

Laboratory-Based Machine Learning Algorithm Reduces Uncertainty and Enhances Diagnostic Accuracy in Periprosthetic Joint Infection

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OBJECTIVES

Although multiple diagnostic criteria exist to aid physicians in diagnosing periprosthetic joint infection (PJI), gaps in their clinical utility remain. Incorrect implementation by physicians, combined with all leading criteria placing a high number of patients into an “inconclusive” class, collectively hinders timely and confident clinical decision-making.

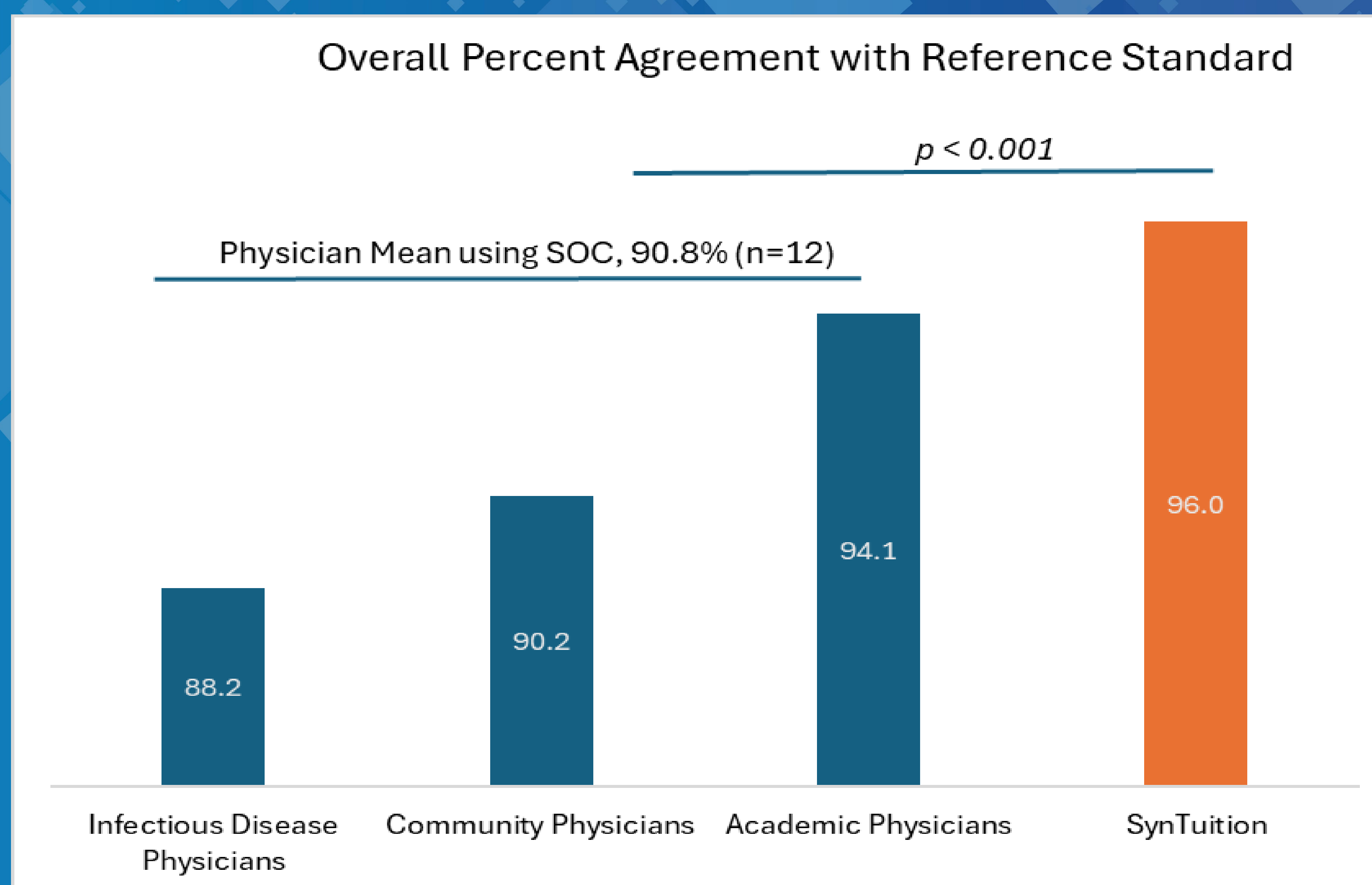
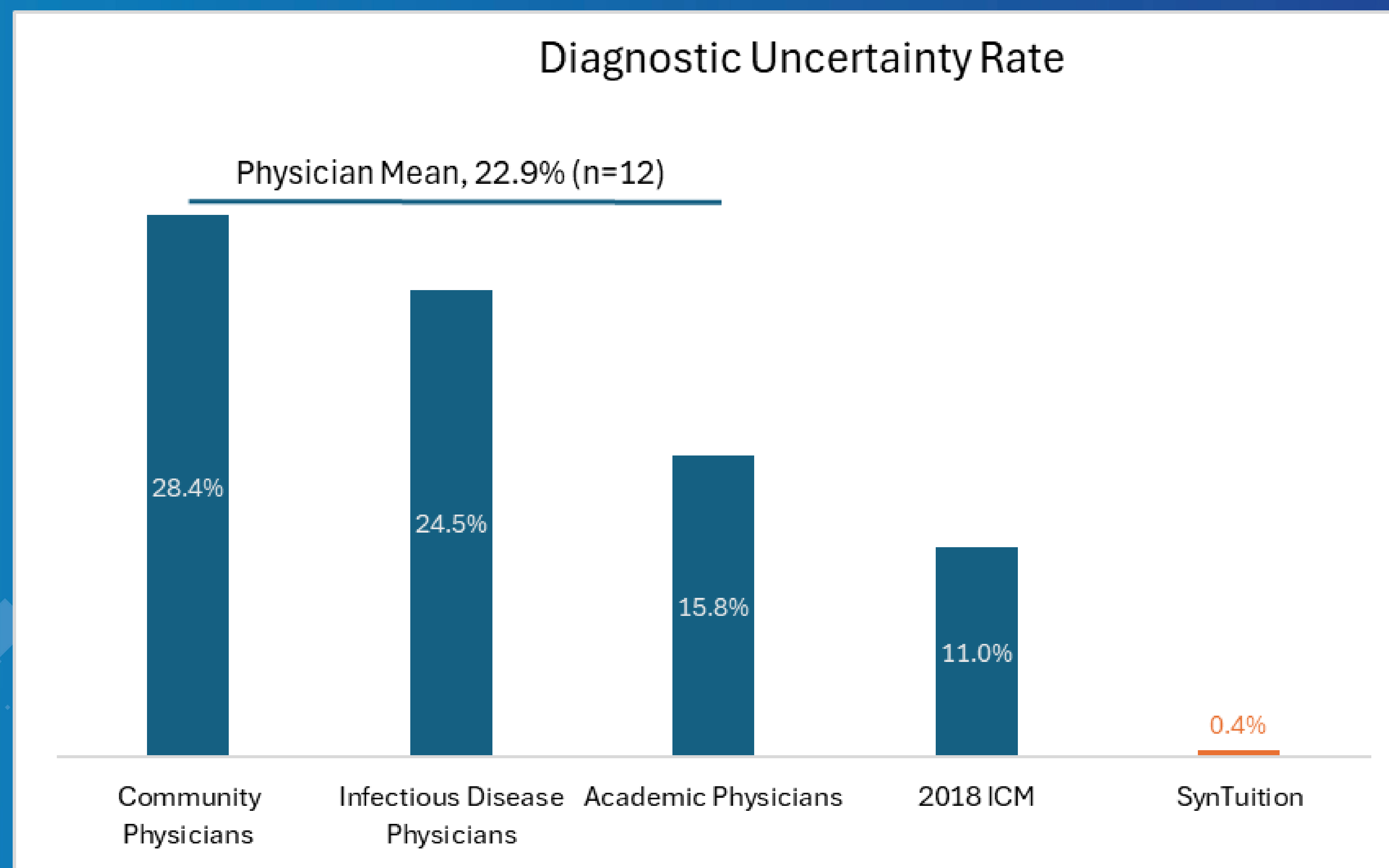
This study aims to evaluate whether SynTuition™, a clinical laboratory-based machine learning (ML) model that generates a PJI probability score from synovial fluid (SF) biomarkers, can mitigate these implementation gaps.

METHODS

274 clinical vignettes were previously presented to twelve physicians with varying expertise and experience to assess their ability to diagnose PJI when all necessary information is available. For this study, the same vignettes were evaluated using SynTuition, and diagnostic performance was compared to that of the physicians.

To generate the PJI probability score, any missing SF biomarker was imputed using a standard method, and SF C-reactive protein (CRP) was converted from serum CRP using a published regression equation.¹ Diagnostic performance was assessed against the SOC 2018 International Consensus Meeting (ICM) criteria, with inconclusive cases adjudicated by expert physicians.

SynTuition™ reduces diagnostic uncertainty by >50-fold and increases accuracy to 96%, enabling definitive classification of nearly all suspected PJI cases



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RESULTS

- The **inconclusive rate and diagnostic accuracy** was 22.9% and 90.8% by physicians and **0.4% and 96% by SynTuition**, respectively.
- SynTuition demonstrated greater ability to accurately differentiate diagnostically ambiguous results compared to physicians. When cases were labeled inconclusive under current diagnostic criteria, physicians remained uncertain 38% to 48% of the time. **SynTuition provided a definitive answer for all cases** and correctly classified 86.7% of them.
- **Physicians predominantly defaulted to a false-positive diagnosis** in inconclusive cases, leading to lower overall accuracy.
- Compared to physicians using SOC, **SynTuition reduced false-positives and lowered overall costs by approximately \$4000 per suspected PJI patient.**

CONCLUSION

SynTuition reduced diagnostic uncertainty by >50-fold, rendering only one equivocal result. SynTuition agreement with the current SOC was significantly higher than that of physicians, confirming the implementation gap. Based on these results, implementing SynTuition into clinical practice may prevent over-diagnosis of PJI, reducing unnecessary 2-stage revision surgery and over-prescription of high-dose systemic antibiotics, resulting in estimated healthcare savings of \$4000 per suspected PJI patient.

CLINICAL SIGNIFICANCE

SynTuition enables definitive PJI diagnosis by reducing uncertainty and enhancing accuracy, resulting in better patient outcomes and substantial healthcare cost savings.