

Diagnostic Performance of Sonication Fluid Culture of Explanted Arthroplasty Implants: A 10 Year Single Institution Experience

Sydney Scanlon MSc ^{1,2}, Nicholas P Drain MD ¹, Gabriela Alba BE ^{1,2}, Noah Feder BS ^{1,2}, Malcolm Dombrowski MD ¹, Johannes F. Plate MD PhD ¹, Michael J O'Malley MD ¹, Brian Klatt MD ¹, Alan Wilson, MD ¹

¹ Department of Orthopaedic Surgery, University of Pittsburgh, Pittsburgh, PA
² School of Medicine, University of Pittsburgh, Pittsburgh, PA

BACKGROUND

- Periprosthetic joint infections (PJI) remain a challenging complication following total joint arthroplasty
- accurate microbiologic diagnosis is essential to guide treatment.
- Sonication of explanted prostheses has demonstrated higher culture sensitivity compared with traditional synovial fluid and tissue cultures.¹
- The optimal colony-forming unit (CFU) threshold for defining positive sonication cultures remains debated, with current research suggesting $\geq$ as appropriate threshold.¹

STUDY AIM

Determine a CFU threshold derived from sonication cultures which maximizes sensitivity and specificity for the diagnosis of PJI.

METHODS

- Retrospective review of revision arthroplasty procedures performed from January 2016 through September 2025 at a multicenter single institution, with sonication cultures obtained.
- Diagnoses of PJI was made using the 2018 Musculoskeletal Infection Society (MSIS) criteria.
- Exclusion criteria: inadequate preoperative workup; lack of CFU reported in EMR; sonication of antibiotic spacers
- Diagnostic performance was evaluated at CFU thresholds of ≥ 1 , ≥ 2 , ≥ 3 , ≥ 4 , ≥ 5 , ≥ 10 , and ≥ 25 .
- Receiver operating characteristic (ROC) analysis was used to identify the optimal CFU threshold for PJI diagnosis.

STUDY COHORT

1,374 revision arthroplasty procedures screened



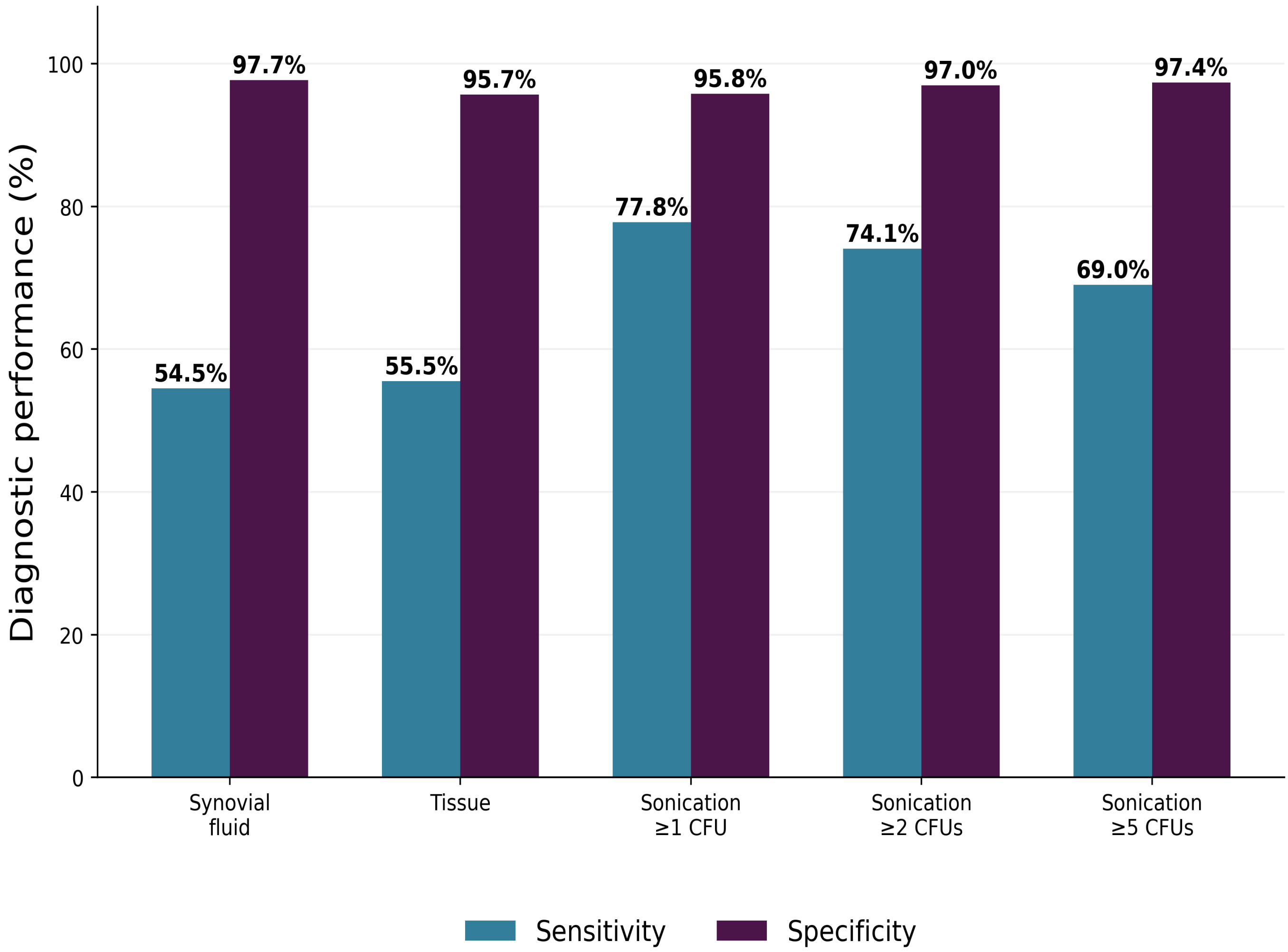
1,145 cases included

316 PJI
(27.6%)

829 aseptic
(72.4%)

RESULTS

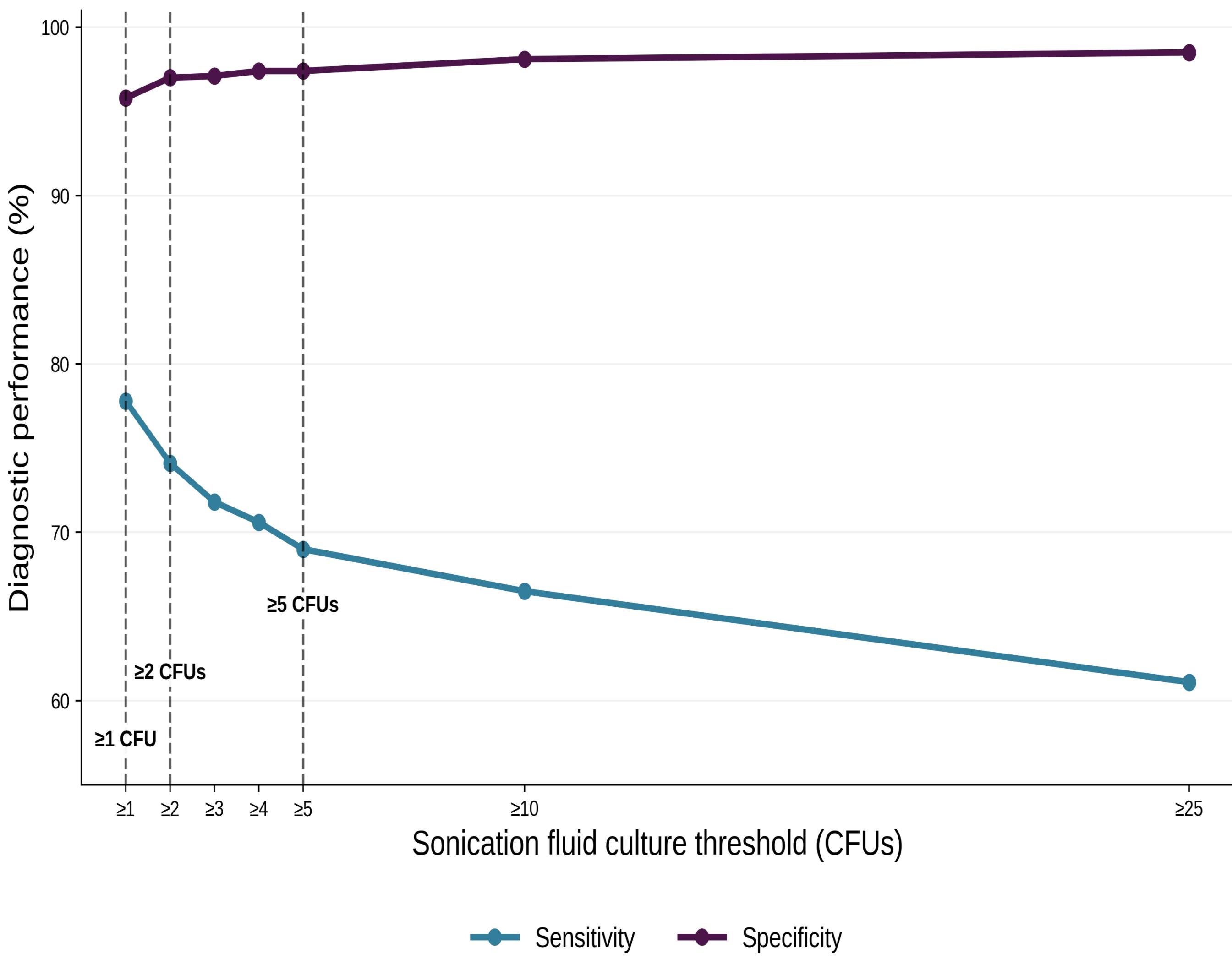
Diagnostic Performance of Culture Techniques



- Figure 1. Diagnostic performance of traditional and sonication fluid culture techniques.** Sonication culture demonstrated greater sensitivity than synovial and tissue cultures while maintaining comparable specificity.

CFU THRESHOLD ANALYSIS

Diagnostic Performance Across Sonication CFU Thresholds



- Figure 2. Diagnostic performance across sonication fluid culture CFU thresholds.** Increasing CFU thresholds decreased sensitivity while specificity remained high.

CLINICAL TAKEAWAY

Sonication cultures with relatively low CFUs are seen with PJI and may not simply reflect contamination. This study demonstrates that lower CFU thresholds improved the diagnosis of PJI while maintaining high specificity.

KEY FINDINGS

77.1 %
Sensitivity at ≥ 1 CFUs

95.8 %
Specificity at ≥ 1 CFUs

74.1 %
Sensitivity at ≥ 2 CFUs

97.0 %
Specificity at ≥ 2 CFUs

69.0 %
Sensitivity at ≥ 5 CFUs

97.4 %
Specificity at ≥ 5 CFUs

- ROC analysis favored ≥ 2 CFUs as the optimal threshold, balancing improved specificity with minimal loss of sensitivity compared with ≥ 1 CFU.

CONCLUSION

Sonication culture demonstrated superior sensitivity for PJI diagnosis compared with traditional synovial fluid and tissue cultures while maintaining high specificity.

Thresholds of 1 and 2 CFUs yielded high sensitivity and specificity, implicating these as optimal thresholds for defining positive sonication culture.

Future studies should focus on long-term clinical outcomes comparing patients with lower CFU sonication cultures which were treated as false positives without antibiotics versus those treated as PJI with antibiotics.

REFERENCES

- Rothenberg AC, Wilson AE, Hayes JP, O'Malley MJ, Klatt BA. Sonication of Arthroplasty Implants Improves Accuracy of Periprosthetic Joint Infection Cultures. Clin Orthop Relat Res. Jul 2017;475(7):1827-1836. doi:10.1007/s11999-017-5315-8
- Ribeiro TC, Honda EK, Daniachi D, et al. The impact of sonication cultures when the diagnosis of prosthetic joint infection is inconclusive. PLoS One. 2021;16(7):e0252322. doi:10.1371/journal.pone.0252322
- Portillo ME, Salvado M, Trampuz A, et al. Improved diagnosis of orthopedic implant-associated infection by inoculation of sonication fluid into blood culture bottles. J Clin Microbiol. May 2015;53(5):1622-7. doi:10.1128/JCM.03683-14
- Parvizi J, Tan TL, Goswami K, et al. The 2018 Definition of Periprosthetic Hip and Knee Infection: An Evidence-Based and Validated Criteria. J Arthroplasty. May 2018;33(5):1309-1314 e2. doi:10.1016/j.arth.2018.02.078

REFERENCES

The authors gratefully acknowledge the UPMC Department of Orthopaedic Surgery, Arthroplasty Division for their support and contributions to this project.