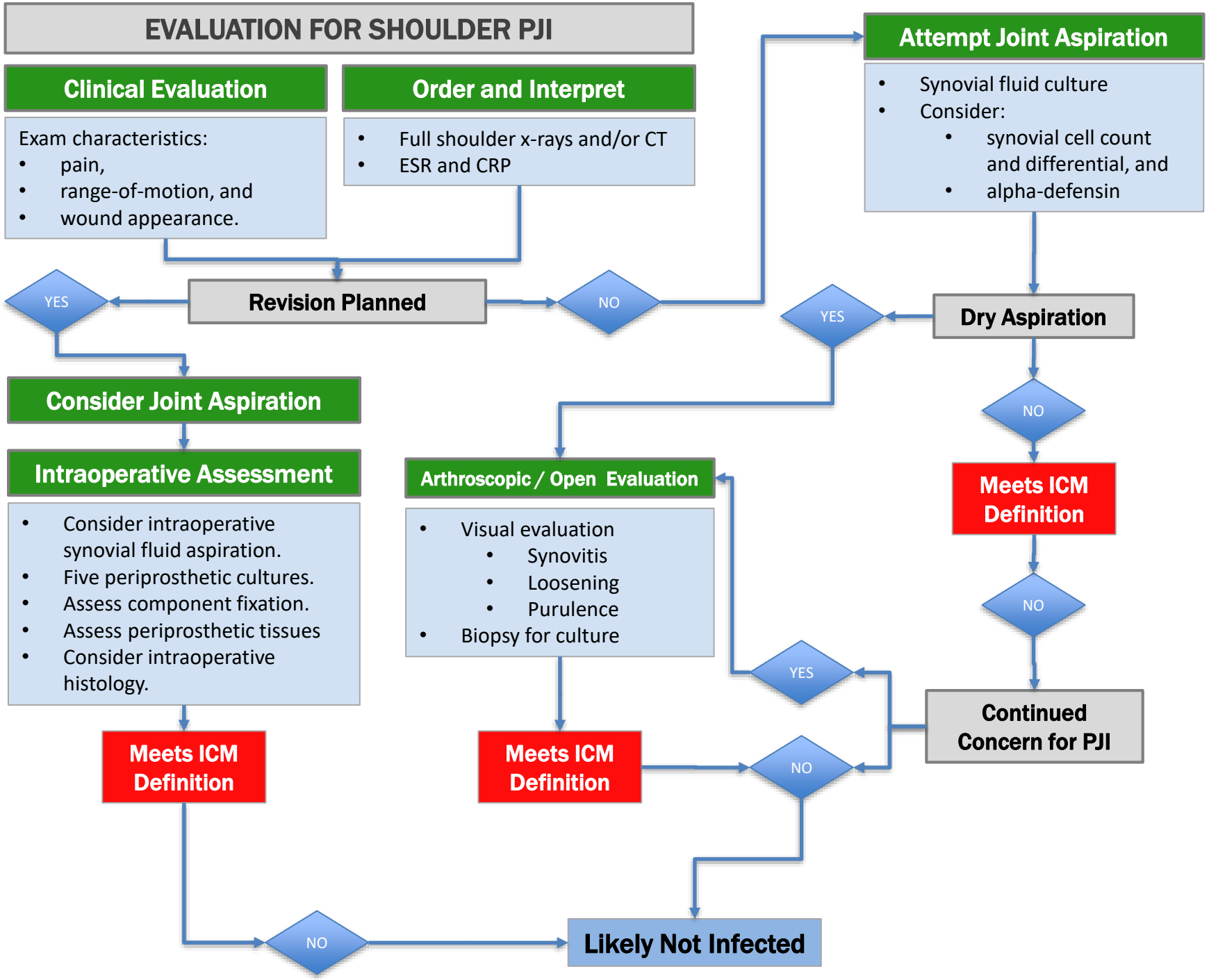
- Painful shoulder arthroplasty:
  - Persistent wound drainage → 4
  - 1/5 intraoperative cultures positive (C. acnes) --> 1
  - All other tests negative

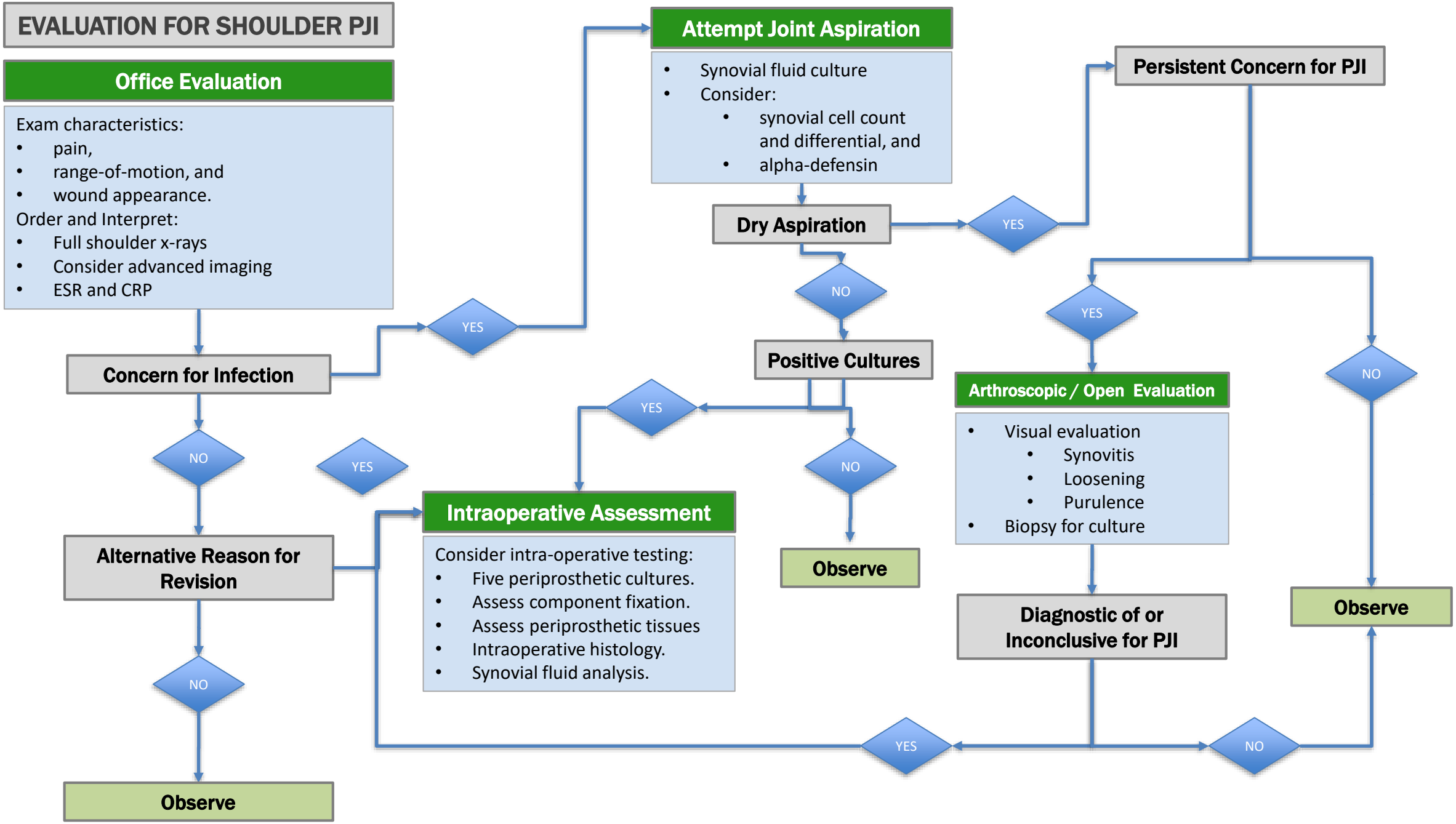
  - Total = 5 (Unlikely PJI)


PAINFUL SHOULDER ARTHROPLASTY
Clinical Evaluation
Exam characteristics:
• pain,
• range-of-motion, and
• wound appearance.
Order and Interpret
• Full shoulder x-rays and/or CT
• ESR and CRP
Revision Planned
YES
NO
Attempt Joint Aspiration
• Synovial fluid culture
• Consider:
• synovial cell count and differential, and
• alpha-defensin
Dry Aspiration
YES
Meets ICM Definition
NO
Consider Joint Aspiration
Intraoperative Assessment
• Consider intraoperative synovial fluid aspiration.
• Five periprosthetic cultures.
• Assess component fixation.
• Assess periprosthetic tissues
• Consider intraoperative histology.
Arthroscopic / Open Evaluation
• Visual evaluation
• Synovitis
• Loosening
• Purulence
• Biopsy for culture
NO
YES
YES
Continued Concern for PJI
Meets ICM Definition
YES
Meets ICM Definition
NO
Likely Not Infected
Infected*


EVALUATION FOR SHOULDER PJI
Initial Assessment
Exam characteristics:
• pain,
• range-of-motion, and
• wound appearance.
Order and Interpret:
• Full shoulder x-rays
• Consider CT / CT-arthrogram
• ESR and CRP
Pre-revision Culturing
• Pre-operative joint aspiration
• Arthroscopic tissue biopsy
• Open tissue biopsy
No Further Evaluation
Surgical Evaluation
• Synovial fluid analysis.
• Five periprosthetic cultures.
• Assess component fixation.
• Assess periprosthetic tissues
• Intraoperative frozen section
NO
YES
Concern for PJI


PAINFUL SHOULDER ARTHROPLASTY
Clinical Evaluation
Exam characteristics:
• pain,
• range-of-motion, and
• wound appearance.
Order and Interpret
• Full shoulder x-rays and/or CT
• ESR and CRP
Meets ICM Definition
YES
NO
Revision Planned
YES
Consider Joint Aspiration
Intraoperative Assessment
• Consider intraoperative synovial fluid aspiration.
• Five periprosthetic cultures.
• Assess component fixation.
• Assess periprosthetic tissues
• Consider intraoperative histology.
NO
Suspicion for PJI
NO
Observe
YES
Attempt Joint Aspiration
• Synovial fluid culture
• Consider:
• synovial cell count and differential, and
• alpha-defensin
Dry Aspiration
NO
Results Concerning for PJI
YES
Persistent Concern for PJI
Arthroscopic / Open Evaluation
• Visual evaluation
• Synovitis
• Loosening
• Purulence
• Biopsy for culture

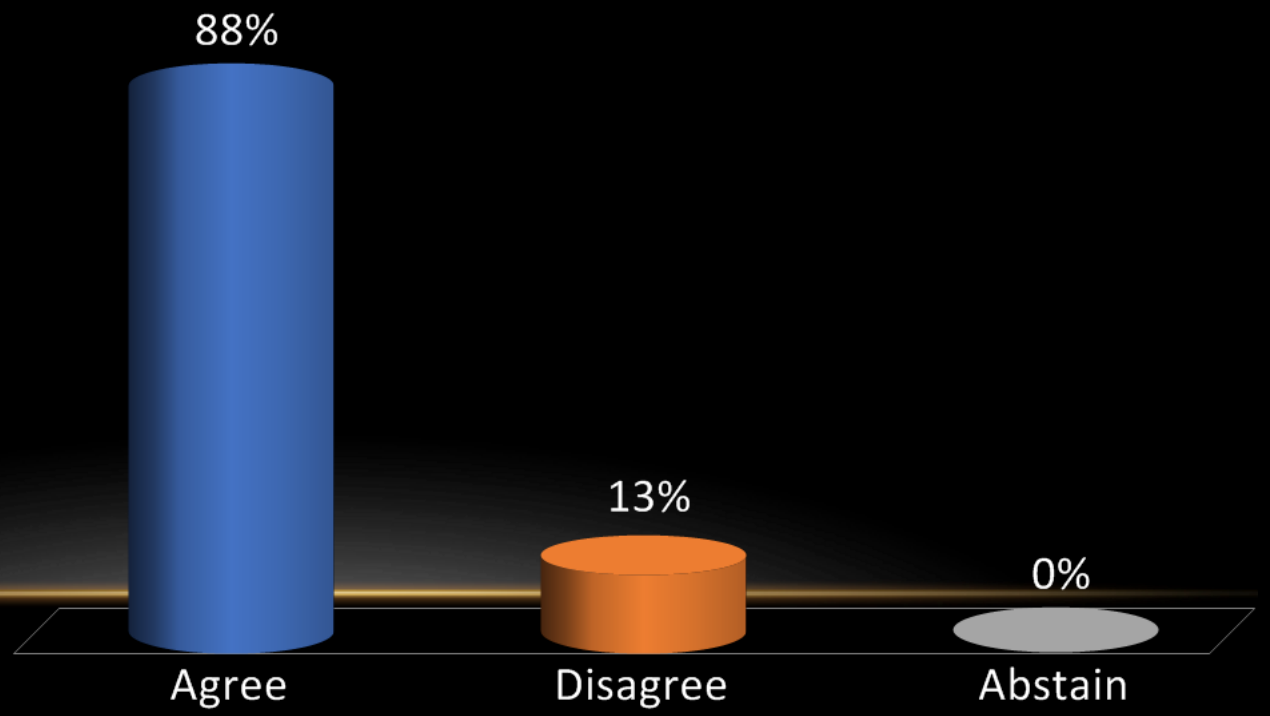

EVALUATION FOR SHOULDER PJI
Clinical Evaluation
Exam characteristics:
• pain,
• range-of-motion, and
• wound appearance.
Order and Interpret
• Full shoulder x-rays and/or CT
• ESR and CRP
Revision Planned
YES
NO
Consider Joint Aspiration
Intraoperative Assessment
• Consider intraoperative synovial fluid aspiration.
• Five periprosthetic cultures.
• Assess component fixation.
• Assess periprosthetic tissues
• Consider intraoperative histology.
Meets ICM Definition
NO
Likely Not Infected
Attempt Joint Aspiration
• Synovial fluid culture
• Consider:
• synovial cell count and differential, and
• alpha-defensin
Dry Aspiration
YES
NO
Meets ICM Definition
NO
Continued Concern for PJI
YES
Arthroscopic / Open Evaluation
• Visual evaluation
• Synovitis
• Loosening
• Purulence
• Biopsy for culture
Meets ICM Definition
NO

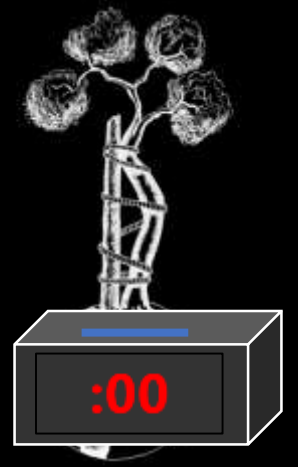

EVALUATION FOR SHOULDER PJI
Office Evaluation
Exam characteristics:
• pain,
• range-of-motion, and
• wound appearance.
Order and Interpret:
• Full shoulder x-rays
• Consider advanced imaging
• ESR and CRP
Concern for Infection
YES
NO
Alternative Reason for Revision
NO
Observe
Attempt Joint Aspiration
• Synovial fluid culture
• Consider:
• synovial cell count and differential, and
• alpha-defensin
Dry Aspiration
YES
NO
Positive Cultures
YES
NO
YES
Intraoperative Assessment
Consider intra-operative testing:
• Five periprosthetic cultures.
• Assess component fixation.
• Assess periprosthetic tissues
• Intraoperative histology.
• Synovial fluid analysis.
Observe
Persistent Concern for PJI
YES
Arthroscopic / Open Evaluation
• Visual evaluation
• Synovitis
• Loosening
• Purulence
• Biopsy for culture
Diagnostic of or Inconclusive for PJI
YES
NO
NO
Observe

**Recommendation:** See written definition of shoulder PJI.

**Level of Evidence:** Consensus.

A. Agree
B. Disagree
C. Abstain



# Treatment

# S-47(Former S-8) Is there a role for postoperative antibiotic treatment for revision arthroplasty with subsequent unexpected positive cultures for a virulent organism (e.g. MRSA, MSSA, or E. coli)?

**RESEARCHED BY:**


Yian, Edward MD, USA

Tashjian, Robert MD, USA

Sheper, Henk MD, Netherlands

# Literature:

- Systematic review:
  - 5 papers
  - 1 systematic review

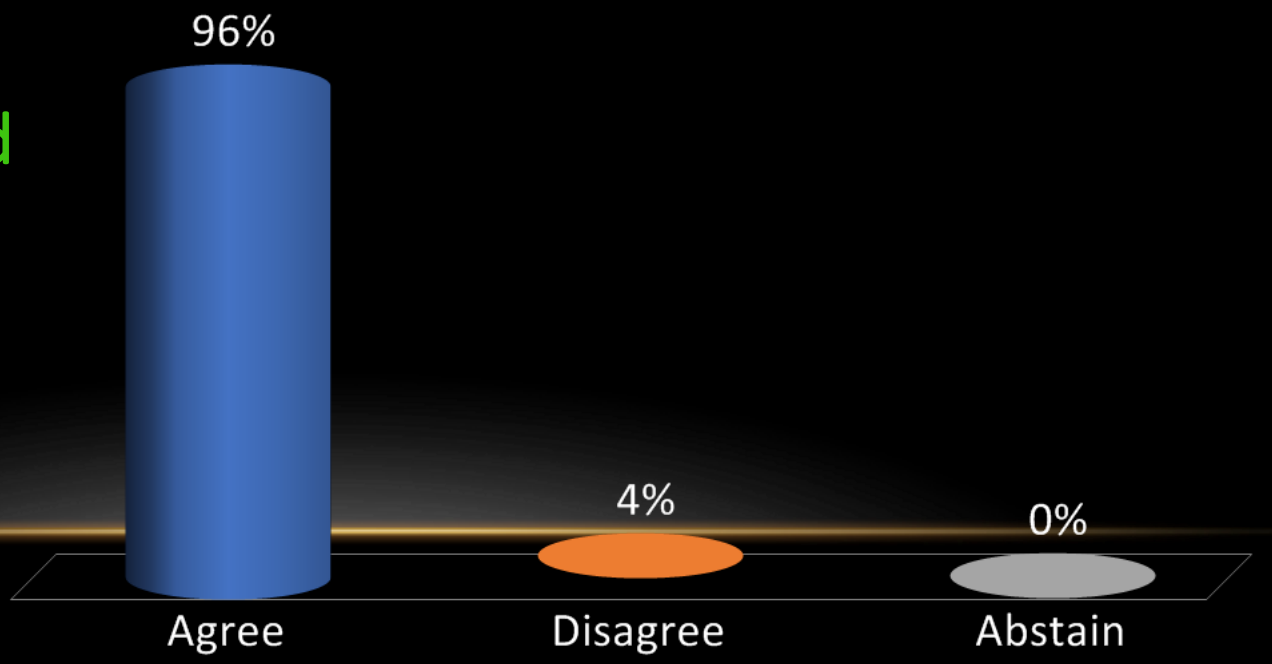

- 4. Grosso MJ, Sabesan VJ, Ho JC, Ricchetti ET, Iannotti JP. Reinfection rates after 1-stage revision shoulder arthroplasty for patients with unexpected positive intraoperative cultures. J Shoulder Elbow Surg. 2012; 21:754-58.
- 5. Foruria AM, Fox TJ< Sperling JW, Cofield RH. Clinical Meaning of Unexpected Positive Cultures (UPC) in Revision Shoulder Arthroplasty. J Shoulder Elbow Surg. 2013; 22:620-27.
- 6. Padegimas EM, Lawrence C, Narzikul AC, Zmistowski BM, Abboud JA, Williams GR, Namdari S. Future surgery after revision shoulder arthroplasty: the impact of unexpected positive cultures. J Shoulder Elbow Surg. 2017:26:975-81.
- 7. Kelly JD II, Hobgood ER. Positive Culture Rate in Revision Shoulder Arthroplasty Clin Orthop Relat Res. 2009; 467:2343-2348.
- 8. Hsu JE, Gorbaty JD, Whitney IJ, Matsen FA III. Single-Stage Revision Is Effective for Failed Shoulder Arthroplasty with Positive Cultures for Propionibacterium. J Bone Joint Surg Am 2016;98:2047-51.
- 9. Kim SJ, Kim JH. Unexpected positive cultures including isolation of Propionibacterium acnes in revision shoulder arthroplasty. Chin Med J 2014;127(22)

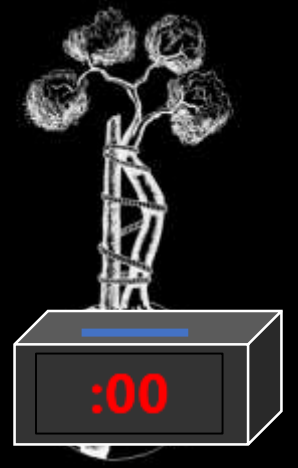

## Recommendation:

In aggregate, published studies do not clearly show superiority for prolonged antibiotic use over no prolonged antibiotic treatment in the setting of revision shoulder arthroplasty with subsequent cultures positive for virulent organisms. However, the data on this specific clinical scenario is limited as the vast majority of unexpected positive cultures are with less virulent organisms (e.g. P acnes, Coag negative staph. species)

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-48(Former S-9) Is there a need for antibiotic therapy following irrigation and debridement of patients with acute shoulder PJI caused by a virulent organism (e.g. MRSA, MSSA, or E. coli)?

**RESEARCHED BY:**

Levine, William
MD,USA

Pottinger, Paul
MD, USA

Nelson, Sandra
Bliss MD,USA

Encalada, Ivana
MD,Mexico

Itamura, John
MD,USA

# Literature:

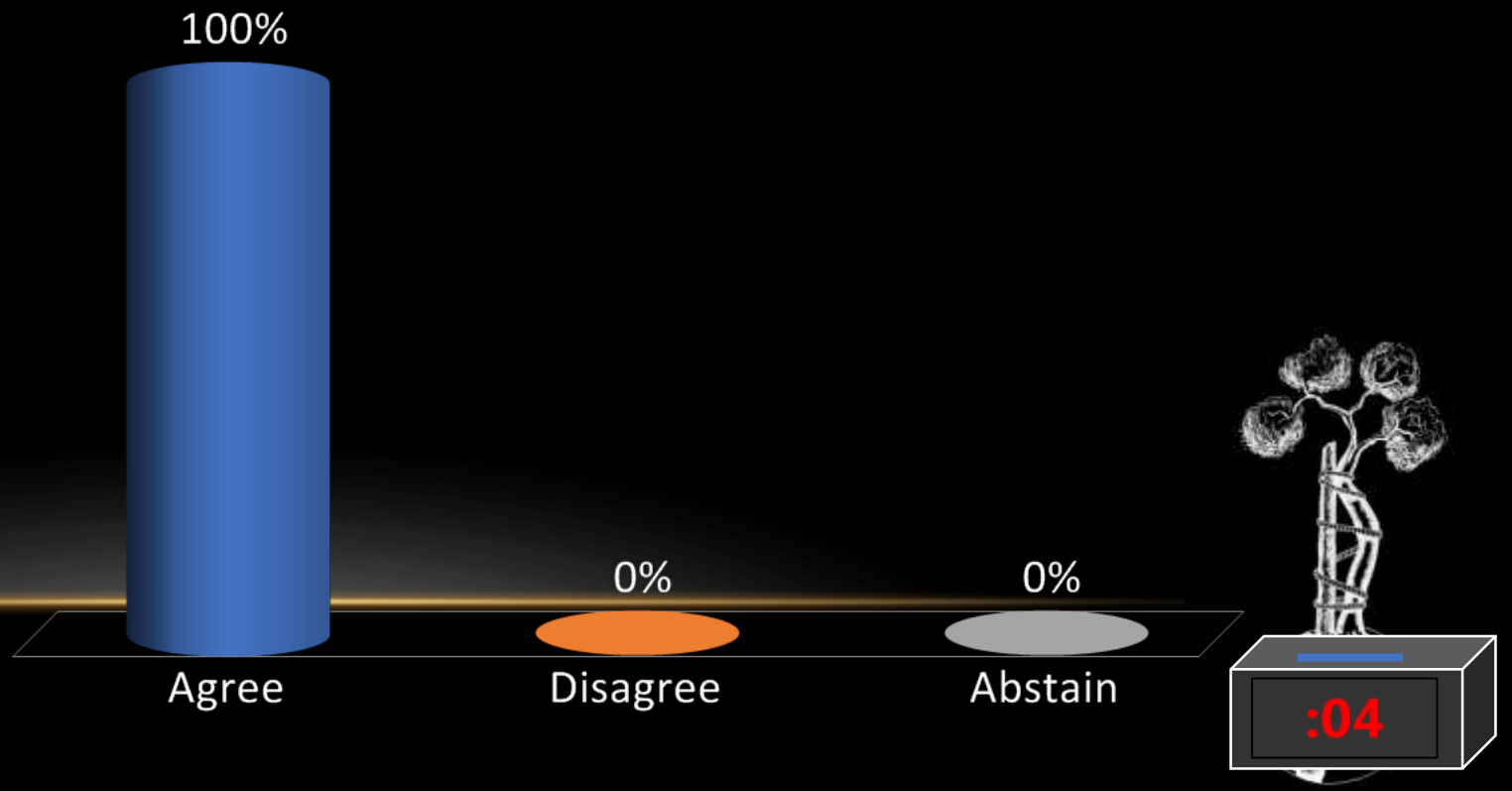
- Systematic review
  - 46 articles reviewed
  - 9 pertinent studies
    - 6 patients with acute PJI by virulent organism

## Recommendation:

In the absence of high level data, we propose that patients with acute PJI of shoulder caused by virulent organisms such as MRSA, MSSA, E. coli, receive postoperative antibiotics. The optimal antibiotic, route of administration, and duration of treatment are unknown and should be individualized after consultation with infectious disease specialists.

## Level of Evidence: Consensus

A. Agree
B. Disagree
C. Abstain



# S-49(Former S-10) Is there a role for antibiotic therapy in the management of acute shoulder PJI with an indolent organism (e.g. *C. acnes* or Coagulase Negative Staphylococcus) after irrigation and debridement?

**RESEARCHED BY:**

Pottinger, Paul
MD, USA

Nelson, Sandra Bliss MD,USA

Encalada, Ivana
MD,Mexico

Itamura, John
MD,USA

Levine, William
MD,USA

# Literature:

- Systemic search:
  - 10 shoulders in 9 patients (1 case series)

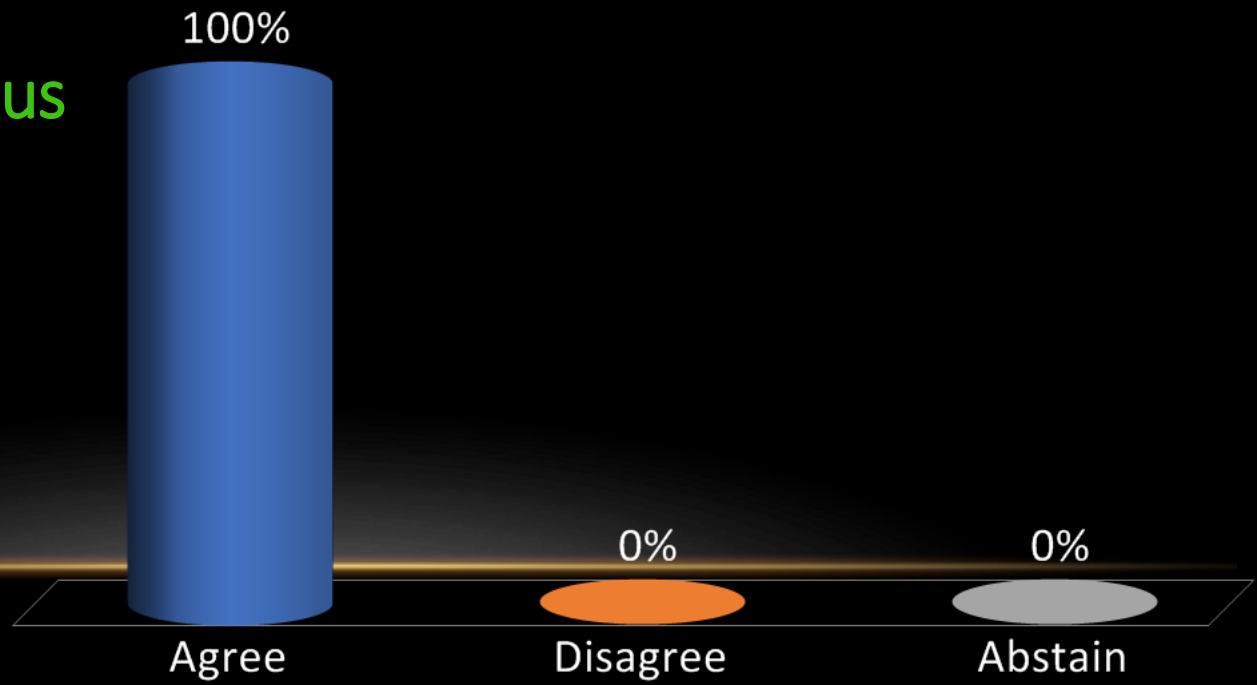
  - Dennison T, Alentorn-Geli E, Assenmacher AT, Sperling JW, Sanchez-Sotelo J, Cofield RH. Management of acute or late hematogenous infection after shoulder arthroplasty with irrigation, debridement, and component retention. JSES. 2017 26. 73-78.

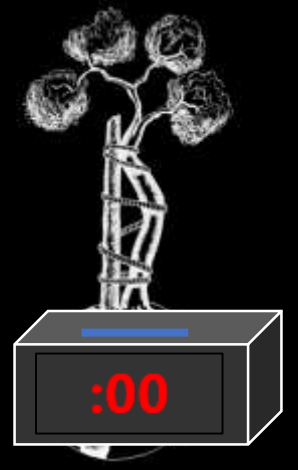
## Recommendation:

Antibiotic therapy following irrigation and debridement for management of acute shoulder PJI with an indolent organism has not been well-studied in the literature. The limited data available suggests treatment should consist of antibiotic therapy, however the optimal antibiotic, route of administration, and duration of treatment are unknown.

## Level of Evidence: Consensus

A. Agree
B. Disagree
C. Abstain



# S-50(Former S-13) Is there a role for non-operative suppressive treatment in the management of subacute or chronic shoulder PJI?

**RESEARCHED BY:**

Ekelund, Anders MD, Sweden

# Literature:

- Systematic review:
  - 5 relevant papers reporting on pooled 8 shoulders

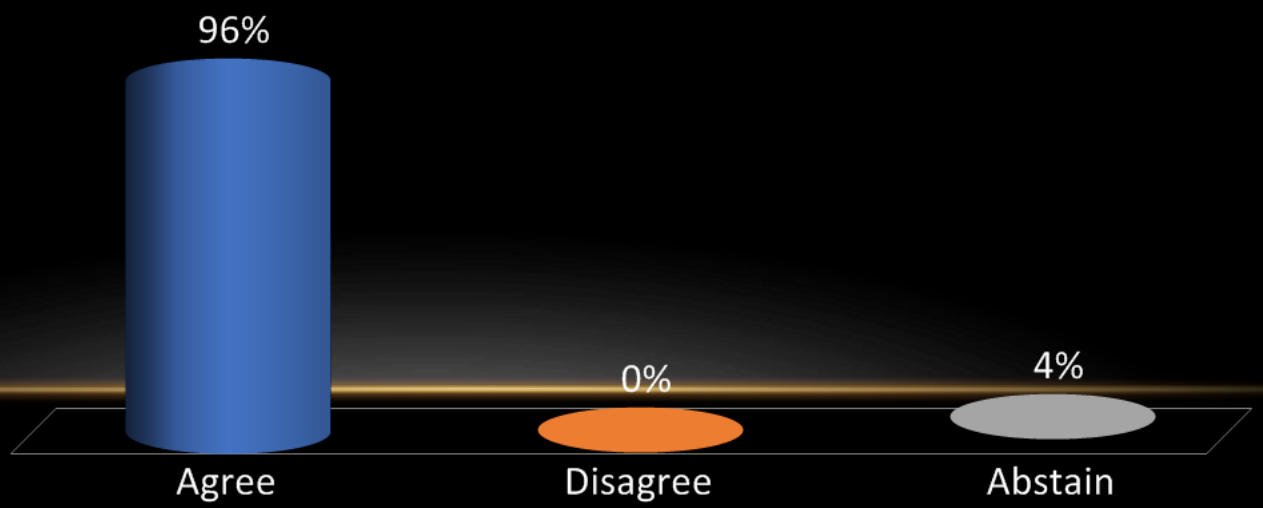

  - Pradier M, Nguyen S, Robineau O, et al. Suppressive antibiotic therapy with oral doxycycline for Staphylococcus aureus prosthetic joint infection: a retrospective study of 39 patients. Int J Antimicrob Agents. 2017; 50: 447-452.
  - Pradier M, Robineau O, Boucher A, et al. Suppressive antibiotic therapy with oral tetracyclines for prosthetic joint infections: a retrospective study of 78 patients. Infection 2018; 46: 39-47.
  - Prendki V, Ferry T, Sergent P et al. Prolonged suppressive antibiotic therapy for prosthetic joint infection in the elderly: a national multicenter cohort study. Eur J Clin Microbiol Infect Dis. 2017; 36: 1577-1585.
  - Prendki V, Sergent P, Barrelet A et al. Efficacy of indefinite chronic oral antimicrobial suppression for prosthetic joint infection in the elderly: a comparative study. Int J Infect Dis 2017; 60: 57-60.
  - Wouthuyzen-Bakker M, Nijman JM, Kampinga GA, von Assen S, Jutte PC. Efficacy of antibiotic suppressive therapy in patients with a prosthetic joint infection. J Bone Joint Infect. 2017; 2: 77-83.

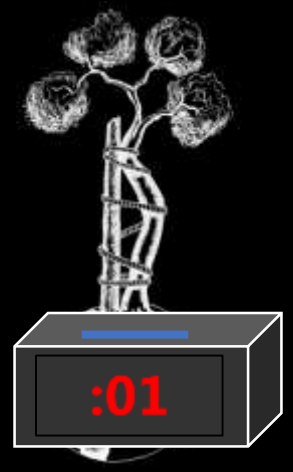

## Recommendation:

Although there is a role for suppressive antibiotic treatment of selected cases of periprosthetic infection of the shoulder, there are only a few shoulders included in the published literature. The vast majority of published cases describe initial irrigation and debridement and these are not well separated in the literature from the small number of cases of patients treated with antibiotics alone. No patient treated with antibiotics alone for shoulder PJI has had antibiotics stopped and remained infection-free, thus concerns related to efficacy, long-term toxicity, and development of resistant strains are paramount with this strategy. No recommendations can be given on indication, type and duration of suppressive antibiotic treatment.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-51(Former S-15) Is there a role for oral suppressive antimicrobial therapy in the setting of retained prostheses after IV therapy in subacute or chronic PJI?

**RESEARCHED BY:**

Cobo Reinoso, Javier MD,
Spain

# Literature:

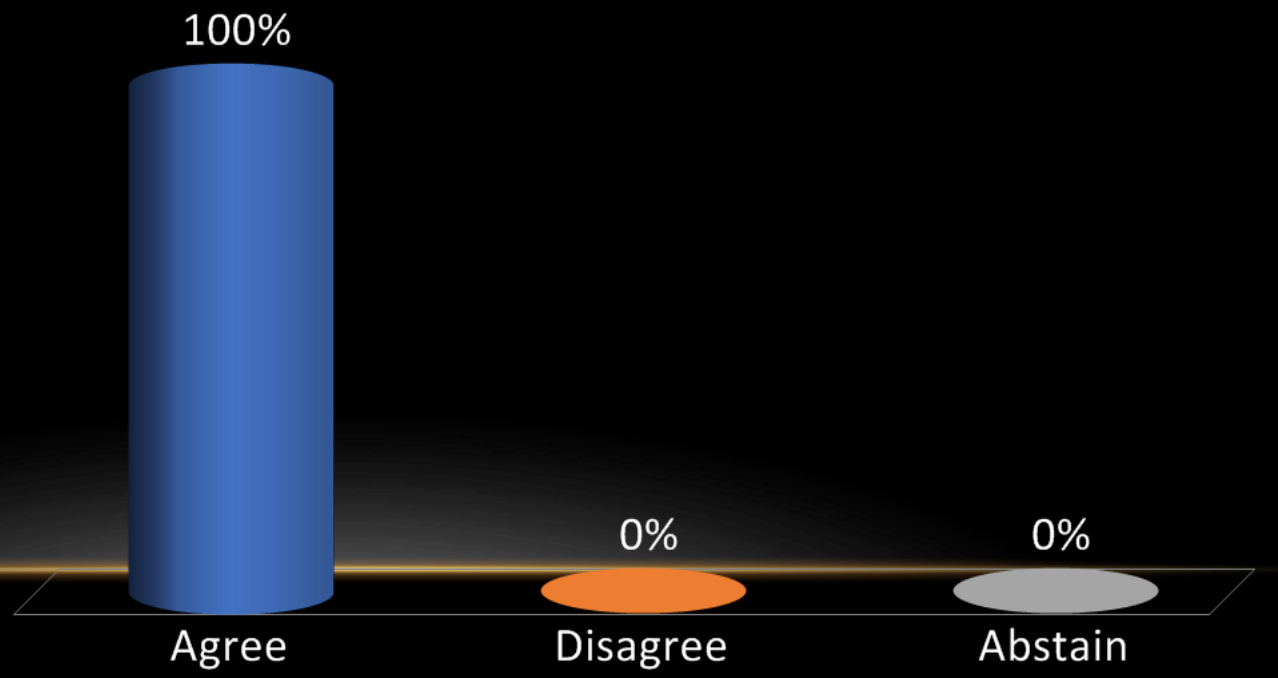
- Systematic review:
  - Search about prosthetic joint infection or arthroplasty and suppressive therapy or suppressive antibiotics yielded 13 references [1–13].
    - Twelve are retrospective descriptive series and one is a propensity score controlled cohort study [9].
    - The vast majority of the cases contained in these series were hip and knee infections and only 9 of the 680 were prosthetic infections.
    - Therefore, the present review is based on the results obtained with prosthetic hip and knee infections for shoulder prostheses.

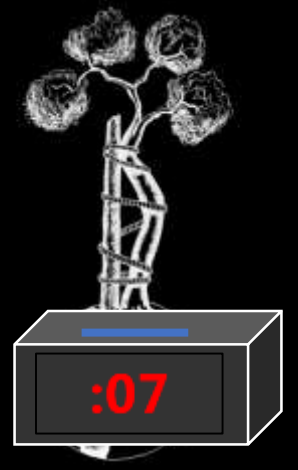
## Recommendation:

The administration of oral suppressive antimicrobial therapy may have a role in management of patients with chronic or subacute PJI who cannot undergo further surgical intervention.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-52(Former S-17) Is there a role for postoperative antibiotic treatment when a revision arthroplasty is performed with subsequent unexpected positive cultures of the shoulder caused by an indolent organism (e.g. P. acnes or Coagulase Negative Staphylococcus)?

**RESEARCHED BY:**

Yian, Edward MD, USA

# Literature:

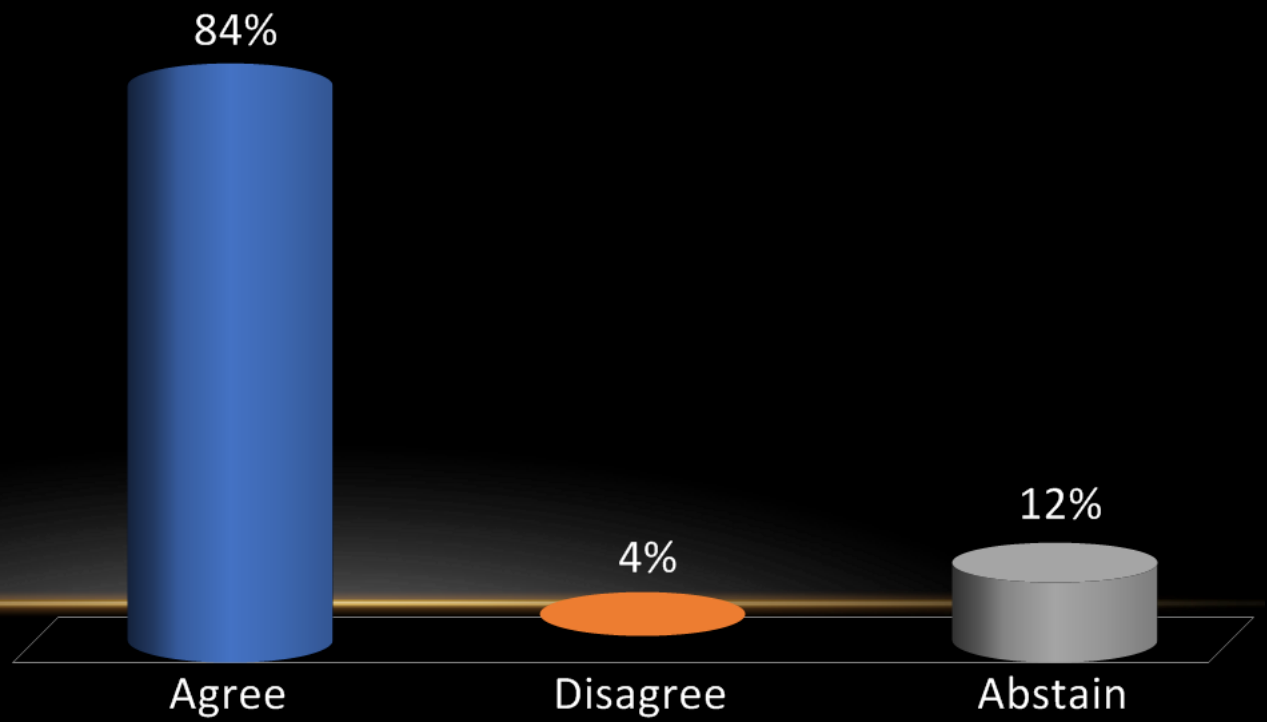
- Systematic Review:
  - 5 retrospective reviews and 1 systematic review
    - 4. Grosso MJ, Sabesan VJ, Ho JC, Ricchetti ET, Iannotti JP. Reinfection rates after 1-stage revision shoulder arthroplasty for patients with unexpected positive intraoperative cultures. J Shoulder Elbow Surg. 2012; 21:754-58.
    - 5. Foruria AM, Fox TJ, Sperling JW, Cofield RH. Clinical Meaning of Unexpected Positive Cultures (UPC) in Revision Shoulder Arthroplasty. J Shoulder Elbow Surg. 2013; 22:620-27.
    - 6. Padegimas EM, Lawrence C, Narzikul AC, Zmistowski BM, Abboud JA, Williams GR, Namdari S. Future surgery after revision shoulder arthroplasty: the impact of unexpected positive cultures. J Shoulder Elbow Surg. 2017:26:975-81.
    - 7. Kelly JD II, Hobgood ER. Positive Culture Rate in Revision Shoulder Arthroplasty Clin Orthop Relat Res. 2009; 467:2343-2348.
    - 8. Hsu JE, Gorbaty JD, Whitney IJ, Matsen FA III. Single-Stage Revision Is Effective for Failed Shoulder Arthroplasty with Positive Cultures for Propionibacterium. J Bone Joint Surg Am 2016;98:2047-51.
    - 9. Kim SJ, Kim JH. Unexpected positive cultures including isolation of Propionibacterium acnes in revision shoulder arthroplasty. Chin Med J 2014;127(22)

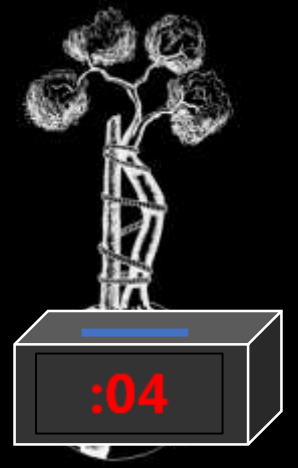
## Recommendation:

Postoperative antibiotic treatment beyond 24 hours after revision arthroplasty with unexpected positive cultures for an indolent organism does not appear to reduce the risk of subsequent infection.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-53(Former S-18) Is there a role for postoperative antibiotics after performing an irrigation and debridement for hematoma complicating a primary or revision shoulder arthroplasty while awaiting culture results?

**RESEARCHED BY:**


Abboud, Joseph MD, USA

Duquin, Thomas MD, USA

Henry, Michael MD, USA

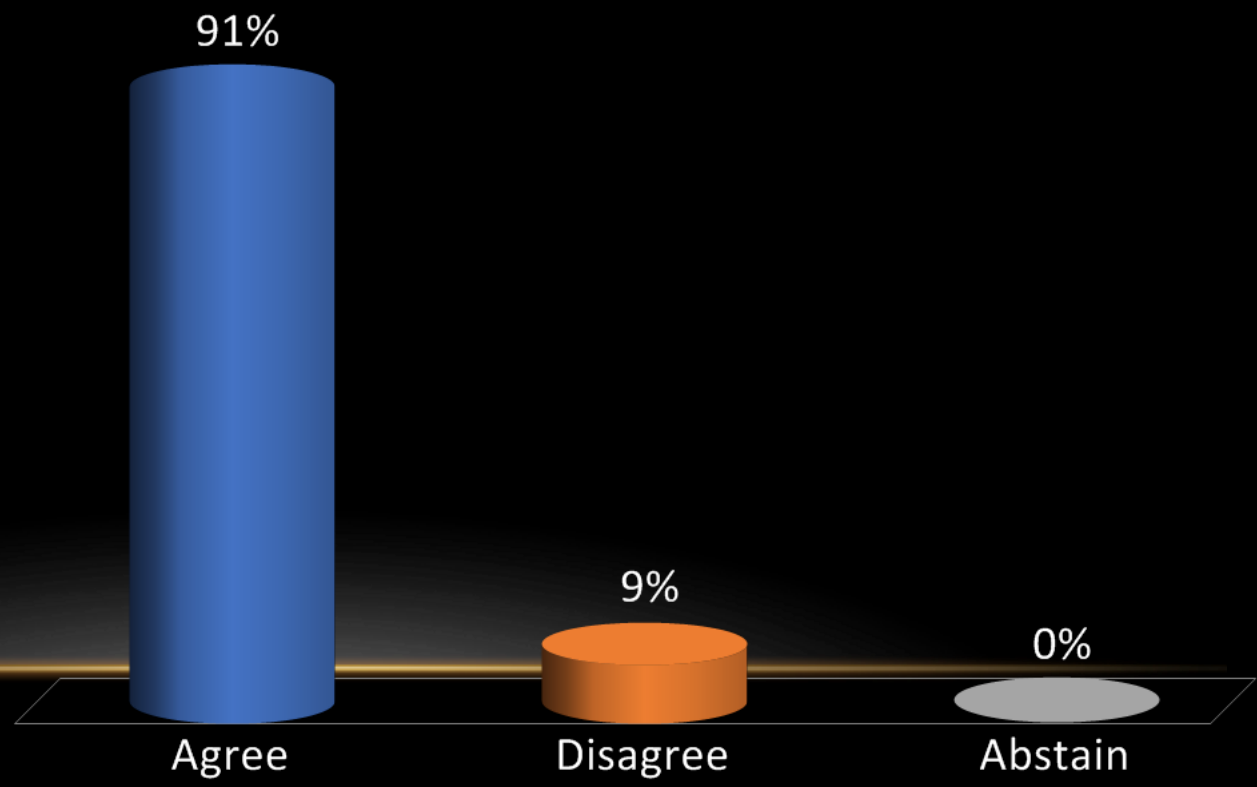
# Literature:

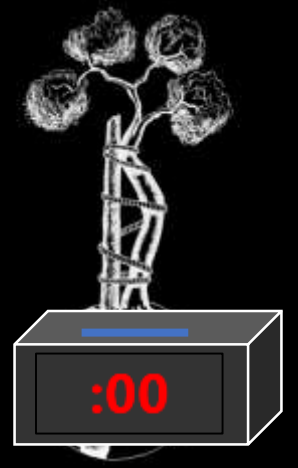
- Systematic review:
  - 337 abstracts → 11 relevant articles (hematoma after shoulder arthroplasty)
  - No direct evidence to answer question

**Recommendation:**
Antibiotics should be given after performing an irrigation and debridement for hematoma after shoulder (primary or revision) arthroplasty while awaiting cultures.

**Level of Evidence:** Consensus

A. Agree
B. Disagree
C. Abstain



# S-54(Former S-37) Is there a role for oral suppressive antimicrobial therapy in acute PJI in the setting of retained prostheses after initial IV therapy? Same duration as for lower extremity arthroplasty? Should it differ by pathogen (e.g. MSSA vs MRSA)?

**RESEARCHED BY:**


Abboud, Joseph MD, USA

Duquin, Thomas MD, USA

Henry, Michael MD, USA

# Literature:

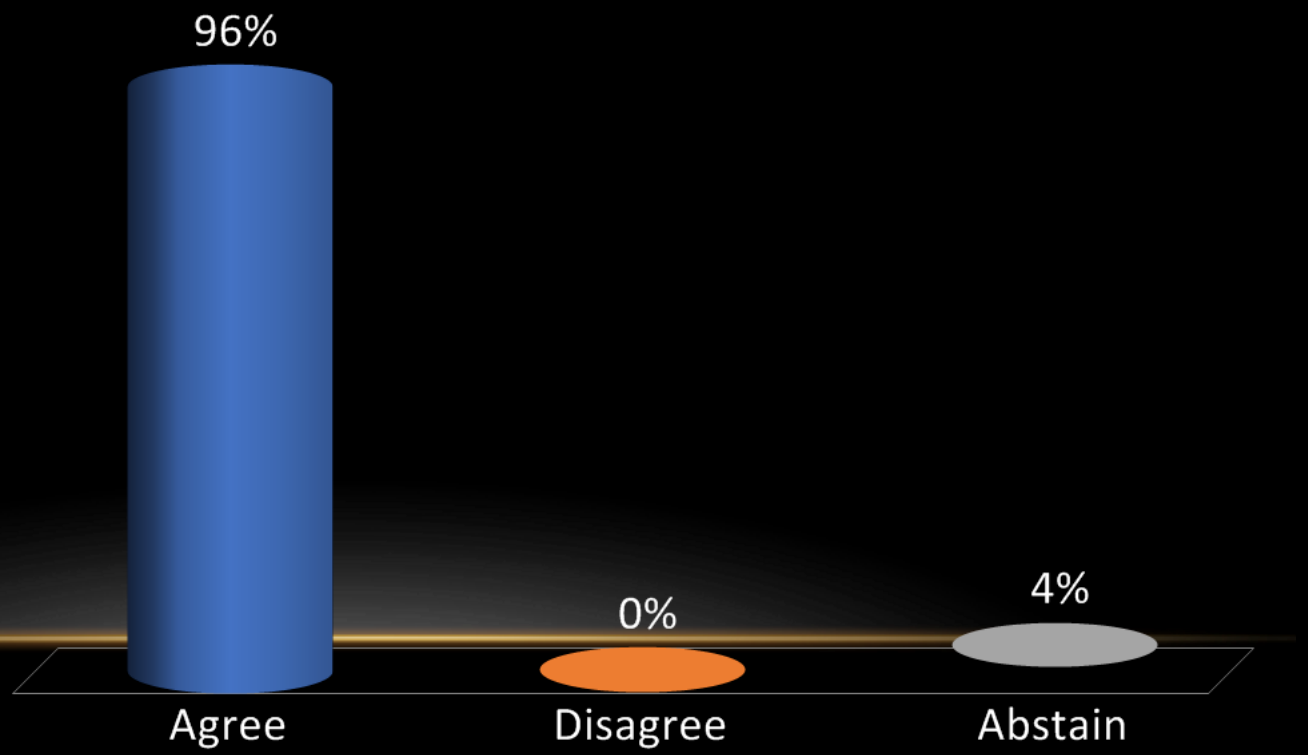
- Systematic review
  - 288 abstracts -> 18 manuscripts
  - “The overall number of patients presented in these articles is also very small; no study exceeded 50 shoulders and the majority reported on the outcomes of less than 10 patients with acute shoulder PJIs treated with irrigation and debridement and implant retention followed by IV and then oral antibiotics.“
  - “However, despite the lack of supporting medical literature, the use of oral antibiotics, based on the more extensive experience with the treatment of hip and knee infections following debridement as well as the current understanding of the role biofilm plays in treatment failure, is likely a reasonable approach for the treatment of acute prosthetic shoulder infections when treating with implant retention, at least until more rigorous outcomes data that supports the contrary is available.”

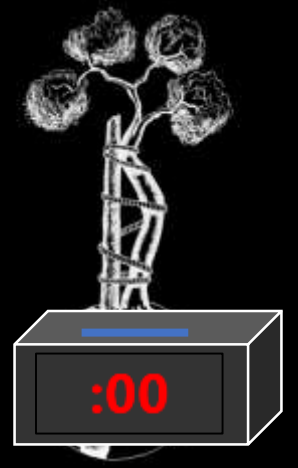
## Recommendation:

While the role of debridement, antibiotics, and implant retention (DAIR) in the treatment of acute prosthetic shoulder infection has not been well-studied, there is likely a role for oral suppressive antimicrobial therapy in the setting of retained infected shoulder prostheses after DAIR. There is no evidence to guide the optimal duration of treatment, nor if treatment should vary by organism.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-55(Former S-45) Should the duration of oral suppressive antimicrobial therapy differ by pathogen (e.g. MSSA vs MRSA) in the treatment of subacute or chronic shoulder PJI?

**RESEARCHED BY:**

Scheper, Henk
MD, Netherlands

Somerson, Jeremy,
MD, USA

Levine, William
MD, USA

Del Pozo, Jose L
MD, Spain

# Literature:

- Systematic Review:
  - 12 relevant studies
  - 34 patients
    - Shoulder PJI and received suppressive antibiotics
    - PJI relapse rate of 29% (10/34)

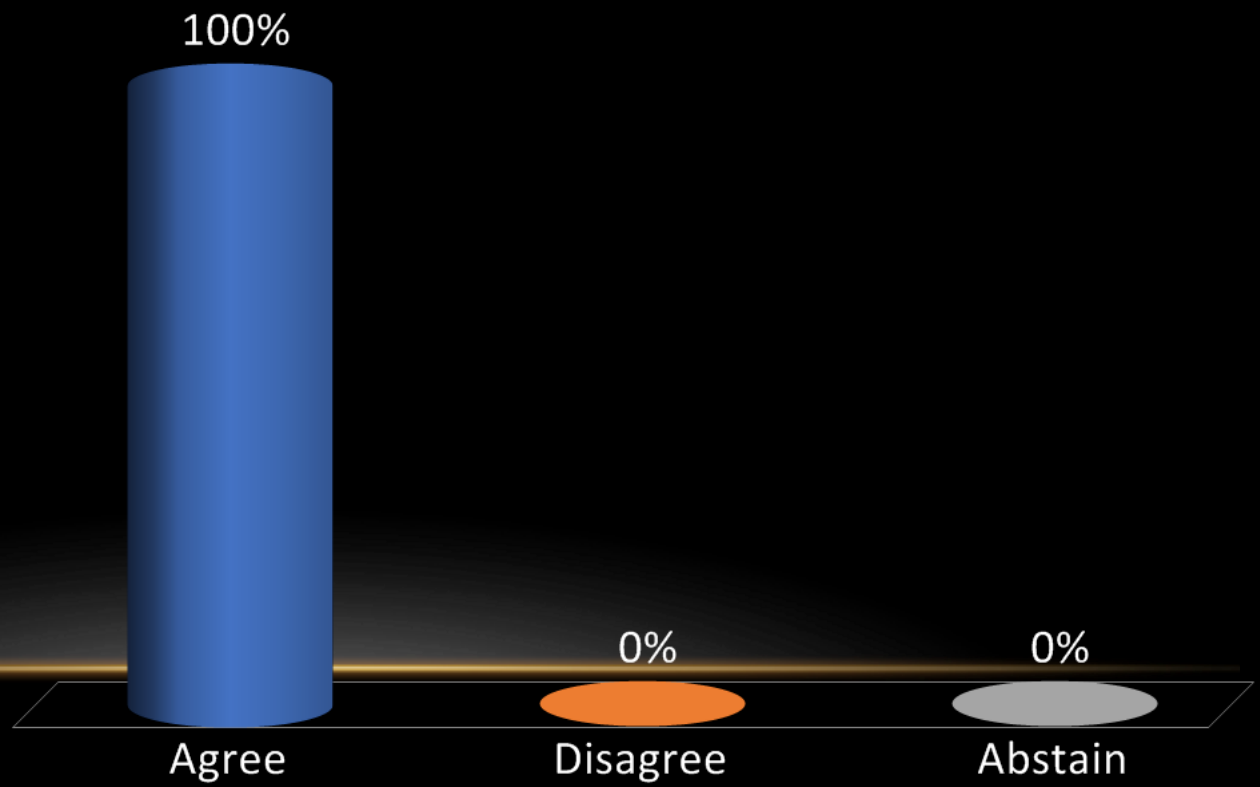
  - A study 24 patients with PJI (2 shoulder patients) did observe that treatment succeeded in almost all patients with a PJI caused by a S. epidermidis

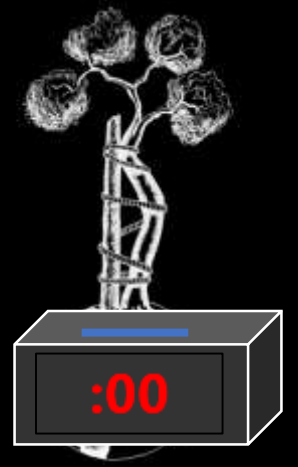
## Recommendation:

There is insufficient evidence to determine whether the duration of oral suppressive antimicrobial therapy should differ by pathogen in the treatment of subacute/chronic shoulder PJI.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



S-56(Former S-76) What are the recommendations for the route (IV versus PO) and duration of postoperative antibiotic treatment when a one-stage revision arthroplasty is performed for subacute or chronic shoulder PJI of the shoulder caused by an indolent organism (e.g. C. acnes or Coagulase Negative Staphylococcus)?

**RESEARCHED BY:**

Entezari, Vahid MD, USA

# Literature:

- Systematic review:
  - 120 papers → 8 relevant

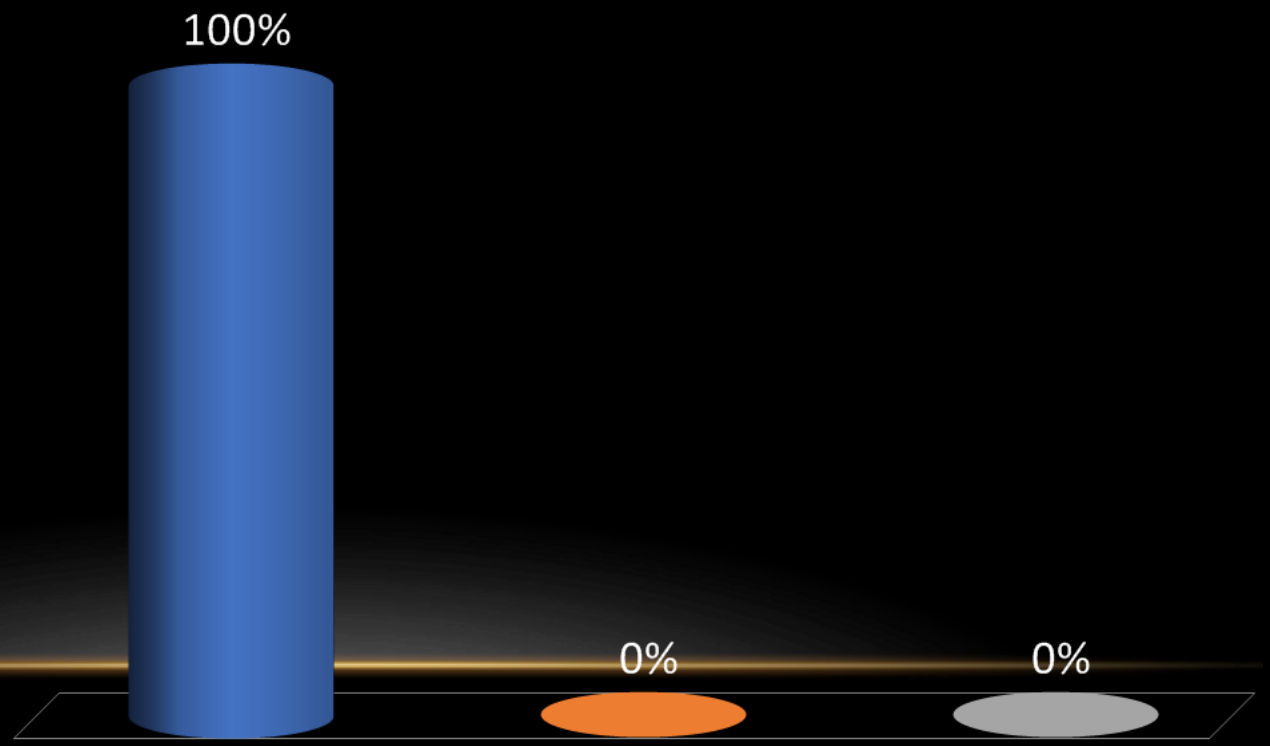

- Grosso MJ, Sabesan VJ, Ho JC, Ricchetti ET, Iannotti JP. Reinfection rates after 1-stage revision shoulder arthroplasty for patients with unexpected positive intraoperative cultures. J Shoulder Elbow Surg 2012; 21: 754-758.
- Coste JS, Reig S, Trojani C, Berg M, Walch G, Boileau P. The management of infection in arthroplasty of the shoulder. J Bone Joint Surg Br 2004; 86: 65-69.
- Padegimas EM, Lawrence C, Narzikul AC, Zmistowski BM, Abboud JA, Williams GR, et al. Future surgery after revision shoulder arthroplasty: the impact of unexpected positive cultures. J Shoulder Elbow Surg 2017; 26: 975-981.
- Keller SC, Cosgrove SE, Higgins Y, Piggott DA, Osgood G, Auwaerter PG. Role of Suppressive Oral Antibiotics in Orthopedic Hardware Infections for Those Not Undergoing Two-Stage Replacement Surgery. Open Forum Infect Dis 2016; 3: ofw176.
- Piggott DA, Higgins YM, Melia MT, Ellis B, Carroll KC, McFarland EG, et al. Characteristics and Treatment Outcomes of Propionibacterium acnes Prosthetic Shoulder Infections in Adults. Open Forum Infect Dis 2016; 3: ofv191.
- Hsu JE, Gorbaty JD, Whitney IJ, Matsen FA, 3rd. Single-Stage Revision Is Effective for Failed Shoulder Arthroplasty with Positive Cultures for Propionibacterium. J Bone Joint Surg Am 2016; 98: 2047-2051.
- Klatte TO, Junghans K, Al-Khateeb H, Rueger JM, Gehrke T, Kendoff D, et al. Single- stage revision for peri-prosthetic shoulder infection: outcomes and results. Bone Joint J 2013; 95-B: 391-395.
- Hsu JE, Bumgarner RE, Matsen FA, 3rd. Propionibacterium in Shoulder Arthroplasty: What We Think We Know Today. J Bone Joint Surg Am 2016; 98: 597-606

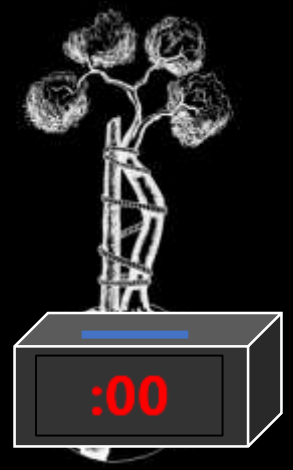

**Recommendation:**
Prior to identification of pathogenic organisms from intra-operative cultures, a course of oral antibiotics may be initiated that covers the potential organism until intraoperative cultures are finalized. If the cultures are positive and periprosthetic infection is diagnosed, then a continued course of antibiotics (up to 6 weeks) should be pursued.

There is no evidence to support a preferred route (oral vs. IV), type and duration of antibiotic treatment.

**Level of Evidence:** Consensus

A. Agree
B. Disagree
C. Abstain



# S-57(Former S-77) What are the recommendations regarding the route (IV versus PO) and length of postoperative antibiotic treatment when a one-stage revision arthroplasty is performed for subacute/chronic shoulder PJI caused by a virulent organism (e.g. MRSA, MSSA, E. coli)?

**RESEARCHED BY:**

Virk, Mandeep MD, USA

Morrey, Mark MD, USA

# Literature:

- Systematic review:
  - 1,434 titles
  - 31 papers
  - 4 studies included

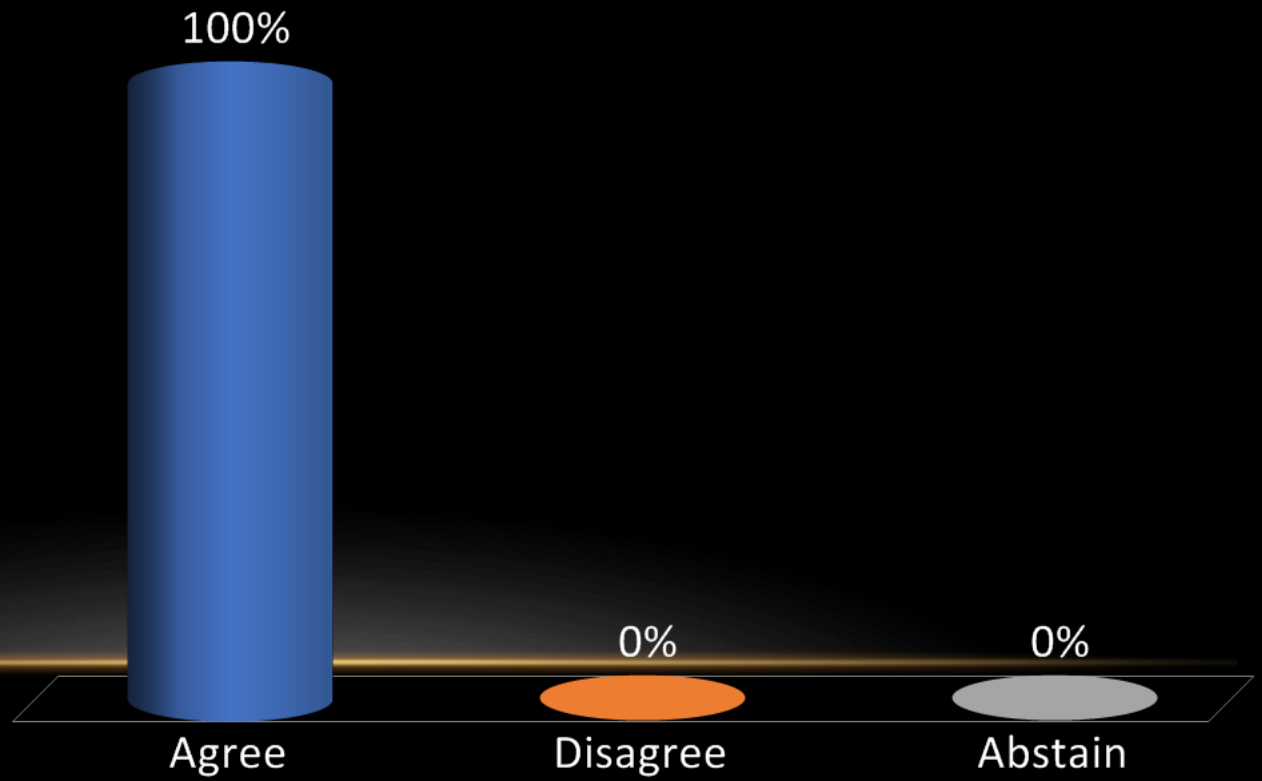

- Klatte TO, Junghans K, Al-Khateeb H, et al. Single-stage revision for peri-prosthetic shoulder infection: Outcomes and results. Bone and Joint Journal. 2013;95B(3):391-395.
- Beekman PDA, Katusic D, Berghs BM, Karelse A, De Wilde L. One-stage revision for patients with a chronically infected reverse total shoulder replacement. Journal of Bone and Joint Surgery - Series B. 2010;92(6):817-822.
- Ince A, Seemann K, Frommelt L, Katzer A, Loehr JF. One-stage exchange shoulder arthroplasty for peri-prosthetic infection. Journal of Bone and Joint Surgery - Series B. 2005;87(6):814-818.
- Cuff DJ, Virani NA, Levy J, et al. The treatment of deep shoulder infection and glenohumeral instability with debridement, reverse shoulder arthroplasty and post- operative antibiotics. Journal of Bone and Joint Surgery - Series B. 2008;90(3):336-342.

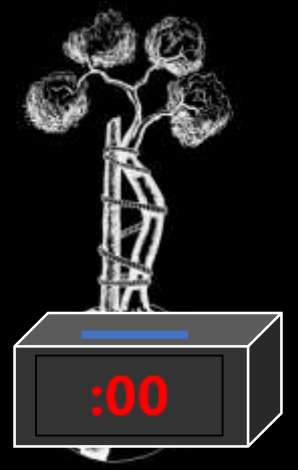

## Recommendation:

Intravenous antibiotics or intravenous followed by oral antibiotics are both reasonable options for one-stage revision shoulder arthroplasty for subacute/chronic shoulder PJI caused by a virulent organism. As there is no consensus on the route or duration, these treatment parameters should be selected in consultation with an infectious disease specialist.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-58(Former S-58) What is the optimal antibiotic treatment for culture-negative cases with positive clinical, radiographic, or intraoperative findings for acute shoulder PJI?

**RESEARCHED BY:**


Clark, Nen MD, Australia

Kelly, Jim MD, USA

Itamura, John MD, USA

Benito, Natividad MD, Spain

# Literature:

- Systematic review:
  - 9 original articles and 1 systematic review
    - Lower extremity studies

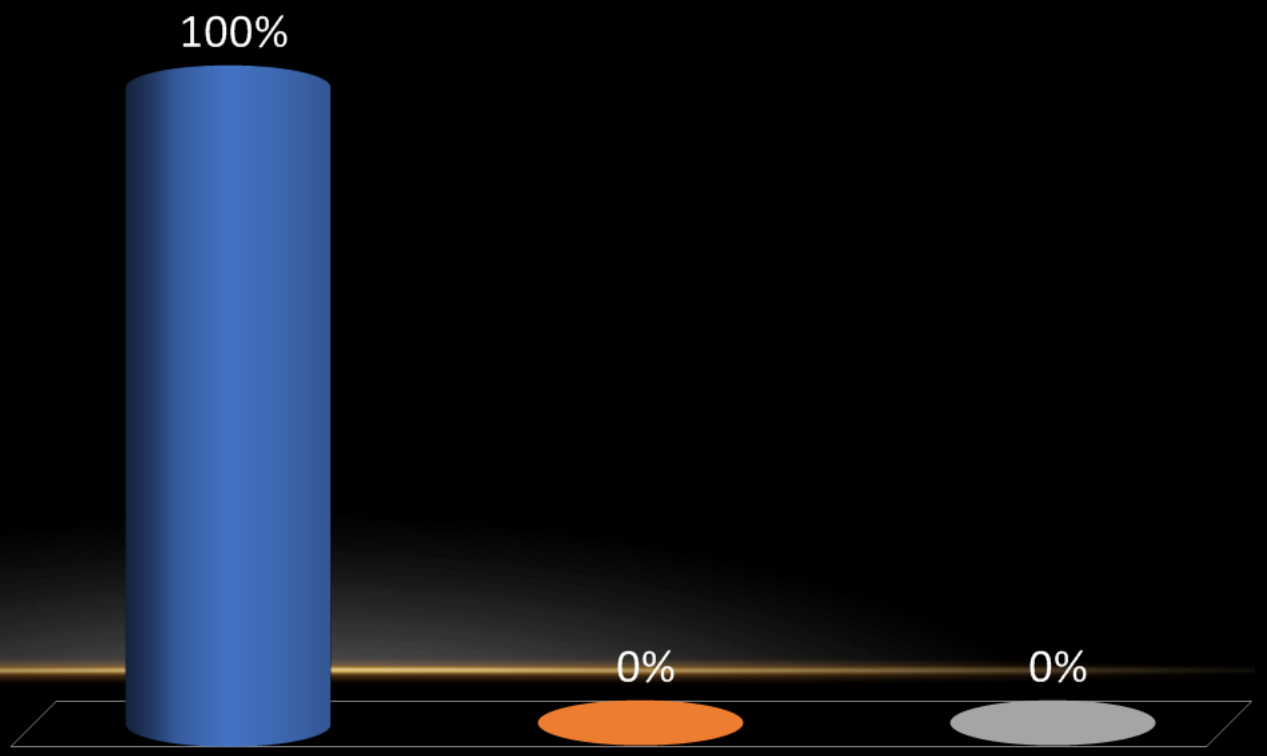
  - Benito et al analyzed the microbiology of 42 infections of shoulder arthroplasty (data not published);
    - twenty-eight (66.7%) PJIs were caused by aerobic gram- positive cocci, mainly coagulase-negative staphylococci, followed by S. aureus;
    - nine (21.4%) were due to Cutibacterium spp., and
    - nine (21.4%) to Enterobacteriaceae
    - two cases were caused by Pseudomonas aeruginosa;
    - five (11.9%) of the PJI cases were polymicrobial infections.

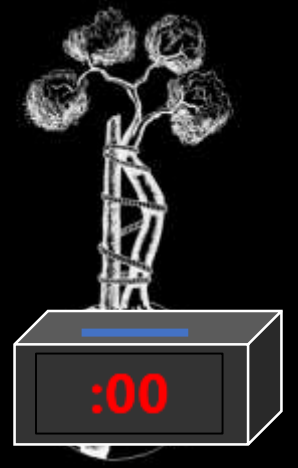
## Recommendation:

The limited data suggests treatment should consist of an empiric antibiotic regimen recommended by an infectious disease specialist considering the local organism profile.

## Level of Evidence: Consensus

A. Agree
B. Disagree
C. Abstain



# S-59(Former S-59) What is the optimal antibiotic treatment for culture-negative cases with positive clinical, radiographic, or intraoperative findings for subacute or chronic shoulder PJI?

**RESEARCHED BY:**

Claro, Rui MD, Portugal

Pottinger, Paul MD, USA

Nelson, Sandra Bliss MD, USA

# Literature:

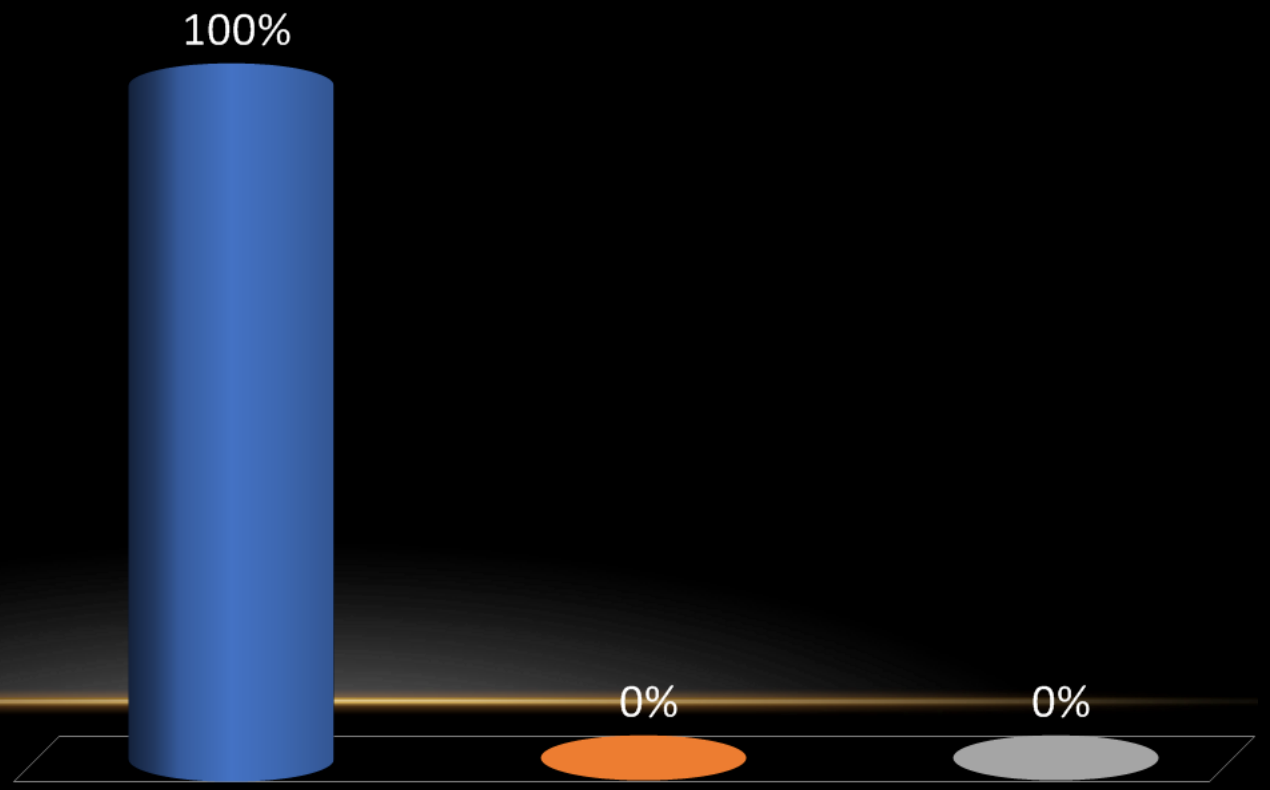
- Systematic review
  - 14 relevant publications
  - There are no studies that have reported clinical outcomes for culture-negative shoulder arthroplasty infections stratified by antimicrobials utilized.
  - In the shoulder, most culture-positive subacute and chronic infections are due to coagulase-negative Staphylococci and Cutibacterium species

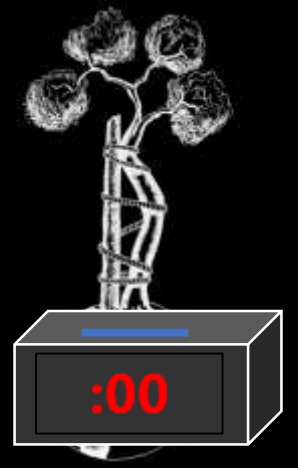
## Recommendation:

The limited data suggests treatment should consist of an empiric antibiotic regimen recommended by an infectious disease specialist considering the local organism profile.

## Level of Evidence: Consensus

A. Agree
B. Disagree
C. Abstain



# S-60(Former S-11) Is there a role for irrigation and debridement with implant retention when treating acute shoulder PJI?

**RESEARCHED BY:**

Khazzam, Michael MD, USA

# Literature:

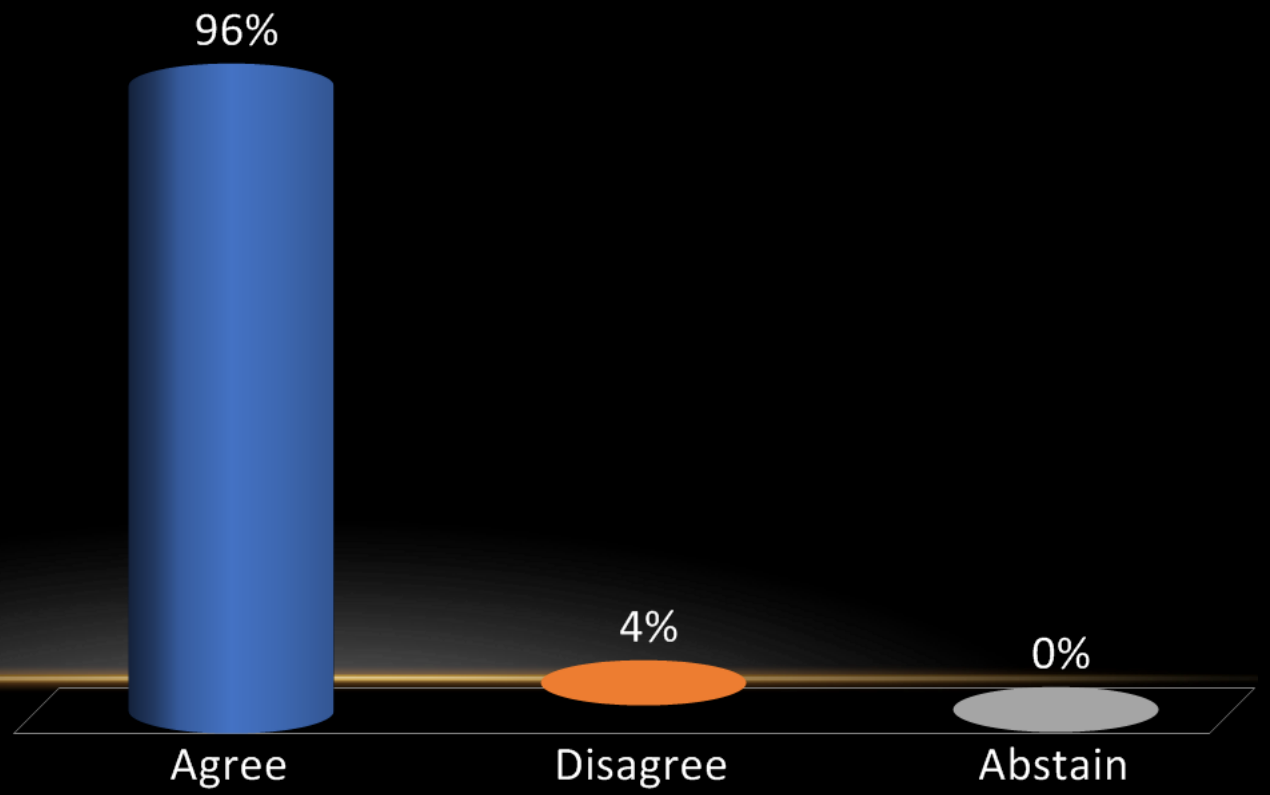
- Systematic review:
  - 66 abstracts reviewed
  - 4 Level IV studies acute PJI (I&D)
  - 37 patients (38 shoulders)
  - 50% failure rate

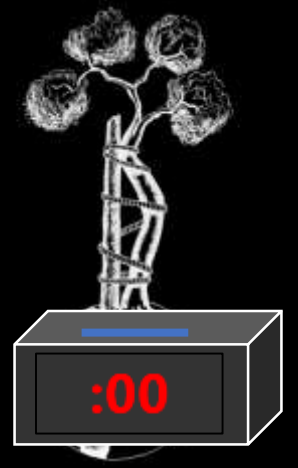
## Recommendation:

There is insufficient high-quality evidence to support or discourage the use of irrigation and debridement with implant retention to treat acute shoulder PJI.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-61(Former S-51) What are the indications for irrigation and debridement with component retention in subacute or chronic shoulder PJI?

**RESEARCHED BY:**

Somerson, Jeremy MD, USA

Levine, William MD, USA

# Literature:

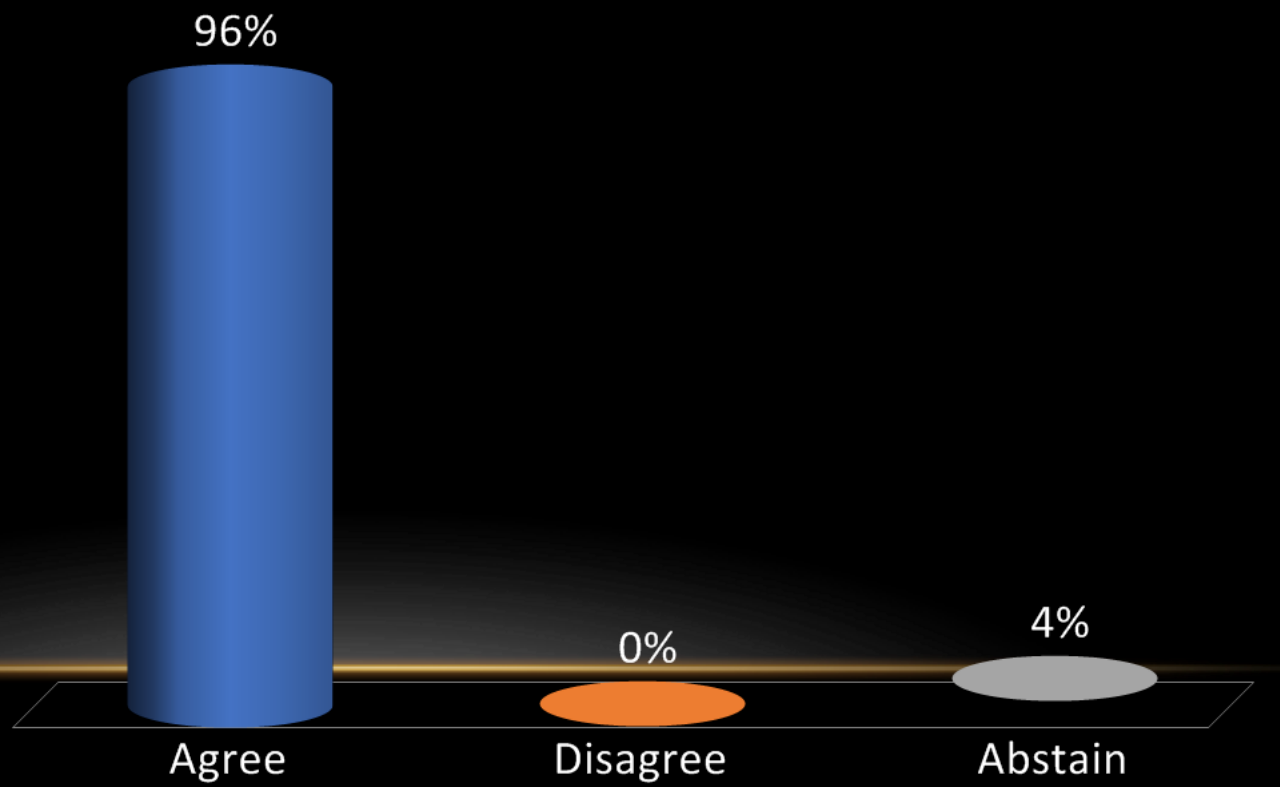
- Systematic Review:
  - 46 potential articles
  - 10 relevant
  - Of the 51 surgical cases identified in studies with a reported eradication rate, approximately half (n=24, 47%) were successfully cured with debridement alone. The majority of these successful treatments were from two recent studies that integrated modular component exchange with partial component retention

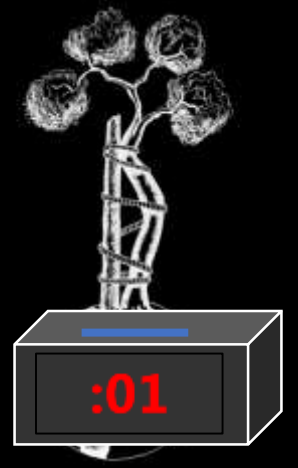
## Recommendation:

Irrigation and debridement with component retention alone for subacute/chronic shoulder PJI in the literature is less successful than component explant, but may play a role in select patients.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-62(Former S-41) Should modular components be exchanged during irrigation and debridement of acute shoulder PJI?

**RESEARCHED BY:**

Page, Richard MD, Australia

# Literature:

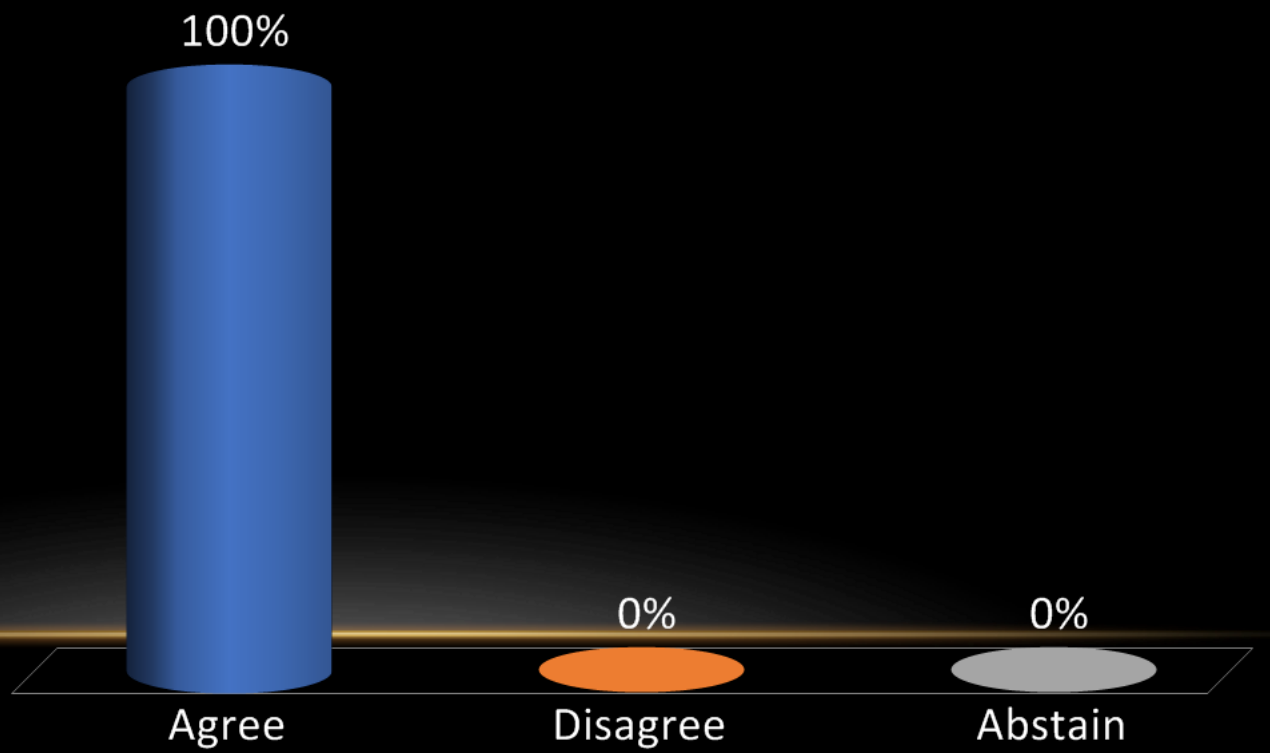
- Systematic Review:
  - 5 papers (53 patients)
  - The pooled infection-free survivorship was
    - 65% in the “modular exchange group” (19/29) vs.
    - 58% (14/24) in the “no exchange group” (p=0.77 fishers exact test).

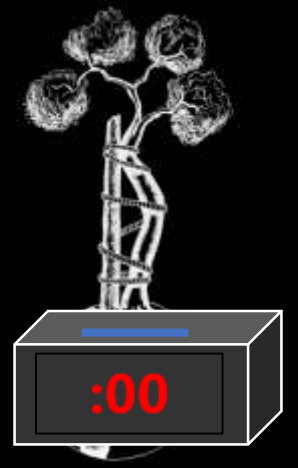
## Recommendation:

Whilst there is logic in exchanging non-fixed modular components such as the bearing surfaces to allow thorough irrigation and debridement of the entire effective joint space and removal of as much biofilm as possible, there is insufficient literature to provide clear guidance.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-63(Former S-42) Should modular components be exchanged during irrigation and debridement of subacute or chronic shoulder PJI?

**RESEARCHED BY:**


Paxton, E. Scott
MD, USA

Clark, Ben
MD, Australia

Page, Richard
MD, Australia

Namdari, Surena
MD, USA

# Literature:

- None

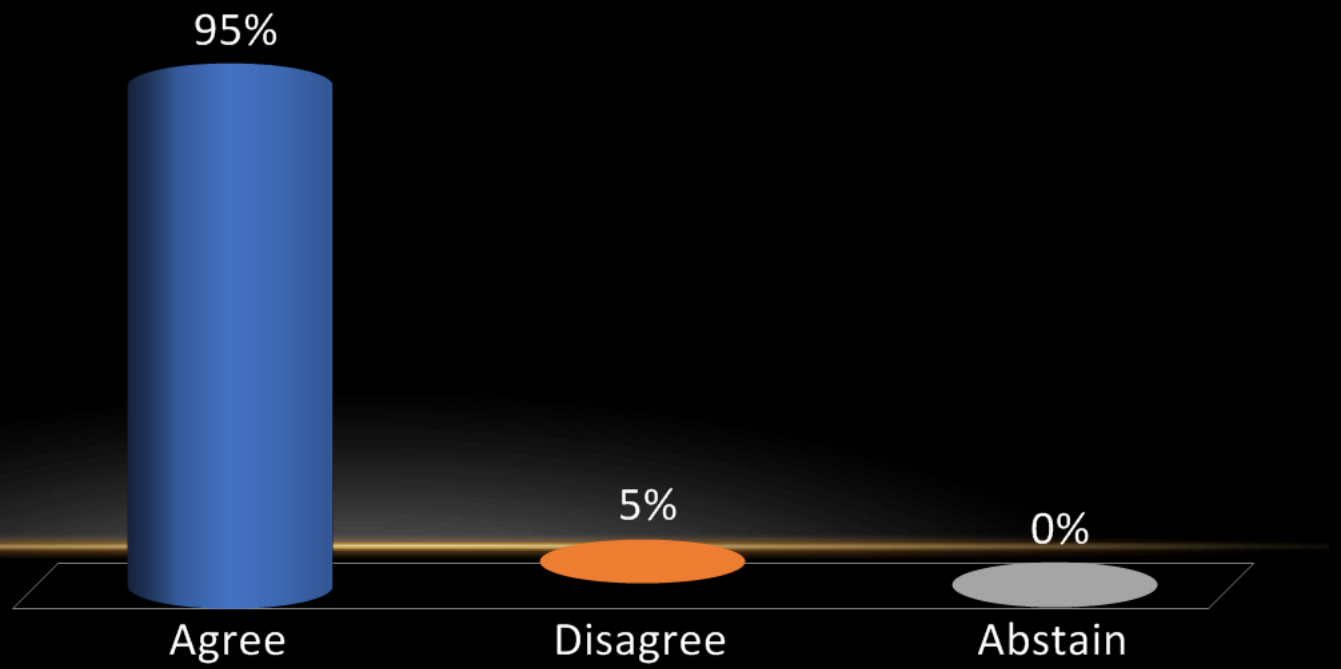
## Recommendation:

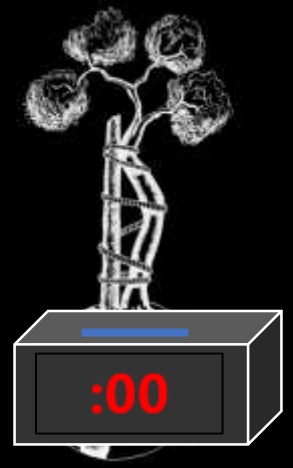
We defer to the response for the Question Shou-XX: Should well-fixed components be removed during irrigation and debridement of sub-acute / chronic shoulder PJI?

It would seem that the recommendation, although of limited strength, would be for well-fixed components to be removed during irrigation and debridement of subacute/chronic shoulder PJI. Therefore it can be extrapolated that modular components, which can be exchanged to remove biofilm with far less morbidity than well-fixed components, should likewise be either exchanged, or removed and replaced with an antibiotic spacer.

## Level of Evidence: No evidence

A. Agree
B. Disagree
C. Abstain



# S-64(Former S-49) Should well-fixed glenoid components be removed during surgical treatment for subacute or chronic shoulder PJI?

**RESEARCHED BY:**

Namdari, Surena
MD, USA

# Literature:

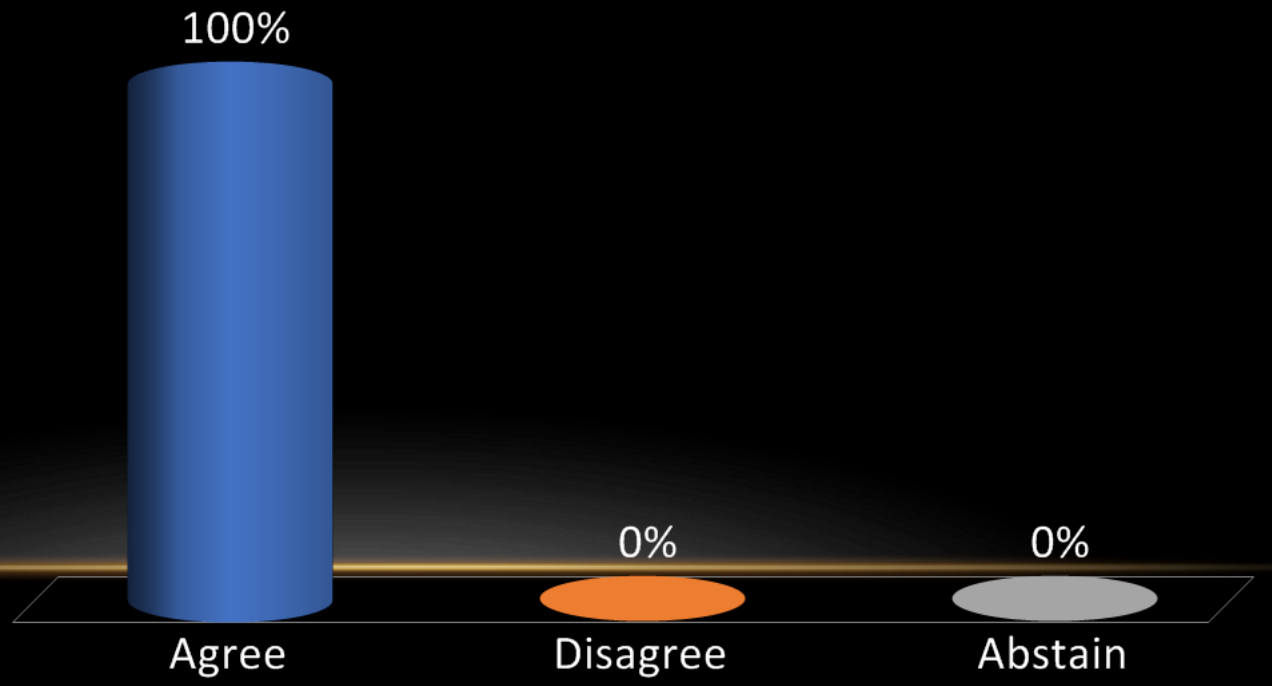
| Study | Date | Study design | # treated w/ I&D and component retention | # failed treatment (%) | #treated w/ 1-stage revision | # failed treatment (%) | #treated w/ 2-stage revision | # failed treatment (%) |
|---|---|---|---|---|---|---|---|---|
| Nelson et al [1] | 2016 | Systematic review | 35 | 11 | 282 | 28 | 97 | 6 |
| Stone et al [3] | 2017 | Retrospective Case series | 15 | 4 | 45 | 2 | 19 | 4 |
| Marcheggiani Muccioli [4] | 2017 | Systematic review | 27 | 8 | 77 | 3 | 98 | 14 |
| Jacquot et al [2] | 2015 | Retrospective Case series | 6 | 3 | n/a | n/a | n/a | n/a |
| **Total** | | | **83** | **26 (31.3 %)** | **404** | **33 (8.2%)** | **214** | **24 (11.2%)** |

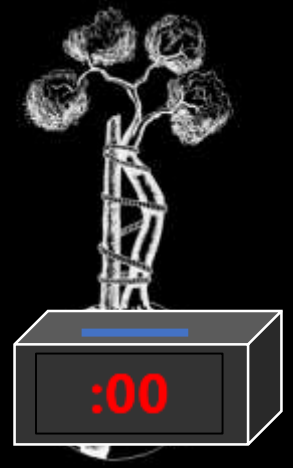
## Recommendation:

Based on the higher rate of reinfection with component retention, we recommend removal of even well-fixed glenoid components in cases of single-stage revision for suspected subacute/chronic PJI. Certainly there may be cases (i.e. high risk surgical patients) where the patient and surgeon may choose to accept the higher failure rate with component retention in order to avoid surgical morbidity introduced by removing well-fixed components.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-65(Former S-27) Is there a role for routine exchange of all well-fixed implants in revision shoulder arthroplasty without clinical or radiographic signs of infection?

**RESEARCHED BY:**

Page, Richard MD, Australia

Cil, Akin MD, USA

# Literature:

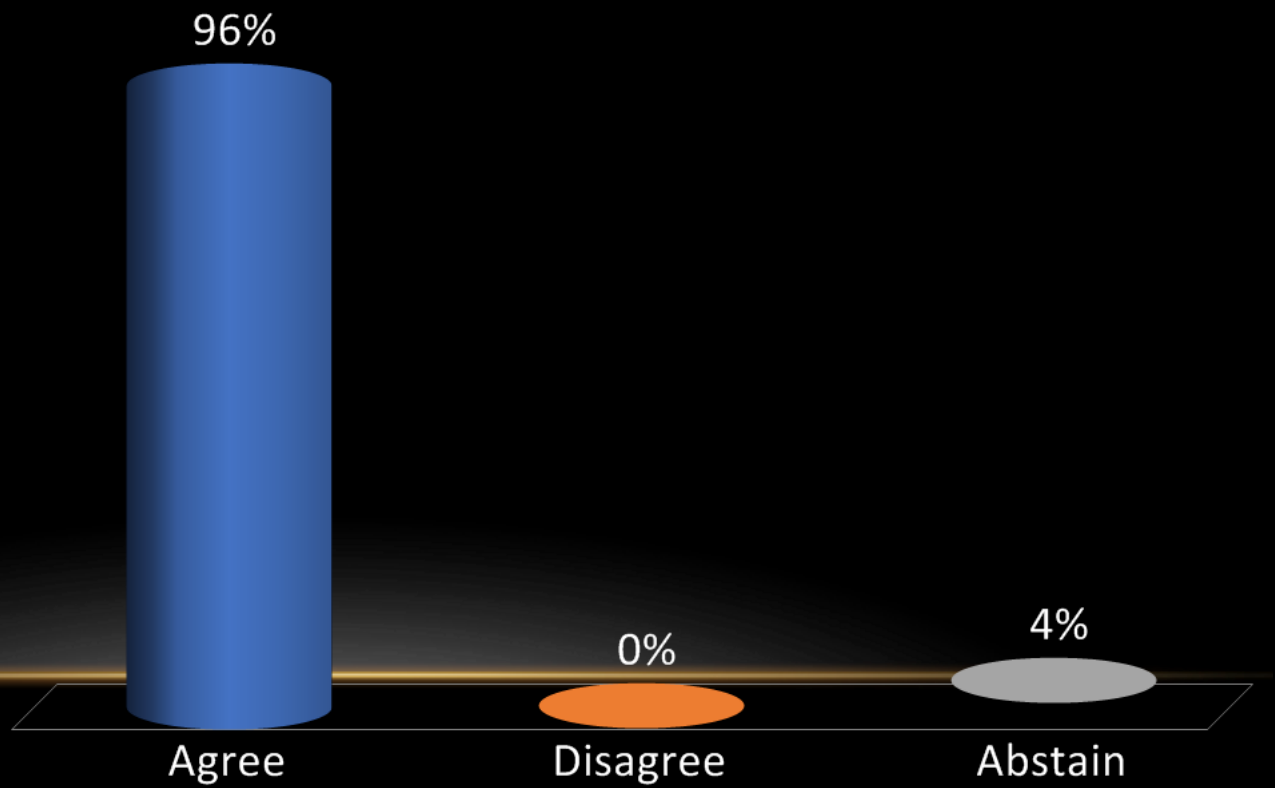

- [1] Foruria AM, Fox TJ, Sperling JW, Cofield RH. Clinical meaning of unexpected positive cultures (UPC) in revision shoulder arthroplasty. J Shoulder Elbow Surg 2013;22:620–7. doi:10.1016/j.jse.2012.07.017.
- **[6] Grosso MJ, Sabesan VJ, Ho JC, Ricchetti ET, Iannotti JP. Reinfection rates after 1-stage revision shoulder arthroplasty for patients with unexpected positive intraoperative cultures. J Shoulder Elbow Surg 2012;21:754–8. doi:10.1016/j.jse.2011.08.052.**
- **[7] Hsu JE, Gorbaty JD, Whitney IJ, Matsen FA. Single-Stage Revision Is Effective for Failed Shoulder Arthroplasty with Positive Cultures for Propionibacterium. J Bone Joint Surg Am 2016;98:2047–51. doi:10.2106/JBJS.16.00149.**
- **[8] Pottinger P, Butler-Wu S, Neradilek MB, Merritt A, Bertelsen A, Jette JL, et al. Prognostic factors for bacterial cultures positive for Propionibacterium acnes and other organisms in a large series of revision shoulder arthroplasties performed for stiffness, pain, or loosening. J Bone Joint Surg Am 2012;94:2075–83. doi:10.2106/JBJS.K.00861.**
- **[9] McGoldrick E, McElvany MD, Butler-Wu S, Pottinger PS, Matsen FA. Substantial cultures of Propionibacterium can be found in apparently aseptic shoulders revised three years or more after the index arthroplasty. J Shoulder Elbow Surg 2015;24:31–5. doi:10.1016/j.jse.2014.05.008.**
- **[10] Topolski MS, Chin PYK, Sperling JW, Cofield RH. Revision shoulder arthroplasty with positive intraoperative cultures: the value of preoperative studies and intraoperative histology. J Shoulder Elbow Surg 2006;15:402–6. doi:10.1016/j.jse.2005.10.001.**
- **[11] Kelly JD, Hobgood ER. Positive culture rate in revision shoulder arthroplasty. Clin Orthop Relat Res 2009;467:2343–8. doi:10.1007/s11999-009-0875-x.**
- **[12] Lutz M-F, Berthelot P, Fresard A, Cazorla C, Carricajo A, Vautrin A-C, et al. Arthroplastic and osteosynthetic infections due to Propionibacterium acnes: a retrospective study of 52 cases, 1995-2002. Eur J Clin Microbiol Infect Dis 2005;24:739–44. doi:10.1007/s10096- 005-0040-8.**

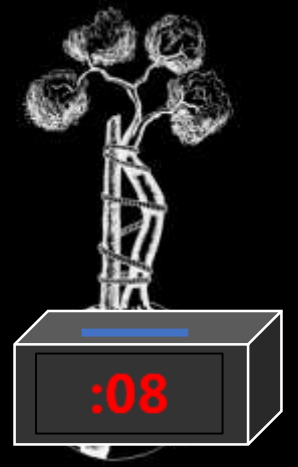

## Recommendation:

Unknown. Even in the setting of possible subsequent unexpected positive cultures, there is sparse literature on the routine exchange of well-fixed implants in revision shoulder arthroplasty.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-66(Former S-71) What are the indications for one versus two-stage exchange arthroplasty in the management of acute shoulder PJI?

**RESEARCHED BY:**

Garrigues, Grant E MD, USA

Torrens, Carlos MD, Spain

Willems, Jaap MD, Netherlands

# Literature:

- Systematic review:
  - 248 results
    - 31 articles relevant
  - Limited breakdown of treatment type and timing of infection.

**Table 1. Reinfection and Complication**

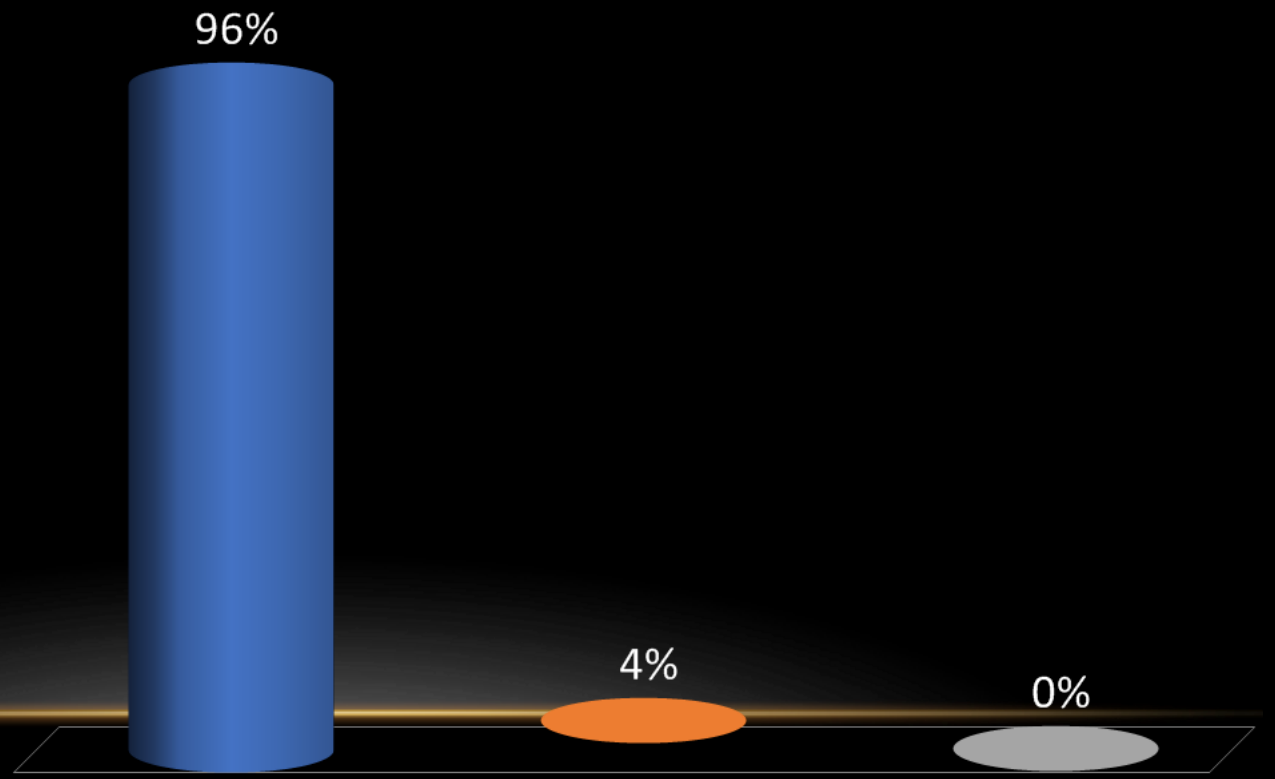
| 1-Stage | Patients | Reinfection % | Pathogens | Constant Score | Complications |
|---|---|---|---|---|---|
| 12 Papers | 161 Total | 5.6% Reinfection | 72 P. acnes | 49.1 | 12.70% |
| | 6 Acute | $p < 0.05$ | 29 CoNS | 44 patients | 79 patients |
| | 13 Subacute | | 20 MSSA | $p < 0.11$ | $p < 0.05$ |
| | 8 Chronic | | 3 MRSA | | |
| **2-Stage** | **Patients** | **Reinfection %** | **Pathogens** | **Constant Score** | **Complications** |
| 27 Papers | 325 Patients | 11.4% Reinfectio | 88 P. acnes | 51.1 | 21.90% |
| | 47 Acute | $p < 0.05$ | 64 CoNS | 102 patients | 205 patients |
| | 46 Subacute | | 33 MRSA | $p < 0.05$ | $p < 0.05$ |
| | 74 Chronic | | 56 MSSA | | |

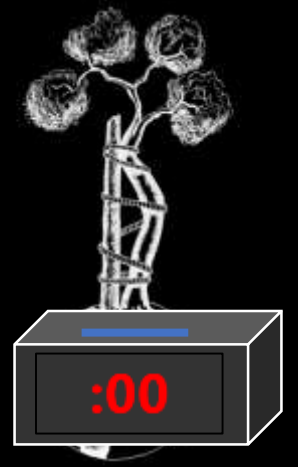
## Recommendation:

Unknown. Single-stage exchange for shoulder PJI had a statistically significant lower reinfection rate and lower complication rate than two-stage exchange in aggregate; however, no studies exist directly comparing these treatments for acute shoulder PJI.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-67(Former S-53) What are the indications for one versus two stage revision in subacute or chronic shoulder PJI?

**RESEARCHED BY:**

Garrigues, Grant E MD, USA

Torrens, Carlos MD, Spain

Willems, Jaap MD, Netherlands

# Literature:

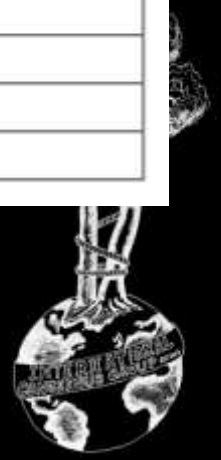
- Systematic review:
  - 248 results
    - 31 articles relevant

**Table 1.** Reinfection and complications for single stage exchange

| Cases | Reinfection Rate | Pathogens | Constant Score (mean) | Complication Rate |
|---|---|---|---|---|
| 161 Total | 5.6 % ($p < 0.001$) | 72 P. acnes | 49.1 ($p < 0.11$) | 12.7 % ($p < 0.001$) |
| 13 Subacute | | 29 CoNS | | |
| 8 chronic | | 20 MSSA | | |
| | | 3 MRSA | | |

**Table 2.** Reinfection and complications for two-stage exchange

| Cases | Reinfection Rate | Pathogens | Constant Score (mean) | Complication Rate |
|---|---|---|---|---|
| 325 Total | 11.4 % ($p < 0.001$) | 88 P. acnes | 51.1 ($p < 0.05$) | 21.9 % ($p < 0.001$) |
| 46 Subacute | | 64 CoNS | | |
| 74 Chronic | | 33 MSSA | | |
| | | 56 MRSA | | |

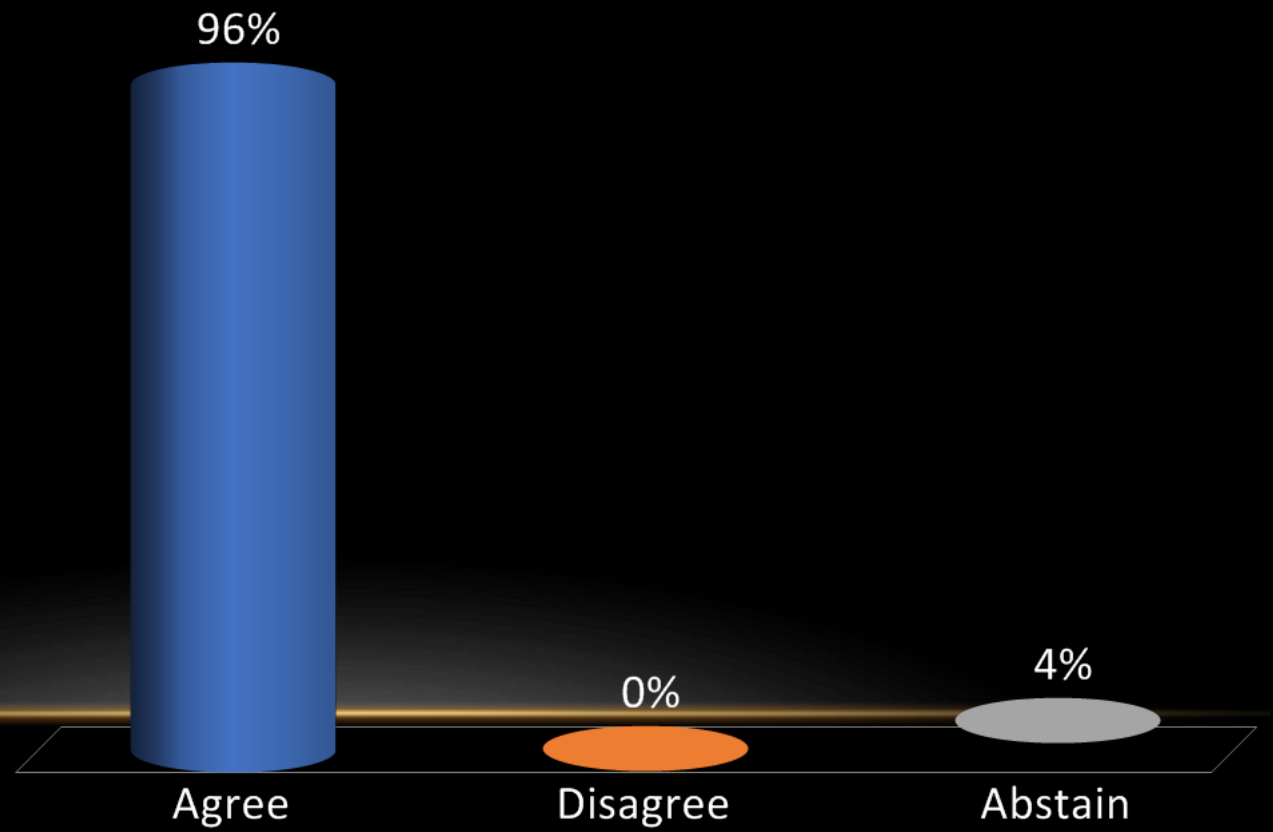


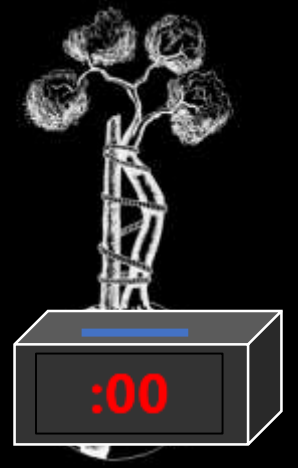
## Recommendation:

The indications for single-stage versus two-stage exchange are unclear at this time. The pooled data demonstrate single stage exchange to be superior to two-stage exchange, but this may be a result of selection bias and other factors.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-68(Former S-25) Is there a role for an antibiotic spacer for the treatment of shoulder PJI?

**RESEARCHED BY:**

Virk, Mandeep MD, USA

Encalada, Ivan MD, Mexico

Williams, Gerald MD, USA

# Literature:

- Systematic review:
  - 34 articles screened -> 12 deemed relevant

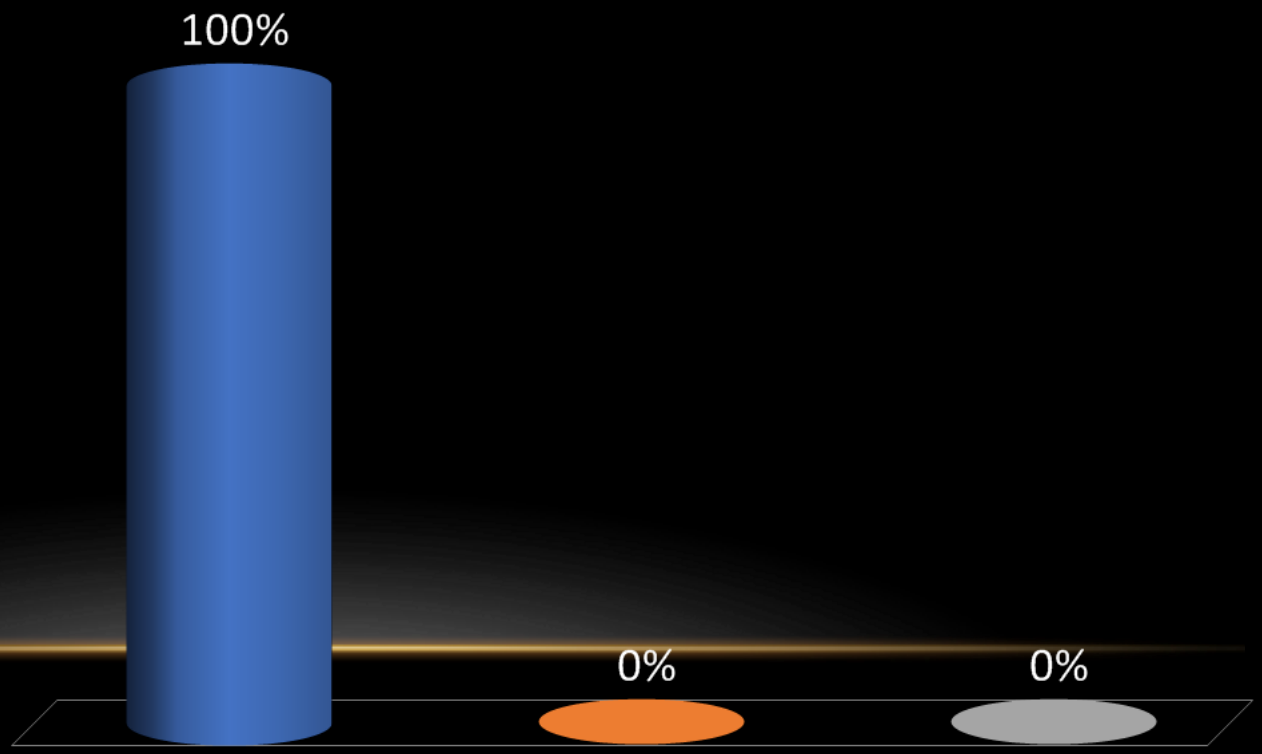
| Study | Number of patients /shoulders (N) and follow up (FU) | Antibiotics used in the cement spacer | Spacer role | Recurrence of infection and complications associated with spacer |
|---|---|---|---|---|
| Jerosch and Schneppenheim 2003 | N=10<br>FU: 6-30 mos (range) | No information | Temporary: 8<br>Permanent: 2 | Recurrence: 0% |
| Themistocleous et al., 2007 | N=4<br>FU: 22 mos | Tobramycin<br>Vancomycin | Temporary: 2<br>Permanent: 2 | Recurrence: 0% |
| Coffey et al., 2010 | N=16<br>FU=20.5 mos | Gentamicin | Temporary: 12<br>Permanent: 4 | Recurrence: 0% |
| Jawa et al., 2010 | N= 28<br>FU= 27.6 mos | Tobramycin<br>Vancomycin | Temporary: 16<br>Permanent: 12 | Recurrence: 5 (18% )<br>Dislocation: 1 (3.5%)<br>Fracture of spacer: 3 (11%) |
| Stine et al., 2010 | N=30<br>FU: 2.4 yrs | Tobramycin<br>Vancomycin | Temporary: 18<br>Permanent: 15 | Recurrence: 0% |
| Romano et al. 2012 | N=32<br>FU: 2.4 yrs | No information | Temporary: 17<br>Permanent: 15 | Recurrence: 3% (one in permanent group) |
| Levy et al. 2014 | N=9<br>FU: 25 mos | Tobramycin<br>Vancomycin | Permanent | Recurrence: 0% |
| Mahure et al. 2016 | N=9<br>FU: 4 yrs | Tobramycin<br>Vancomycin<br>Gentamycin | Permanent | Recurrence: 0%<br>Glenoid erosion: 2 (22%)<br>Periprosthetic fracture: 1 (11%) |
| Pellegrini et al. 2017 | N=19<br>FU: 8 yrs | Gentamycin,<br>Clindamycin,<br>Vancomycin | Permanent | Recurrence: 0%<br>Glenoid osteolysis (1; 5.3%) |
| Padegimas et al. 2018 | N=37<br>FU: 4 yrs | Tobramycin<br>Vancomycin | Temporary | Spacer revision: 1 (2.7%)<br>6 positive cultures at second stage but no clinical signs of infection |
| Lee et al., 2018 | N=12<br>FU: 40.8 mos | Vancomycin | Temporary: 9 | Recurrence: 0% |
| Torrens et al. 2018 | N=21 | Tobramycin | Temporary | Revision of spacer: 1<br>3 Positive cultures at second stage (13.6%) |

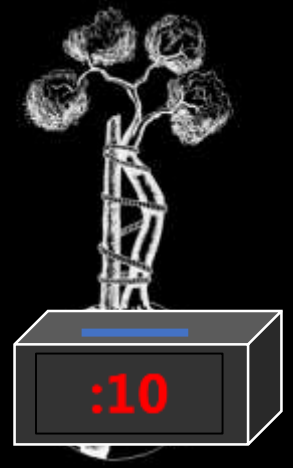
## Recommendation:

An antibiotic loaded cement spacer may be used as part of a shoulder two-stage exchange arthroplasty for local delivery of high concentration of antibiotics. An antibiotic loaded cement spacer may be used as a definitive/permanent treatment option in select cases.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-69(Former S-21) Is there a role for preoperative joint aspiration prior to reimplantation during two-stage exchange for shoulder PJI?

**RESEARCHED BY:**

King, Joseph J MD,
USA

Hasan, Samer S MD,
USA

# Literature:

- Systematic review performed:
  - 255 articles -> 31 relevant

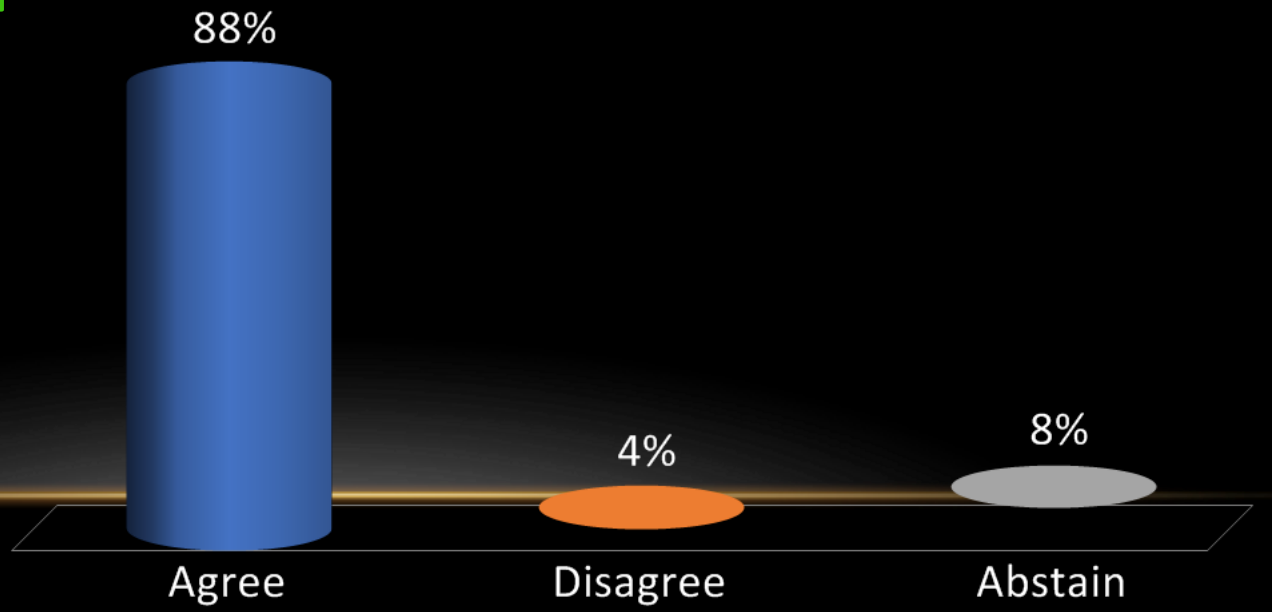

- Buchalter DB, Mahure SA, Mollon B, Yu S, Kwon YW, Zuckerman JD. Two-stage revision for infected shoulder arthroplasty. J Shoulder Elbow Surg. 2017;26:939-947.
- Sabesan VJ, Ho JC, Kovacevic D, Iannotti JP. Two-stage reimplantation for treating prosthetic shoulder injections. Clin Orthop Rel Res. 2011;469:2538-2543.
- Weber P, Utzschneider S, Sadoghi P, Andress H-J, Jansson V, Müller PE. Management of the infected shoulder prosthesis: a retrospective analysis and review of the literature. Int Orthop. 2011;35:365-373.
- Ghijselings S, Stuyck J, Debeer P. Surgical treatment algorithm for infected shoulder arthroplasty A retrospective analysis of 17 cases. Acta Orthop Belgica. 2013. 79. 226-35.
- Ricchetti ET, Frangiamore SJ, Grosso MJ, Alolabi B, Saleh A, Bauer TW, Iannotti JP. Diagnosis of Periprosthetic Infection After Shoulder Arthroplasty: a critical review analysis. JBJS Reviews. 2013. 1(1): e3.
- Updegrove GF, Armstrong AD, Kim HMM. Preoperative and intraoperative infection workup in apparently aseptic revision shoulder arthroplasty. J Shoulder Elbow Surg (2015) 24, 491-500.

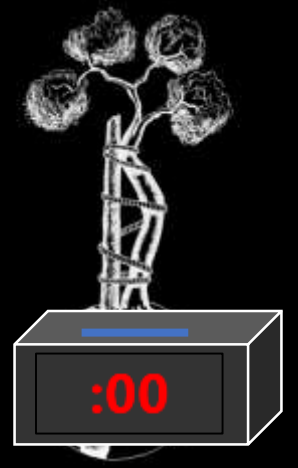

## Recommendation:

There is a dearth of information on the role of preoperative joint aspiration prior to second stage revision after treatment of shoulder PJI. Furthermore, several studies have pointed to the high incidence of “dry taps” and false negative cultures from joint aspirates. Thus, there is little evidence in support of routine preoperative aspiration prior to second stage reimplantation.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-70(Former S-23) Is there a role for pre-reimplantation open or arthroscopic tissue biopsy in the evaluation during two-stage exchange of shoulder PJI?

**RESEARCHED BY:**


Cvetanovich, Gregory MD, USA

Romeo, Anthony MD, USA

# Literature:

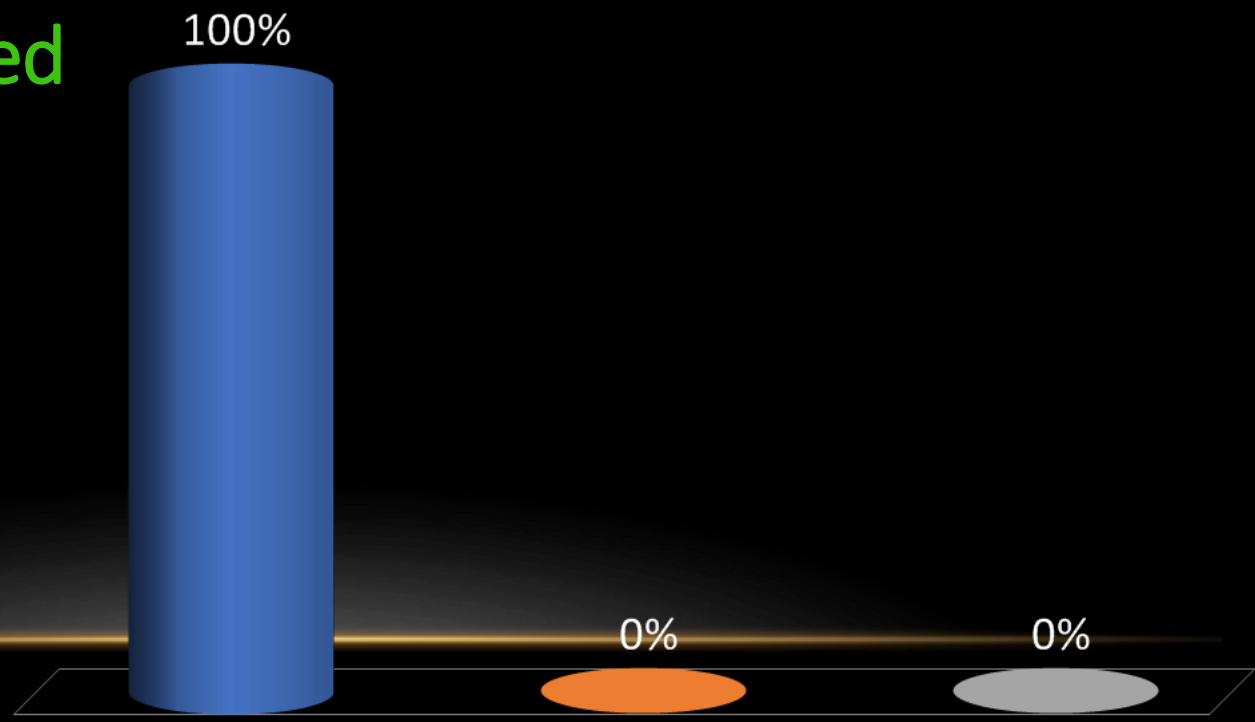

- Zhang AL, Feeley BT, Schwartz BS, Chung TT, Ma CB. **Management of deep postoperative shoulder infections: is there a role for open biopsy during staged treatment?** J Shoulder Elbow Surg. 2015 Jan;24(1):e15–20. doi:10.1016/j.jse.2014.04.007

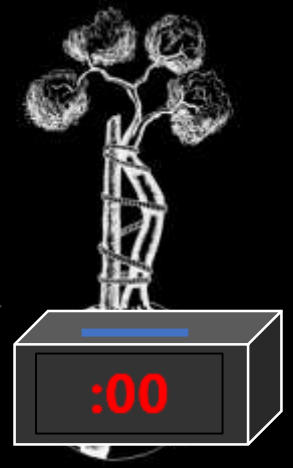
## Recommendation:

Unknown. There is one level IV study suggesting that open biopsy prior to second stage revision for shoulder PJI can identify patients with persistent infection who may benefit from subsequent repeat I&D prior to second stage reimplantation.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-71(Former S-62) What is the optimal implant for treatment of acute PJI: reverse TSA, anatomic TSA, versus hemiarthroplasty?

**RESEARCHED BY:**

Frankle, Mark MD, USA

Hsu, Jason MD, USA

# Literature:

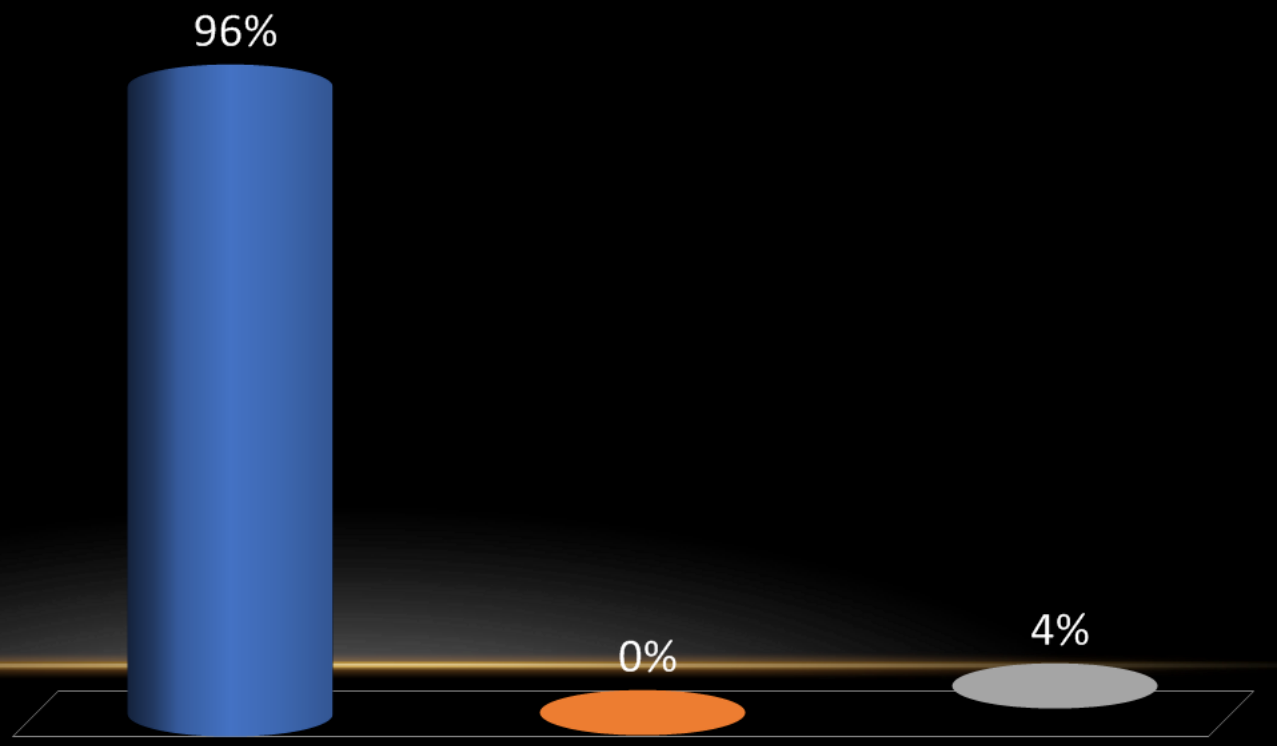
- Systematic review:
  - A total of 2,354 studies were identified. We reviewed the titles and abstracts of all studies and excluded studies that included patients with shoulder infection without arthroplasty or included patients with arthroplasty of joints other than the shoulder.
  - Of 42 studies:
    - 19 stratified acute PJI from subacute/chronic PJI with 20% of included patients (93/459) in the acute category.
    - While there were a fair number of studies that described patients with acute PJI, the types of implants explanted and implanted were not regularly reported or stratified.
    - Therefore, drawing conclusions regarding re- infection rates and clinical outcomes was limited

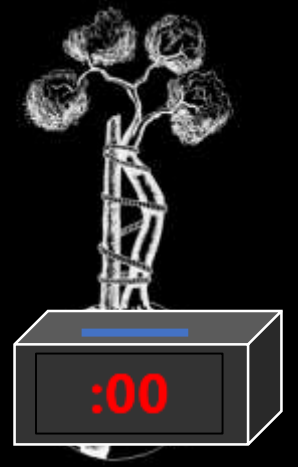
## Recommendation:

The optimal implant for treatment of acute PJI is dependent on the status of the rotator cuff, humeral and glenoid bone stock, and patient factors.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-72(Former S-63) What is the optimal implant for treatment of subacute or chronic PJI: reverse TSA, anatomic TSA, versus hemiarthroplasty?

**RESEARCHED BY:**

Hsu, Jason MD, USA

# Literature:

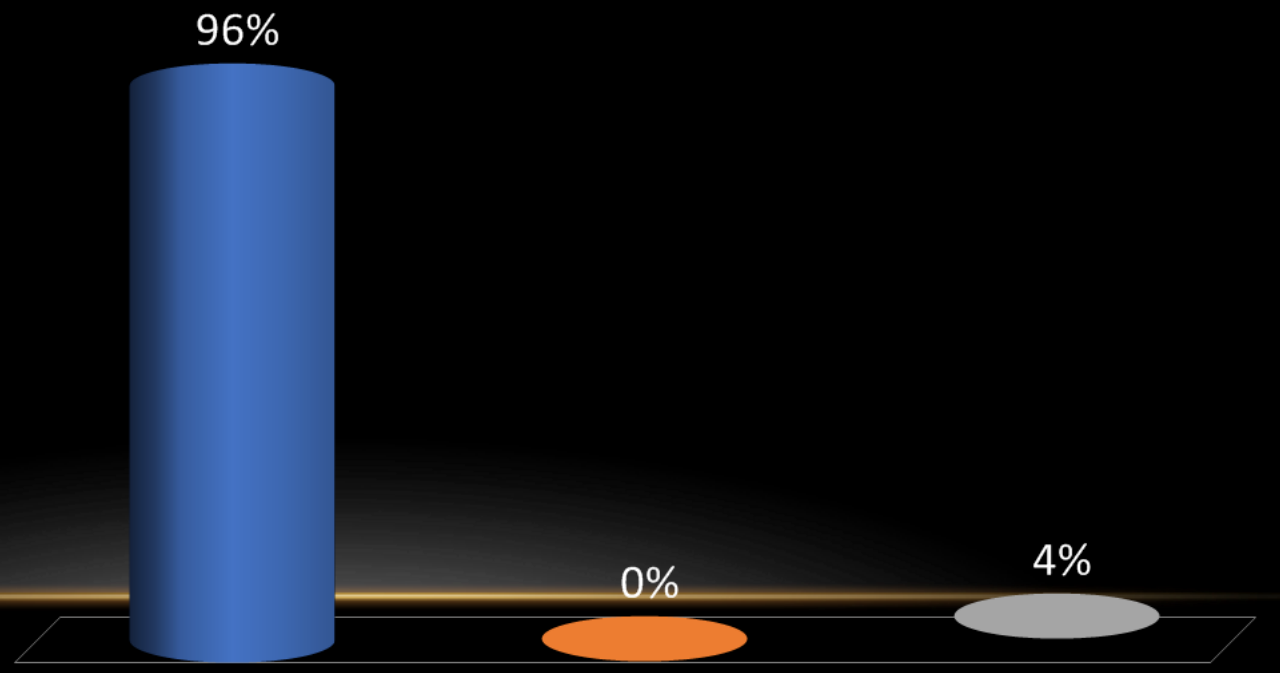
- Systematic Review:
  - Of 42 studies, 20 stratified either subacute and/or chronic PJI from acute PJI with 80% of included patients (366/459) in the subacute or chronic category.
    - Of these studies, only 3 included clinical outcomes comparing different implant types.
  - This limitation, in addition to the lack of a consensus definition for shoulder PJI and re-infection, compromise the ability to make any firm conclusions from the available literature.

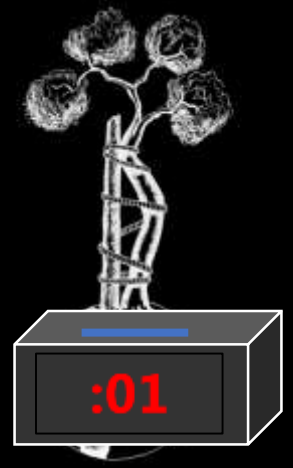
## Recommendation:

The optimal implant for treatment of subacute/chronic PJI is dependent on the status of the rotator cuff, humeral and glenoid bone stock, and patient factors.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-73(Former S-52) What are the indications for resection shoulder arthroplasty in acute PJI?

**RESEARCHED BY:**


Mora, Jose M MD, Spain

Lambert, Simon MD, UK

# Literature:

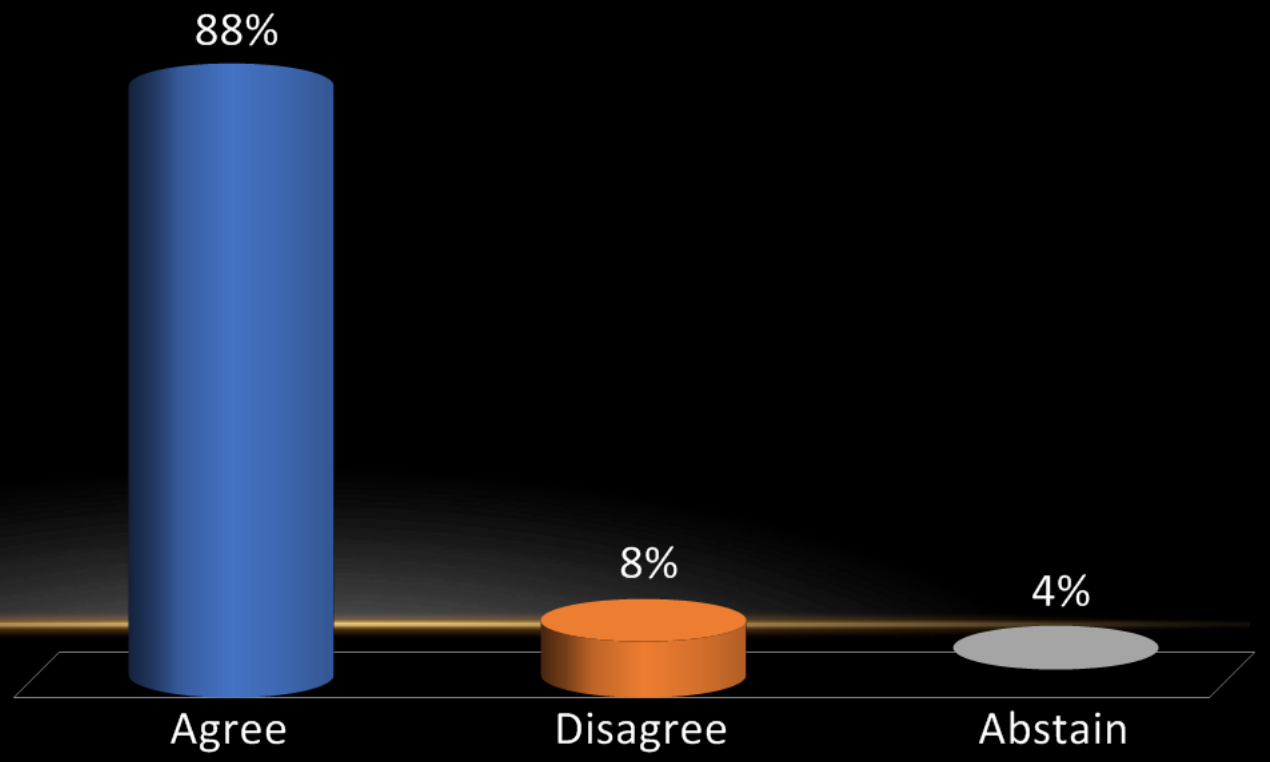

- Bonnevialle N, Dauzeres F, Toulemonde J, Elia F, Laffosse J-M, Mansat P. EFORT Open Reviews, 2017; 2: 104-9. Periprosthetic shoulder infection: an overview. DOI: 10.1302/2058-5241.2.160023.
- George DA, Volpin A, Scarponi S, Haddad FS, Romano CL. BMC Musculoskeletal Disorders. 2016; 17: 52. DOI: 10.1186/s12891-016-0901-6.

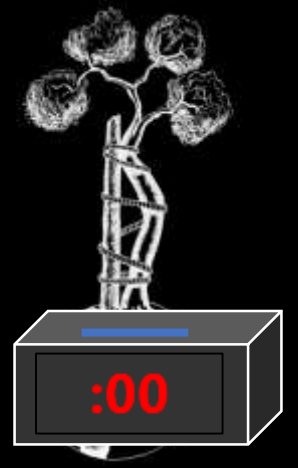

## Recommendation:

There are no available reports on resection shoulder arthroplasty for acute PJI. At this time there is no evidence to routinely recommend this treatment for this indication.

## Level of Evidence: No evidence

A. Agree
B. Disagree
C. Abstain



# S-74(Former S-26) Is there a role for resection shoulder arthroplasty in the management of subacute or chronic PJI?

**RESEARCHED BY:**


Mora, Jose M MD, Spain

Lambert, Simon MD, UK

# Literature:

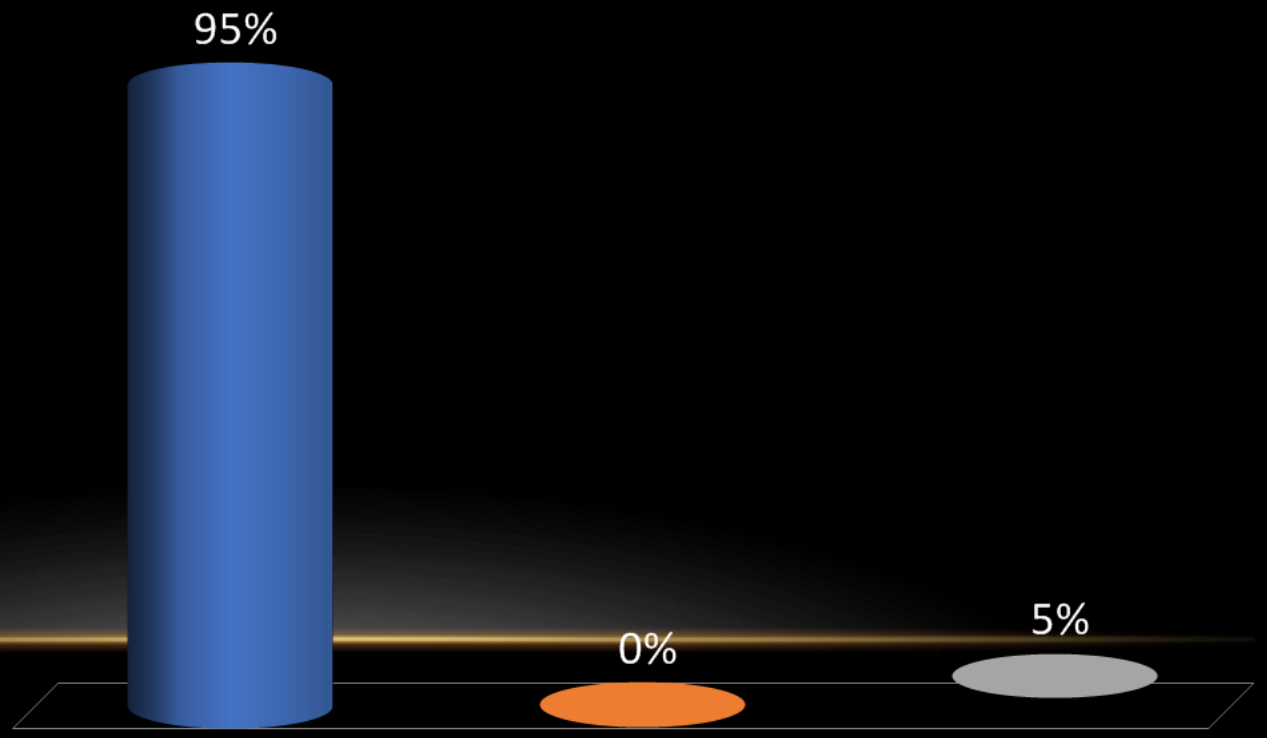

- Braman JP, Sprague M, Bishop J, Lo IK, Lee EW, Flatow EL. The outcome of resection shoulder arthroplasty for recalcitrant shoulder infections. J Shoulder Elbow Surg, 2006; 15(5): 549-53.
- Ghijselings S, Stuyck J, Debeer P. Surgical treatment algorithm for infected shoulder arthroplasty A retrospective analysis of 17 cases. Acta Orthop. Belg. 2013; 79: 626-635
- Maynou C, Menager S, Senneville E, Bocquet D, Mestdagh H. Clinical results of resection arthroplasty for infected shoulder arthro- plasty. Rev Chir Orthop Reparatrice Appar Mot, 2006; 92:567-74.
- Rispoli DM, Sperling JW, Athwal GS, Schleck CD, Cofield RH. Pain relief and functional results after resection arthroplasty of the shoulder. J Bone Joint Surg Br 2007; 89(9): 1184-7.
- Stevens NM, Kim HM, Armstrong AD. Functional outcomes after shoulder resection: the patient's prespective. J Shoulder Elbow Surg 2015; 24: 1224-33.
- Verhelst L, Stuyck J, Bellemans J, Debeer P. Resection arthroplasty of the shoulder as a salvage procedure for deep shoulder infection: does the use of a cement spacer improve outcome? J Shoulder Elbow Surg 2011; 20(8): 1224-33.

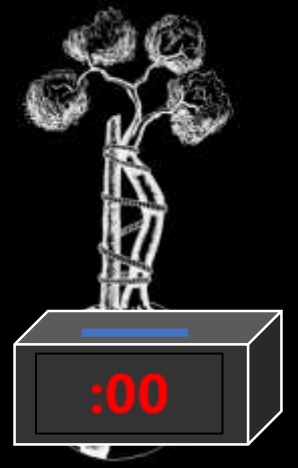

## Recommendation:

The available literature does not support specific indications for resection arthroplasty for subacute or chronic shoulder PJI with sufficient quality information to provide guidance. Resection arthroplasty is an acceptable salvage treatment to eradicate shoulder PJI when revision to a definitive implant is considered too risky due to patient medical co-morbidities or technical complexity.

## Level of Evidence: Limited

A. Agree
B. Disagree
C. Abstain



# S-75(Former S-39) Should bone graft or cement be removed during treatment of acute shoulder PJI?

**RESEARCHED BY:**

Khazzam Michael MD, USA

# Literature:

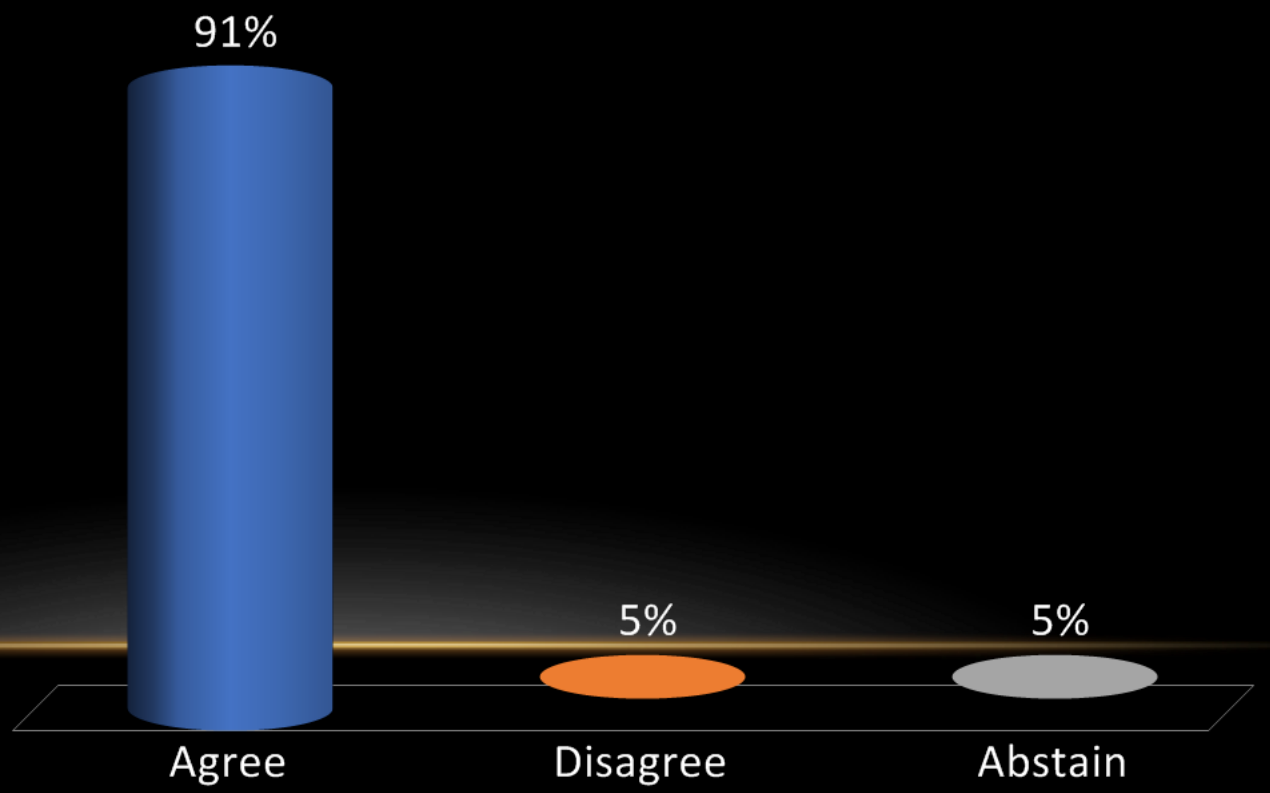
- NONE

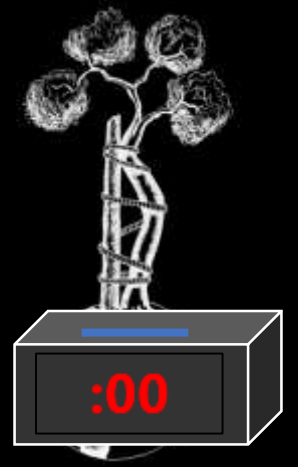
## Recommendation:

Unknown. There are no reported investigations to guide the decision-making process regarding how to manage cement and / or autograft bone graft in the setting of shoulder PJI.

## Level of Evidence: No evidence

A. Agree
B. Disagree
C. Abstain



# S-76(Former S-40) Should bone graft or cement be removed in treatment for subacute or chronic shoulder PJI?

**RESEARCHED BY:**

Khazzam Michael MD, USA

# Literature:

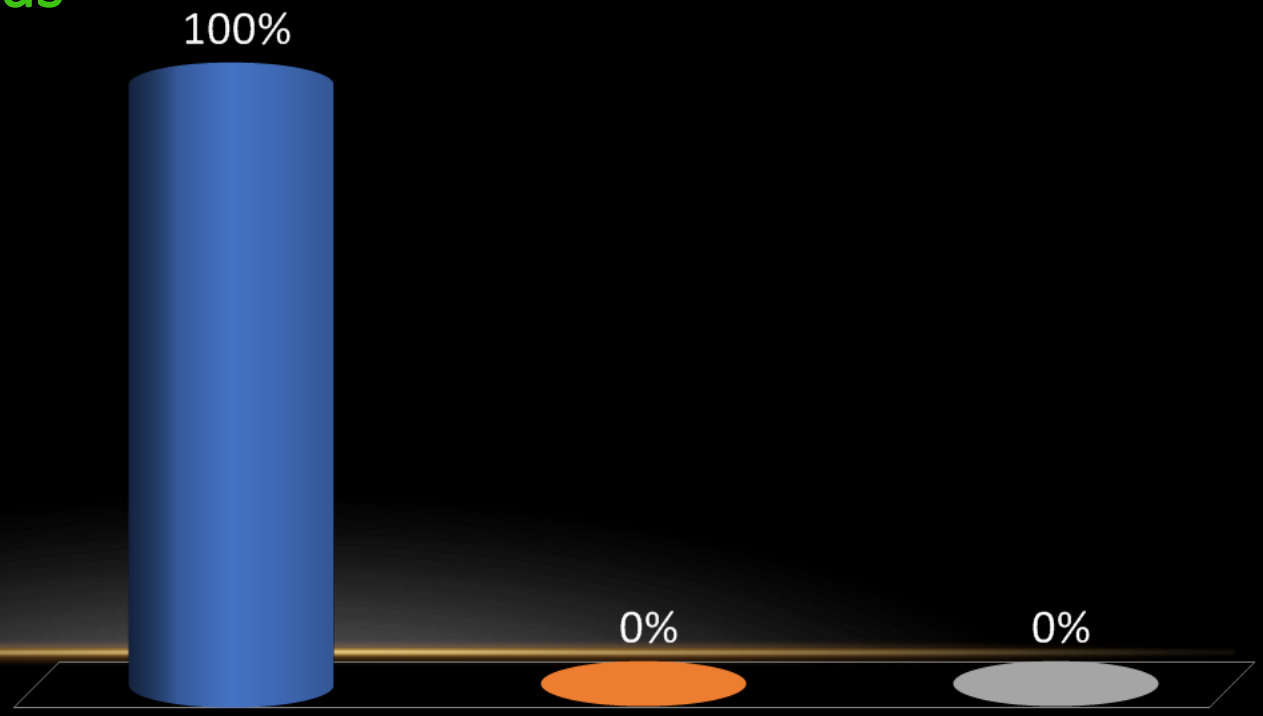
- NONE

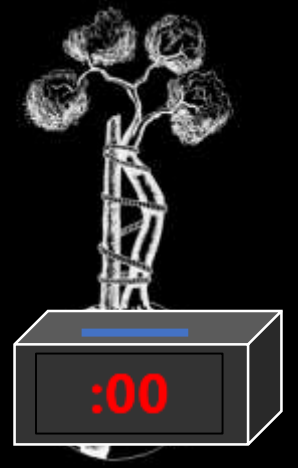
## Recommendation:

Unknown. There are no reported investigations to guide the decision-making process regarding how to manage cement and / or autograft bone graft in the setting of shoulder PJI.  An attempt should be made to remove all loose, necrotic, and foreign material.

## Level of Evidence: Consensus

A. Agree
B. Disagree
C. Abstain



Sponsored question: Can new microcurrent technology wound dressings like JumpStart further reduce the risk of *Cutibacterium (Propionibacterium) acne* infection after shoulder arthroplasty if placed over the incision area?

A. Yes
B. No
C. Abstain