# The Diagnostic Performance of Routine Lab Tests for Identifying Periprosthetic Joint Infection following Hip Hemiarthroplasty

Mehdi Sina Salimy[1], Tyler James Humphrey, Kyle Alpaugh, Hany S Bedair[1], Christopher Michael Melnic
[1]Massachusetts General Hospital

INTRODUCTION: Hip hemiarthroplasty (HHA) is the recommended surgical management for select patients that have sustained a femoral neck fracture. Studies have demonstrated better functional outcomes, particularly in frail and low mobility patients, compared to the alternative surgical management in total hip arthroplasty (THA). Despite these benefits, periprosthetic joint infection (PJI) continues to be a devastating complication of HHA with a high morbidity and mortality rate. There is a paucity of literature available for the diagnosis of PJI specific to HHA, although some studies have investigated the optimal thresholds for commonly used diagnostic tests in this population. Thus, the primary purpose of this study was to evaluate the utility and reliability of serum and synovial diagnostic markers for establishing a diagnosis of PJI in patients following HHA and to compare those values to the current diagnostic criteria established by the 2018 International Consensus Meeting (ICM) on Musculoskeletal Infection.

METHODS: After institutional review board approval, a query was performed across a single healthcare system consisting of both community hospitals and tertiary referral centers from January 2000 to December 2021. Patients were identified by Current Procedural Terminology (CPT) codes 27236 or 27125 with additional infection-related International Classification of Diseases, Ninth Revision (ICD-9) code 99666 or Tenth Revision (ICD-10) codes T84.51 and T84.52, respectively. A second query was performed to collect further information on ruled-out aseptic cases using joint aspiration and culture data CPT codes 89051 and 20611 with mention of infection in the operative notes. A manual chart review of all patient records was performed and the 2018 ICM criteria were applied to determine aseptic and septic cohorts. Demographic, laboratory, and microbiological data were collected when available. Preoperative or intraoperative synovial fluid nucleated cell (NC) count, synovial polymorphonuclear (PMN) percentage, serum erythrocyte sedimentation rate (ESR), serum C-reactive protein (CRP), and serum white blood cell (WBC) count were compared with Student's t-test between aseptic and septic cases. A subgroup analysis comparing mean synovial and serum lab values between acute and chronic PJI patients was performed. Receiver operating characteristic (ROC) curves and Youden's index were used to assess diagnostic performance and the optimal cutoff point of each test.

RESULTS: After applying exclusion criteria, the final cohort consisted of 98 patients with 64 representing 65.3% of the total study population identified as having PJI. The mean time to revision surgery was 73.5 months in the aseptic cohort compared to 12.9 months in the septic cohort (p=0.002). Mean laboratory values for synovial NC count (1,498.0 vs. 120,992.2, p<0.001), synovial PMN percentage (56.2 vs. 91.3, p<0.001), serum ESR (36.3 vs. 75.6, p<0.001), serum CRP (20.2 vs. 125.8, p<0.001), and serum WBC count (8.5 vs. 11.5, p<0.001) differed significantly between the aseptic and septic cohorts, respectively. Further subgroup analysis between acute PJI of <90 days (N=40) and chronic PJI of >90 days (N=24) demonstrated no statistical difference in mean values for all five diagnostic tests. Synovial NC count, synovial PMN percentage, and serum CRP demonstrated excellent discrimination ability for the diagnosis of PJI with an AUC of 0.99, 0.90, and 0.93, respectively. Serum ESR demonstrated good ability with an AUC of 0.83 while serum WBC count demonstrated poor utility as a diagnostic test with an AUC of 0.68. The optimal cutoff value was 2,700 cells/µL for synovial NC count (100% sensitivity, 90% specificity), 81.0% for synovial PMN percentage (96% sensitivity and 89% specificity), 52.0 mm/hr for serum ESR (75% sensitivity and 80% specificity), and 40.0 mg/L for serum CRP (85% sensitivity and 92% specificity) (Figure 1). The positive predictive value (PPV) and negative predictive value (NPV) were 97% and 100% for synovial NC count, 94% and 92% for synovial PMN percentage, 88% and 63% for serum ESR, and 95% and 77% for serum CRP. The causative organism was identified in 61 patients (95.3%) with *Staphylococcus* species being the most commonly identified in 40 patients (65.6%).

DISCUSSION AND CONCLUSION: Our findings support the continued use of routine serum and synovial fluid diagnostic tests due to their excellent discriminatory ability for diagnosing PJI in HHA patients. The optimal cutoff values for three diagnostic markers from this study were very close in alignment with the 2018 ICM criteria, suggesting that organizations like the ICM or the Musculoskeletal Infection Society (MSIS) should consider these results in the future definitions of PJI criteria.

Synovial Fluid Nucleated Cell Count — AUC: 99%

Synovial Fluid Polymorphonuclear Percentage — AUC: 90%

Serum ESR — AUC: 83%

Serum CRP — AUC: 93%