Synovial Fluid Culture Performance and Its Relationship to Inflammation

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INTRODUCTION:

Many historical assessments of synovial fluid (SF) culture diagnostic performance for prosthetic joint infection (PJI) involved smaller studies predating current culture methods, biomarkers, and infection definitions. This study evaluates the diagnostic performance of synovial fluid culture in a contemporary laboratory and investigates the relationship between culture-positivity and host inflammation.

METHODS:

SF samples from 143,168 painful hip and knee arthroplasties, submitted by 2,974 institutions to a single laboratory between January 2016 and April 2023, were analyzed. Each sample included completely annotated diagnostic SF tests. SF cultures were performed in a clinical laboratory with aerobic and anaerobic culture bottles using a standard laboratory platform. Diagnostic performance was based on the synovial fluid category of the 2018 International Consensus Meeting (ICM) point system. Principal component analysis (PCA) condensed five host inflammation biomarkers into a single PCA score, categorizing samples by inflammation degree from -21 to 21.

RESULTS:

SF-culture sensitivity and specificity, compared to the 2018 ICM classification, were 67.7% and 99.6%, with a 0.4% false-positive rate.

Culture-positivity rates were examined in relation to the biomarker PCA score, revealing associations with host inflammation. The false-positive culture rate was 0.3% in samples with the lowest scores (-21 to -4). Culture-positivity increased exponentially with higher inflammatory PCA scores, reaching 86.4% sensitivity for samples with a PCA score of 21. Cohorts with different ICM classifications but similar biomarker PCA scores displayed comparable culture-positivity. For example, ICM Inconclusive and Infected samples showed similarly rising culture-positivity with biomarker PCA scores from 12 to 19, starting at 17.2% and 11.7%, and reaching 87.7% and 80.6%, respectively (Figure 1). Organism species proportions remained relatively stable with increasing inflammatory PCA scores.

DISCUSSION AND CONCLUSION:

Modern SF culture techniques offer sensitivity in line with prior literature and a substantially lower false-positive rate (0.4%) than earlier reports. We found a robust link between SF culture positivity and host inflammation, surpassing relationships with modern scoring systems. A new association between SF culture and host inflammation is described, further stratifying samples within 2018 ICM diagnostic categories.

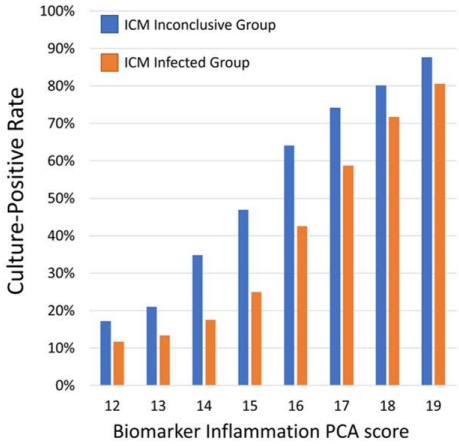

Figure 1 – The biomarker PCA score, which reduces the dimensionality of multiple biomarker results into a single inflammatory measure, stratifies samples into cohorts of increasing culture-positivity, despite the sample's classification as Inconclusive or Infected by the ICM point system.