SH27: How should cultures be obtained and handled during surgery?

Liaison: Surena Namdari
Lead delegate: Kathleen Leinweber
Supportive delegates: Christopher Joyce; Jacob Kirsch

Response: The following recommendations are made for culture acquisition:

- Obtain 5 deep soft tissue samples with fresh, sterile instruments from unique sites.
- Specimens transferred directly by the surgeon into sterile containers, sealed immediately, and transported promptly.
- Fluid sampling should not be used in isolation.

Strength of Recommendation: Limited

Delegate Vote: 54 (100%) agree; 0 disagree; 0 abstain

Rationale: A comprehensive literature review was performed to identify studies on obtaining and handling cultures. Searches for the terms shoulder, arthroplasty, replacement, infection, culture, sampling, collection were performed using PubMed and Google Scholar through 2025. Inclusion criteria were all basic science and clinical studies that reported on culture technique. Exclusion criteria were non-English language articles, retracted studies. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) criteria were followed. Given the limited number of high-quality articles identified utilizing the search terms, searches were separately and independently performed by multiple authors to identify articles on sample acquisition and handling. A summary of the data is reported below.

Accurate diagnosis and subsequent management of periprosthetic shoulder infection often relies heavily on the results of intraoperative deep tissue cultures. Culture results during revision arthroplasty are most commonly positive for *Cutibacterium acnes*(1–4), however, the presence of positive cultures may not correlate with clinical infection.(5–11) Furthermore, recent data has demonstrated a complex natural microbiome to the shoulder with various phylotypes of *C. acnes,* each with differing proinflammatory and pathogenic potential.(12) Given the complexities involved in accurately diagnosing a periprosthetic joint infection (PJI) of the shoulder, consensus recommendations were previously made to obtain five deep tissue specimens from various location (not defined) using fresh instrumentation, with direct placement into sterile specimen containers.(13) We sought to update and enhance previous recommendations based on recent literature.

The role of synovial fluid for diagnosing suspected PJI remains controversial. Several prior studies have demonstrated lower sensitivity of fluid cultures compared to soft tissue specimens.(14–16) Recently, Lapner et al.(17) performed a prospective multicenter study of 69 patients and compared preoperative fluoroscopic guided synovial biopsy and fluid aspiration to open cultures. PJI was defined as having two or more matching positive cultures. The authors found that preoperative aspiration detected none of the open biopsy proven infections. However, if preoperative synovial biopsy was negative, there was an 81% probability of not having an infection. Based on the cumulative evidence which demonstrates low diagnostic accuracy of

synovial fluid aspiration, it is recommended that tissue specimens are the preferred type of specimen to culture in the setting of suspected shoulder PJI.

Optimal specimen handling is necessary to avoid contamination of specimens, which may lead to false positive results. This is of particular importance for shoulder PJI given that *C. acnes* is well known to colonize patients and the operating room environment. A recent systematic review demonstrated that *C. acnes* was detectable in the operating room air (mean 15%), patient skin prior to preparation (mean 47%) and patient skin after preparation (mean 18%).(18) Consensus recommendations were previously established to use fresh instruments to obtain and place specimens directly into sterile containers.(19) Subsequent to these recommendations, Hsu et al.(20) performed a survey based study to elicit the variability with regards to specimen handling across multiple institutions. Only 56% of surveyed surgeons reported using separate sterile instruments for harvesting individual specimens. Moreover, 31% reported that they hand the specimens off to a surgical technician on a piece of gauze for collection. The substantial variability in all aspects of specimen handling and processing highlighted by this study despite consensus recommendations underly the need for more rigorous guidelines. We continue to recommend the use of separate fresh sterile surgical instruments to obtain each individual culture specimen with direct placement into a sterile contained to minimize the risk of contamination and false positive results.

The ideal number of specimens to accurately predict shoulder PJI is important to understand to minimize the cost and risk of false positive results with oversampling. Previous ICM recommendations suggested to obtain 5 specimens.(13) These recommendations were based on older data demonstrating a positive correlation between the number of samples and the likelihood of positive cultures(2) and data suggesting at least 4 specimens were necessary to provide a 95% change of detecting an organism.(15) More recently, Mahylis et al.(21) performed a retrospective review evaluating the impact of obtaining 5 specimens for suspected PJI. Specimens were obtained in accordance to recent ICM recommendations. Interestingly, the addition of 5 or more specimens compared to a single sample influenced the diagnosis and antibiotic treatment for suspected infection in 45% of cases. Additionally, Torrens et al.(22) found that in the setting of primary reverse shoulder arthroplasty, for every additional specimen obtained up to the 5th culture there was a significant increase in the sensitivity to detect *C. acnes*, however, after the 5th culture there was no longer a significant increase in the sensitivity or prevalence. Therefore, based on current literature we continue to advocate for 5 separate soft tissue specimens to be obtained for culture.

The optimal location for specimen sampling is unknown. A recent systematic review demonstrated that among all studies evaluated, there was little consistency regarding the specific location of biopsied specimens.(23) Previous studies have suggested that *C.* acnes may not be evenly distributed throughout the shoulder.(14,24) Patzer et al.(24) performed a prospective randomized study on 115 patients undergoing primary shoulder arthroscopy with an intact rotator cuff whereby the arthroscope was initially placed either in the glenohumeral joint or the subacromial space. Cultures were obtained of this specific area to identify whether there were differences in the prevenance of *C. acnes.* Interestingly, *C. acnes* was present in 19% of cultures from the glenohumeral joint, whereas it was only present in 3.5% of cultures of the subacromial space. Matsen et al.(15) previously reported that periprosthetic membranes, particularly the

humeral canal had the highest rate of positive *C. acnes* cultures. However, more recent data makes this correlation less clear. Lapner et al.(17) collected specimens from the anterior capsule, rotator interval, greater tuberosity, humeral canal and the glenoid surface during open biopsy and reported similar accuracy at detecting infection across all different biopsy sites. While it seems rational that areas with clear clinical signs of soft tissue inflammation, purulence or necrosis should always be sampled, there is little evidence to clearly suggest that certain specific locations of the shoulder are more accurate for soft tissue sampling in the detecting PJI.

Explanted components represent an important source for detecting *C. acnes* in the setting of shoulder PJI. *C. acnes* forms a bacterial biofilm on implant surfaces, which is an important characteristic of its pathogenicity.(5) Therefore, it is plausible that implant surfaces may be more valuable for detecting *C. acnes* than the surrounding soft tissue. Previous data has reported conflicting evidence pertaining to the role of sampling explanted components.(8,14,25) Recently, Nhan et al.(26) performed the first study evaluating the results of culturing explanted components (humeral head, humeral stem and glenoid) compared to the soft tissues adjacent to the explanted component (collar membrane, humeral canal tissue and periglenoid tissue). The authors reported that explanted components had a higher rate of positive cultures and a higher density of *C. acnes* growth than adjacent soft tissue specimens. Furthermore, between 25-43% of explanted components had positive *C. acnes* cultures when the adjacent soft tissue specimens did not demonstrate any *C. acnes* growth. Conversely, there was a much lower rate (0-21%) of the tissue culture being positive when the adjacent explanted component was negative for *C. acnes* growth. In this study, including the explanted components in addition to the soft tissue specimens that were obtained would have nearly doubled the number of "probable" PJI's based on the most recent ICM definition.(13) Therefore, it seems that culturing explanted components could add significant clinical value to the sensitivity for detecting *C. acnes* compared to soft tissue specimens alone.

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