The Diagnostic Value of Metagenomic Next-Generation Sequencing Versus Traditional Microbiological Testing in Native Pyogenic Spinal Infections: A Systematic Review and Meta-Analysis

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INTRODUCTION: Native pyogenic spinal infections (PSIs), including spondylodiscitis and vertebral osteomyelitis, are challenging to diagnose due to low culture sensitivity and delayed results. Metagenomic next-generation sequencing (mNGS) has emerged as a promising diagnostic tool, but its comparative clinical utility remains uncertain. The purpose of this study is to systematically compare the diagnostic performance and clinical impact of mNGS versus conventional microbial culture in detecting pathogens responsible for native PSIs.

METHODS: A total of 1,197 patients from 11 studies were included, encompassing those with suspected or confirmed native spinal infections of bacterial, fungal, or viral etiology. Primary outcomes included pooled sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Secondary outcomes assessed diagnostic yield, time to diagnosis, treatment modification, and false-positive or contamination events. A comprehensive literature search was performed across six major databases. Eligible studies directly compared mNGS with standard culture for native PSIs and reported diagnostic performance metrics. Data were extracted and analyzed using a random-effects model to produce pooled estimates. Study quality was assessed using the Newcastle-Ottawa Scale. Systematic review and meta-analysis were conducted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISM) guidelines.

RESULTS: Pooled sensitivity and specificity of mNGS were 89.7% (95% CI: 85.6–93.1%) and 86.2% (95% CI: 80.5–91.0%), respectively. mNGS demonstrated a significantly higher diagnostic yield (69–90%) compared to culture (27.2–44.7%) and enabled faster diagnosis (mean 17.7–48 hours). mNGS informed antimicrobial changes in up to 70.3% of cases and detected a broader pathogen spectrum. The incidence of false positives was low but non-negligible, emphasizing the need for careful interpretation.

DISCUSSION AND CONCLUSION:

mNGS outperforms conventional culture in sensitivity, speed, and breadth of pathogen detection in native PSIs and supports more tailored antimicrobial therapy. However, careful interpretation is necessary due to potential false positives. These findings support the integration of mNGS into clinical workflows, particularly in complex or culture-negative infections.