

# Leukocyte Esterase Strip Test: The Game-Changer in Early Detection and Prevention of Prosthetic Joint Infections

Mohammad Ayati Firoozabadi<sup>1</sup>, Hesam Rezaee<sup>2</sup>, Omid Salkhori<sup>1</sup>, Seyed Mohammad Javad Mortazavi<sup>3,\*</sup>

<sup>1</sup> Associate Professor, Department of Orthopedic Surgery, Joint Reconstruction Research Center, Imam Khomeini Hospital Complex, Tehran University of Medical Sciences, Tehran, Iran

<sup>2</sup> Assistant Professor, Department of Orthopedic Surgery, Joint Reconstruction Research Center, Imam Khomeini Hospital Complex, Tehran University of Medical Sciences, Tehran, Iran

<sup>3</sup> Professor, Department of Orthopedic Surgery, Joint Reconstruction Research Center, Imam Khomeini Hospital Complex, Tehran University of Medical Sciences, Tehran, Iran

\*Corresponding author: Seyed Mohammad Javad Mortazavi; Joint Reconstruction Research Center, Imam Khomeini Hospital Complex, Tehran University of Medical Sciences, Tehran, Iran. Tel: +98-2161192730, Email: smjmort@yahoo.com

Received: 17 June 2025; Revised: 25 August 2025; Accepted: 01 October 2025

## Abstract

**Background:** This study aimed to assess the diagnostic performance and preventive utility of the leukocyte esterase (LE) strip test in periprosthetic joint infections (PJIs) associated with hip and knee arthroplasty.

**Methods:** A comprehensive literature search was performed in PubMed, Scopus, and Web of Science databases for studies published between 2000 and 2024. Search terms included “leukocyte esterase”, “strip test”, “prosthetic joint infection”, and “synovial fluid biomarkers”. Relevant studies were reviewed to evaluate LE testing methodologies and diagnostic accuracy.

**Results:** The LE strip test is a rapid and inexpensive bedside tool that offers results within minutes. It demonstrates high specificity as a rule-out test preoperatively and reliable sensitivity for PJI confirmation postoperatively. The accuracy of the test is enhanced by sample centrifugation and glucose testing.

**Conclusion:** The LE strip test is a valuable tool for preoperative screening and postoperative diagnosis of PJI, especially when incorporated into comprehensive diagnostic algorithms.

**Keywords:** Total Hip Arthroplasty; Knee Arthroplasty; Leukocytes; Esterase

**Citation:** Ayati Firoozabadi M, Rezaee H, Salkhori O, Mortazavi SMJ. **Leukocyte Esterase Strip Test: The Game-Changer in Early Detection and Prevention of Prosthetic Joint Infections.** *J Orthop Spine Trauma* 2026; 12(1): 5-8.

## Background

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) are increasing globally due to excellent clinical outcomes and aging populations (1). Despite advances, periprosthetic joint infection (PJI) remains a serious complication with a 1-2 percent incidence, leading to morbidity, functional loss, and costly revisions (2). Early diagnosis and prevention are critical. Leukocyte esterase (LE) strip testing, initially designed for detecting urinary tract infections (UTIs), has been adapted for synovial fluid analysis to identify neutrophil esterase activity. This offers a rapid and cost-effective diagnostic tool (3). Recent international guidelines, such as the 2018 International Consensus Meeting (ICM) and the 2021 European Bone and Joint Infection Society (EBJIS) criteria, now incorporate LE testing into PJI diagnostic algorithms, emphasizing its growing acceptance (4, 5).

## Methods

This narrative review aimed to assess the diagnostic accuracy and clinical utility of the LE strip test in detecting PJI in hip and knee arthroplasty. A thorough literature search was performed in PubMed, Scopus, and Web of Science databases for articles published between 2000 and 2024, using keywords such as “leukocyte esterase”, “strip test”, “prosthetic joint infection”, and “synovial fluid biomarkers”. Additionally, reference lists from relevant studies and international guidelines [EBJIS, ICM, Musculoskeletal Infection Society (MSIS)] were manually screened to identify further sources. Studies were eligible for inclusion if they reported on the diagnostic performance of the LE strip test in PJI, involved human subjects, and were published in English. Case reports,

conference abstracts, and studies unrelated to orthopedic infections were excluded from the analysis.

Key data, including diagnostic criteria, test methodology, and sensitivity/specificity values, were extracted and analyzed. The quality of the included studies was evaluated using the Quality Assessment of Diagnostic Accuracy Studies-2 (QUADAS-2) tool (Table 1). The findings were synthesized narratively to examine the role of the LE strip test in diagnosis and its integration into multimodal diagnostic algorithms for the diagnosis of PJI.

### 1. LE Strip Test

Activated neutrophils release LE during infection and inflammation. The LE strip test uses a colorimetric change to detect esterase activity in synovial fluid, graded from 0 to +3 (6). In figure 1, positive and negative results of the LE strip test are shown. Synovial fluid centrifugation before testing improves specificity by removing confounding blood components, reducing false positives in inflammatory arthritis (7).



**Figure 1.** Leukocyte esterase (LE) strip test color change - negative vs. positive samples

Copyright © 2026 Tehran University of Medical Sciences. Published by Tehran University of Medical Sciences.



This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International license (<https://creativecommons.org/licenses/by-nc/4.0/>). Noncommercial uses of the work are permitted, provided the original work is properly cited.

**Table 1.** Risk of bias summary for included studies using the Quality Assessment of Diagnostic Accuracy Studies-2 (QUADAS-2) tool

References/year	Risk of bias in patient selection	Risk of bias in index test	Risk of bias in reference standard	Concerns regarding applicability	Comments
Parvizi et al. (3), 2011	Low	Low	Low	Low	Direct evaluation of the LE strip test in PJI
Parvizi et al. (8), 2018	Low	Low	Low	Low	Validated diagnostic criteria definition
Li et al., 2020 (9), 2017	Moderate	Low	Low	Low	LE vs. histology, possible sample selection bias
Colvin et al. (10), 2015	Low	Low	Low	Low	LE strip test application in PJI
Deirmengian et al. (11), 2018	Low	Low	Low	Low	Diagnostic challenges and LE test accuracy
Haertle et al. (12), 2022	Low	Low	Low	Low	Combined LE and glucose testing for PJI
Zhang et al. (13), 2020	Moderate	Low	Low	Moderate	Effect of inflammatory arthritis on LE test accuracy
Wyatt et al. (14), 2016	Low	Low	Low	Low	Systematic review and meta-analysis; high quality
De Vecchi et al. (15), 2016	Moderate	Low	Low	Moderate	PCR, LE, CRP, leukocyte count comparison

PJI: Periprosthetic joint infection; LE: Leukocyte esterase; PCR: Polymerase chain reaction; CRP: C-reactive protein

Parvizi et al. first validated the LE test for PJI diagnosis in 2018, demonstrating sensitivity and specificity comparable to more expensive tests (8). Studies report sensitivity ranging from 79% to 92% and specificity of up to 96%, highlighting its reliability (9, 10). Notably, LE testing maintains diagnostic performance even after antibiotic administration, a significant advantage over culture methods (11). Digital readers have further enhanced reproducibility, reducing subjective interpretation errors seen with naked-eye color reading (12). Combining LE with other synovial biomarkers, such as alpha-defensin and calprotectin, improves diagnostic accuracy, supporting a multi-modal testing approach (5, 12).

## 2. Interpreting LE Strip Results in Clinical Scenarios

**Preoperative Infection Detection:** Identifying infection before arthroplasty is essential to prevent postoperative PJI. LE strip testing has demonstrated utility in distinguishing between bacterial and inflammatory arthritis in emergency settings, with a high negative predictive value (NPV) allowing for the safe rule-out of infection (16). Hassas Yeganeh et al. showed LE's ability to differentiate septic arthritis from rheumatoid arthritis (RA) with sensitivity of ~80% and specificity of ~79% (17). This makes LE testing a valuable tool for triaging patients before joint replacement surgery.

**Diagnosing PJI:** PJI diagnosis relies on positive cultures and histology. LE strip testing shows excellent sensitivity and specificity for PJI detection, with some studies reporting near 100% sensitivity and specificity in clinical settings (7, 10). However, false negatives can occur, particularly in low-grade infections or when antibiotic treatment is present (12). Combined LE and glucose strip testing improves specificity (up to 98%) but may reduce sensitivity (17). Thus, LE test results should be interpreted in conjunction with clinical findings, serum markers [C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR)], and microbiological cultures (18).

### Diagnostic Criteria for PJI

Accurate diagnosis of PJI remains a complex process that requires the integration of clinical, laboratory, and microbiological data. The EBJIS 2021 diagnostic criteria are among the most recent and widely accepted frameworks (4):

- Major criteria (confirming infection if any present):
  - Two or more cultures with phenotypically identical organisms from periprosthetic tissue/fluid
  - Sinus tract communicating with prosthesis
- Minor criteria (supportive evidence, scoring applied):
  - Elevated serum CRP or ESR
  - Elevated synovial white blood cell (WBC) count and neutrophil percentage (cut-offs vary)
  - Positive histopathology ( $\geq 5$  neutrophils per high-power field)

- Positive synovial biomarkers (including LE strip test, alpha-defensin, and calprotectin)
- Purulence in joint fluid.

The LE strip test, especially with strong positive results (+2 or +3), is incorporated as a minor criterion that significantly raises suspicion for infection when combined with other parameters. The interpretation of LE must consider the clinical context and additional tests for accuracy. Other established criteria include the 2013 MSIS and 2018 ICM definitions, which similarly incorporate LE testing as part of minor criteria.

**Aspiration of Bloody Synovial Fluid:** In cases where synovial fluid is visibly bloody, the interpretation of the LE strip test is challenging due to interference by blood pigments, which can cause false-positive results. Current best practice involves centrifugation of the sample at 3000 revolutions per minute (rpm) for 3 minutes to separate blood components and clarify the fluid (7, 19).

After centrifugation, the LE test is repeated on the clear supernatant, improving specificity. The LE strip should be read within 2 to 5 minutes after immersion in synovial fluid. For centrifuged samples, the exact timing applies after the supernatant is applied. Delayed reading can cause inaccurate results due to color fading or progression. This approach reduces false positives and enhances the diagnostic accuracy of LE testing in samples with blood or contamination.

**Antibiotic Influence on Diagnosis:** Antibiotic therapy before aspiration reduces culture sensitivity but has a minimal effect on LE strip test accuracy. Shahi et al. demonstrated that LE testing remained reliable even after antibiotic usage, which is a significant advantage in clinical practice, where empirical antibiotics are frequently administered before completing the diagnostic workup (16). This improves the timely diagnosis and treatment planning of PJI.

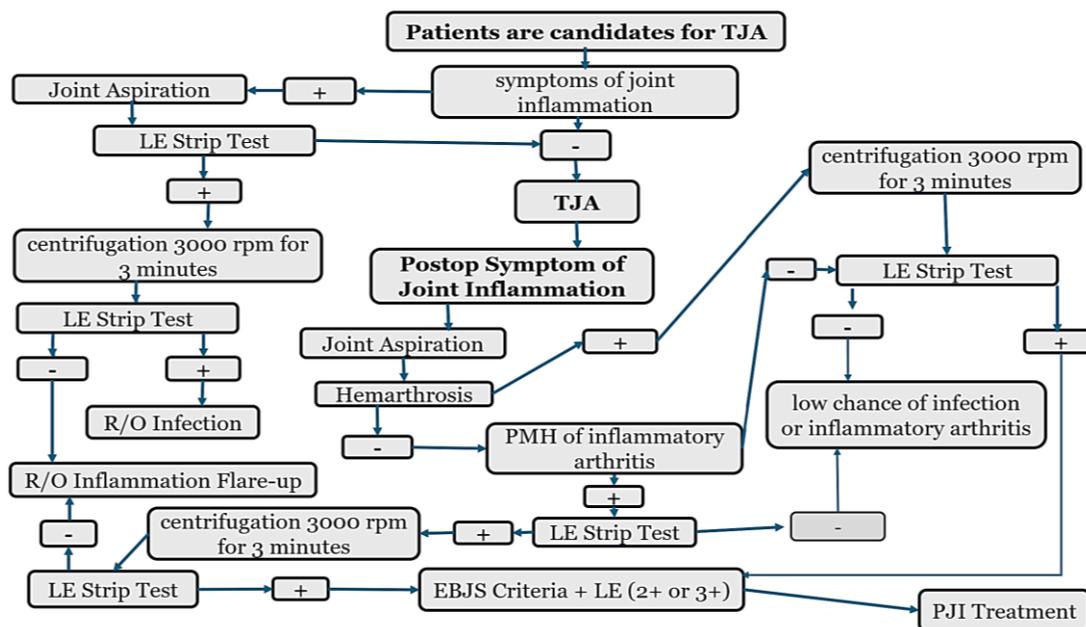
### Differentiating PJI from Inflammatory Flare-Ups:

Inflammatory arthritis can cause false-positive LE results. Centrifugation of synovial fluid samples effectively reduces these false positives by removing inflammatory cells and debris, enhancing specificity (7). Zheng and Zhang found that centrifugation improved the reliability of the LE test in patients with inflammatory arthritis, thereby reducing the risk of misdiagnosis (19).

Figure 2 illustrates the diagnostic algorithm for evaluating patients who are candidates for joint replacement surgery or have undergone the procedure, with the goal of ruling out infection.

### 3. Emerging Biomarkers and Future Directions

The LE strip test is part of an expanding panel of synovial biomarkers for the diagnosis of PJI. Alpha-defensin and calprotectin assays demonstrate high accuracy but are more costly and less readily available (16, 20).



**Figure 2.** The diagnostic algorithm for evaluating patients who are candidates for joint replacement surgery or have undergone the procedure (LE: Leukocyte esterase; PJI: Periprosthetic joint infection; TJA: Total joint arthroplasty; EBJS: European Bone and Joint Infection Society; PMH: Past Medical History)

Combining LE testing with these biomarkers and clinical scoring systems can improve early and accurate detection of PJI, thereby reducing unnecessary surgeries and healthcare costs (18, 21). The diagnostic performance and characteristics of LE, microbial culture, alpha-defensin, and inflammatory markers (CRP and ESR) in detecting PJI have been reported in several studies (Table 2) (22-24).

Diagnostic method	Sensitivity (%)	Specificity (%)	Cost	Time to result	Antibiotic impact
LE test	79-92	90-96	<1\$	2-5 minutes	Low
Microbial culture	65-85	95-98	Medium	3-7 days	High
Alpha-defensin	90-97	95-97	High	1 day	Low
CRP and ESR	70-85	70-80	Low	Few hours	Moderate

LE: Leukocyte esterase; CRP: C-reactive protein; ESR: Erythrocyte sedimentation rate

Machine learning models integrating LE results, clinical parameters, and serum biomarkers are under development, showing potential to enhance diagnostic precision and guide individualized treatment. Continued research and multicenter trials are needed to refine testing algorithms and implement them in routine clinical practice (25).

**Conclusion**

The LE strip test offers a quick, reliable, and cost-effective method for early detection and prevention of PJIs in hip and knee replacements. It is beneficial as a rule-out test before surgery and as a rule-in test after surgery when used in conjunction with other diagnostic tools. Its effectiveness remains strong even after previous antibiotic treatment and can be improved through sample centrifugation and combined biomarker testing. Incorporating LE strip testing into international diagnostic standards demonstrates its clinical value, and ongoing technological advancements are expected to further enhance its accuracy and utility.

**Conflict of Interest**

The authors declare no conflict of interest in this study.

**Acknowledgements**

This research did not receive any specific grant from any funding agency in the public, commercial, or not-for-profit sector.

**References**

- Kurtz SM, Ong KL, Schmier J, Mowat F, Saleh K, Dybvik E, et al. Future clinical and economic impact of revision total hip and knee arthroplasty. *J Bone Joint Surg Am.* 2007;89(Suppl 3): 144-51. doi: 10.2106/jbjs.G.00587. [PubMed: 17908880].
- Tande AJ, Patel R. Prosthetic joint infection. *Clin Microbiol Rev.* 2014;27(2):302-45. doi: 10.1128/cmr.00111-13. [PubMed: 24696437]. [PubMed Central: PMC3993098].
- Parvizi J, Jacovides C, Antoci V, Ghanem E. Diagnosis of periprosthetic joint infection: the utility of a simple yet unappreciated enzyme. *J Bone Joint Surg Am.* 2011;93(24):2242-8. doi: 10.2106/jbjs.J.01413. [PubMed: 22258769].
- McNally M, Sousa R, Wouthuyzen-Bakker M, Chen AF, Soriano A, Vogely HC, et al. The EBJS definition of periprosthetic joint infection. *Bone Joint J.* 2021;103-b(1):18-25. doi: 10.1302/0301-620x.103b1.Bjj-2020-1381.R1. [PubMed: 33380199]. [PubMed Central: PMC7954183].
- Deirmengian C, Kardos K, Kilmartin P, Cameron A, Schiller K, Parvizi J. Combined measurement of synovial fluid αDefensin and C-reactive protein levels: highly accurate for diagnosing periprosthetic joint infection. *J Bone Joint Surg Am.* 2014;96(17):1439-45. doi: 10.2106/jbjs.M.01316. [PubMed: 25187582].
- Wang C, Li R, Wang Q, Wang C. Synovial Fluid Leukocyte Esterase in the Diagnosis of Peri-Prosthetic Joint Infection: A Systematic Review and Meta-Analysis. *Surg Infect (Larchmt).* 2018;19(3):245-53. doi: 10.1089/sur.2017.192. [PubMed: 29099342].
- Li R, Lu Q, Zhou YG, Chai W, Lu SB, Chen JY. Centrifugation May Change the Results of Leukocyte Esterase Strip Testing in the Diagnosis of Periprosthetic Joint Infection. *J Arthroplasty.* 2018;33(9):2981-5. doi: 10.1016/j.arth.2018.04.015. [PubMed: 29752029].
- Parvizi J, Tan TL, Goswami K, Higuera C, Della Valle C, Chen AF,

- et al. The 2018 definition of periprosthetic hip and knee infection: An evidence-based and validated criteria. *J Arthroplasty*. 2018;33(5):1309-14.e2. doi: [10.1016/j.arth.2018.02.078](https://doi.org/10.1016/j.arth.2018.02.078). [PubMed: [29551303](https://pubmed.ncbi.nlm.nih.gov/29551303/)].
9. Li R, Li X, Yu B, Li X, Song X, Li H, et al. Comparison of leukocyte esterase testing of synovial fluid with synovial histology for the diagnosis of periprosthetic joint infection. *Med Sci Monit*. 2017;23:4440-6. doi: [10.12659/msm.906705](https://doi.org/10.12659/msm.906705). [PubMed: [28912417](https://pubmed.ncbi.nlm.nih.gov/28912417/)]. [PubMed Central: [PMC5612200](https://pubmed.ncbi.nlm.nih.gov/PMC5612200/)].
  10. Colvin OC, Kransdorf MJ, Roberts CC, Chivers FS, Lorans R, Beauchamp CP, et al. Leukocyte esterase analysis in the diagnosis of joint infection: can we make a diagnosis using a simple urine dipstick? *Skeletal Radiol*. 2015;44(5):673-7. doi: [10.1007/s00256-015-2097-5](https://doi.org/10.1007/s00256-015-2097-5). [PubMed: [25626524](https://pubmed.ncbi.nlm.nih.gov/25626524/)].
  11. Deirmengian CA, Liang L, Rosenberger JP, Joaquin TR, Gould MR, Citrano PA, et al. The leukocyte esterase test strip is a poor rule-out test for periprosthetic joint infection. *J Arthroplasty*. 2018;33(8):2571-4. doi: [10.1016/j.arth.2018.03.005](https://doi.org/10.1016/j.arth.2018.03.005). [PubMed: [29656969](https://pubmed.ncbi.nlm.nih.gov/29656969/)].
  12. Haertlé M, Kolbeck L, Macke C, Graulich T, Stauß R, Omar M. Diagnostic accuracy for periprosthetic joint infection does not improve by a combined use of glucose and leukocyte esterase strip reading as diagnostic parameters. *J Clin Med*. 2022;11(11):2979. doi: [10.3390/jcm11112979](https://doi.org/10.3390/jcm11112979). [PubMed: [35683369](https://pubmed.ncbi.nlm.nih.gov/35683369/)]. [PubMed Central: [PMC9181009](https://pubmed.ncbi.nlm.nih.gov/PMC9181009/)].
  13. Zhang J, Gui B, Cheng F, Rong G, Tang Z, Shen C. Influence of inflammatory arthritis on leukocyte esterase strip results in the diagnosis of periprosthetic joint infection. *J Orthop Surg Res*. 2020;15(1),10. doi: [10.1186/s13018-019-1523-0](https://doi.org/10.1186/s13018-019-1523-0).
  14. Wyatt MC, Beswick AD, Kunutsor SK, Wilson MJ, Whitehouse MR, Blom AW. The alpha-defensin immunoassay and leukocyte esterase colorimetric strip test for the diagnosis of periprosthetic infection: A systematic review and meta-analysis. *J Bone Joint Surg Am*. 2016;98(12):992-1000. doi: [10.2106/jbjs.15.01142](https://doi.org/10.2106/jbjs.15.01142). [PubMed: [27307359](https://pubmed.ncbi.nlm.nih.gov/27307359/)]. [PubMed Central: [PMC4901182](https://pubmed.ncbi.nlm.nih.gov/PMC4901182/)].
  15. De Vecchi E, Villa F, Bortolin M, Toscano M, Tacchini L, Romanò CL, et al. Leucocyte esterase, glucose and C-reactive protein in the diagnosis of prosthetic joint infections: a prospective study. *Clin Microbiol Infect*. 2016;22(6):555-60. doi: [10.1016/j.cmi.2016.03.020](https://doi.org/10.1016/j.cmi.2016.03.020). [PubMed: [27040804](https://pubmed.ncbi.nlm.nih.gov/27040804/)].
  16. Shahi A, Alvand A, Ghanem E, Restrepo C, Parvizi J. The leukocyte esterase test for periprosthetic joint infection is not affected by prior antibiotic administration. *J Bone Joint Surg Am*. 2019;101(8):739-44. doi: [10.2106/jbjs.18.00615](https://doi.org/10.2106/jbjs.18.00615). [PubMed: [30994592](https://pubmed.ncbi.nlm.nih.gov/30994592/)].
  17. Hassas Yeganeh M, Talaei M, Bazzaz AE, Rahmani K, Sinaei R, Fathi M, et al. Determination of diagnostic value (validity) leukocyte esterase (urine dipstick strip) in differentiating inflammatory arthritis from bacterial arthritis. *Adv Rheumatol*. 2020;60(1):11. doi: [10.1186/s42358-020-0115-3](https://doi.org/10.1186/s42358-020-0115-3). [PubMed: [31992368](https://pubmed.ncbi.nlm.nih.gov/31992368/)].
  18. Al-Jabri T, Ridha M, Wood MJ, Kayani B, Jayadev C, McCulloch RA, et al. An overview of the current diagnostic approach to periprosthetic joint infections. *Orthop Rev (Pavia)*. 2024;16:120308. doi: [10.52965/001c.120308](https://doi.org/10.52965/001c.120308). [PubMed: [38957745](https://pubmed.ncbi.nlm.nih.gov/38957745/)]. [PubMed Central: [PMC11218870](https://pubmed.ncbi.nlm.nih.gov/PMC11218870/)].
  19. Zheng QY, Zhang GQ. Application of leukocyte esterase strip test in the screening of periprosthetic joint infections and prospects of high-precision strips. *Arthroplasty*. 2020;2(1):34. doi: [10.1186/s42836-020-00053-5](https://doi.org/10.1186/s42836-020-00053-5). [PubMed: [35236471](https://pubmed.ncbi.nlm.nih.gov/35236471/)]. [PubMed Central: [PMC8796411](https://pubmed.ncbi.nlm.nih.gov/PMC8796411/)].
  20. Wasterlain AS, Goswami K, Ghasemi SA, Parvizi J. Diagnosis of periprosthetic infection: Recent developments. *J Bone Joint Surg Am*. 2020;102(15):1366-75. doi: [10.2106/jbjs.19.00598](https://doi.org/10.2106/jbjs.19.00598). [PubMed: [32769605](https://pubmed.ncbi.nlm.nih.gov/32769605/)].
  21. Ting NT, Della Valle CJ. Diagnosis of periprosthetic joint infection-an algorithm-based approach. *J Arthroplasty*. 2017;32(7):2047-50. doi: [10.1016/j.arth.2017.02.070](https://doi.org/10.1016/j.arth.2017.02.070). [PubMed: [28343826](https://pubmed.ncbi.nlm.nih.gov/28343826/)].
  22. Zheng QY, Li R, Ni M, Ren P, Ji QB, Sun JY, et al. What Is the optimal timing for reading the leukocyte esterase strip for the diagnosis of periprosthetic joint infection? *Clin Orthop Relat Res*. 2021;479(6):1323-30. doi: [10.1097/corr.0000000000001609](https://doi.org/10.1097/corr.0000000000001609). [PubMed: [33492869](https://pubmed.ncbi.nlm.nih.gov/33492869/)]. [PubMed Central: [PMC8133206](https://pubmed.ncbi.nlm.nih.gov/PMC8133206/)].
  23. Gautam VK, Saini R, Sharma S. Effectiveness of leukocyte esterase as a diagnostic test for acute septic arthritis. *J Orthop Surg (Hong Kong)*. 2017;25(1):2309499016685019. doi: [10.1177/2309499016685019](https://doi.org/10.1177/2309499016685019). [PubMed: [28134047](https://pubmed.ncbi.nlm.nih.gov/28134047/)].
  24. Parvizi J, Gehrke T, Chen AF. Proceedings of the international consensus on periprosthetic joint infection. *Bone Joint J*. 2013; 95-b(11):1450-2. doi: [10.1302/0301-620x.95b11.33135](https://doi.org/10.1302/0301-620x.95b11.33135). [PubMed: [24151261](https://pubmed.ncbi.nlm.nih.gov/24151261/)].
  25. Dragosloveanu S, Vulpe DE, Andrei CA, Nedelea DG, Garofil ND, Anghel C, et al. Predicting periprosthetic joint Infection: Evaluating supervised machine learning models for clinical application. *J Orthop Translat*. 2025;54:51-64. doi: [10.1016/j.jot.2025.06.016](https://doi.org/10.1016/j.jot.2025.06.016). [PubMed: [40703570](https://pubmed.ncbi.nlm.nih.gov/40703570/)]. [PubMed Central: [PMC12284488](https://pubmed.ncbi.nlm.nih.gov/PMC12284488/)].