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Understanding Antibiotic Influence on Medical Test Outcomes: A Systematic Review

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Abstract

This systematic review examines the effects of antibiotic administration on the accuracy of medical test outcomes, aiming to provide healthcare professionals with insights into the diagnostic challenges posed by antibiotic interference.A comprehensive literature search was conducted across databases including PubMed, Scopus, and Web of Science, covering studies published between 2016 and 2024. Studies were selected based on their focus on antibiotic interactions with diagnostic tests in clinical settings, with strict inclusion and exclusion criteria applied. Data were extracted from relevant studies, focusing on specific medical tests affected, types of antibiotics involved, and outcomes observed. Quality assessment was conducted using PRISMA guidelines to ensure the reliability of included studies.The review identified multiple instances where antibiotics influenced the accuracy of key diagnostic tests. For example, antibiotics commonly impacted blood culture results, leading to false negatives in detecting infections. Urinalysis and inflammatory marker tests were also affected, often resulting in reduced sensitivity and specificity. Liver function and renal function tests showed variability in results due to certain antibiotics, potentially complicating patient assessment. Mechanistic insights suggest that antibiotic effects on bacterial growth, immune modulation, and metabolic interactions are primary contributors to altered diagnostic results.Antibiotic administration can significantly interfere with various diagnostic tests, posing risks to accurate diagnosis and timely intervention. These findings highlight the importance of obtaining a thorough medication history and considering potential test interference in clinical decision-making. Further research is recommended to develop guidelines for minimizing diagnostic inaccuracies due to antibiotic influence.

Keywords: *Antibiotics, Diagnostic Interference, Medical Test Accuracy, Diagnostic Challenges, Blood Culture, Urinalysis, Inflammatory Markers, Liver Function Tests, Renal Function Tests.*

Introduction

The accurate diagnosis of medical conditions relies heavily on laboratory and imaging tests, which guide treatment plans and help monitor disease progression. However, diagnostic accuracy can be compromised by various factors, including the administration of medications, such as antibiotics, which may interfere with test outcomes (Pavlov et al., 2019; Alrabei, 2023). Antibiotics are widely prescribed for bacterial infections, but their unintended effects on diagnostic tests present significant challenges in clinical practice. These interferences can lead to inaccurate test results, affecting treatment decisions and patient outcomes (Martínez-Gamboa et al., 2020; McLellan et al., 2018).

Antibiotic interference in diagnostic tests is particularly concerning because of the broad impact it can have across various testing methods. For example, studies have shown that antibiotics can suppress bacterial growth in blood cultures, leading to false-negative results that hinder accurate infection detection (Patel et al., 2021; Mohammad et al., 2024). In a clinical context, these false negatives can delay appropriate treatment, potentially leading to complications in patients with serious infections. Blood culture tests, critical for diagnosing bloodstream infections, are highly sensitive to antibiotic interference, as the growth of pathogenic organisms can be inhibited when antibiotics are present in the bloodstream (El-Azeem et al., 2018; Almomani et al., 2023).

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Additionally, antibiotics may affect inflammation markers such as C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR), which are commonly used to monitor inflammatory conditions. Some antibiotics exhibit immunomodulatory effects, reducing inflammation markers and potentially masking the presence of an infection or inflammatory condition (Jones et al., 2017; Azzam et al., 2023). This effect can complicate the diagnosis and monitoring of patients with chronic inflammatory diseases or acute infections (Husain et al., 2019). Moreover, liver and renal function tests are also susceptible to alterations when patients are on antibiotic therapy, as certain antibiotics can increase or decrease specific enzymes, misleading the clinical assessment of organ function (Singh et al., 2022).

Despite these known challenges, systematic reviews on the impact of antibiotics on diagnostic tests remain limited, especially in terms of consolidating data across test types and antibiotic classes. Understanding the mechanisms of interference, such as the metabolic effects of antibiotics or their interaction with bacterial growth in cultures, is crucial for improving diagnostic accuracy in patients undergoing antibiotic therapy. This review aims to systematically examine existing literature on how antibiotics impact diagnostic test outcomes, focusing on the extent and mechanisms of interference. By identifying patterns and clinical implications, this review seeks to support healthcare professionals in recognizing and mitigating the diagnostic challenges associated with antibiotic administration.

Methods

Search Strategy

To conduct a comprehensive review of existing literature, a systematic search was performed across multiple academic databases, including PubMed, Scopus, and Web of Science. The search focused on studies published from 2016 to 2024 to ensure the inclusion of recent and relevant data. Key search terms used included “antibiotics AND diagnostic interference,” “antibiotics AND medical test accuracy,” “blood culture AND antibiotics,” “urinalysis AND antibiotics,” and “inflammatory markers AND antibiotic impact.” Boolean operators and filters (such as publication date and peer-reviewed journals) were used to refine search results, ensuring high-quality sources.

Inclusion and Exclusion Criteria

Articles were selected based on predefined inclusion and exclusion criteria to focus the review on studies that explore the impact of antibiotics on medical test accuracy:

Inclusion Criteria

Studies published between 2016 and 2024.

Articles focused on human subjects.

Peer-reviewed journal articles.

Studies examining the effect of antibiotics on diagnostic test outcomes, including blood cultures, urinalysis, inflammation markers, liver and renal function tests, and other clinical laboratory tests.

Studies that provide data on specific antibiotic classes and their potential interference with test results.

Exclusion Criteria

Studies that focused exclusively on veterinary medicine.

Non-peer-reviewed articles (e.g., conference abstracts, opinion pieces).

Studies that did not focus on diagnostic tests or lacked clear outcome measures.

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Articles published in languages other than English, given resource limitations for translation.

Study Selection Process

The study selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure transparency and reproducibility. Titles and abstracts from the initial search results were screened independently by two reviewers to assess relevance. Full-text articles were then retrieved for all studies that met the inclusion criteria or lacked sufficient information for immediate exclusion.

Each article was carefully reviewed to confirm that it met the criteria. Any disagreements between reviewers regarding the inclusion or exclusion of articles were resolved through discussion or, when necessary, consultation with a third reviewer.

Data Extraction and Synthesis

Data were systematically extracted from the selected studies, focusing on the following variables:

Study Characteristics: Authors, publication year, study design, and sample size.

Types of Tests Examined: Diagnostic tests impacted by antibiotics, including blood cultures, urinalysis, inflammatory markers (e.g., C-reactive protein, ESR), and liver and renal function tests.

Antibiotics Involved: Specific antibiotics or classes of antibiotics (e.g., beta-lactams, fluoroquinolones) investigated in each study.

Observed Outcomes: Specific findings related to diagnostic interference, such as reduced sensitivity, specificity, false positives, or false negatives.

Mechanisms of Interaction: If reported, any biological or pharmacological mechanisms explaining how antibiotics affected test accuracy.

The extracted data were then synthesized into a summary table, categorizing studies by diagnostic test type and antibiotic class. This table enabled a clear comparison of findings across studies, highlighting trends and variability in diagnostic interference due to antibiotics.

Quality Assessment

To ensure the reliability and validity of the findings, a quality assessment of each included study was conducted using PRISMA and additional criteria for evaluating risk of bias. Studies were assessed based on sample size adequacy, study design, clarity of outcome measures, and potential confounding factors. Studies with significant methodological weaknesses or high risk of bias were noted, although no studies were excluded solely based on these factors. A summary of the quality assessment results is included to contextualize the findings and aid in interpreting the implications.

Results

A total of 47 studies were included in this systematic review, covering a wide range of diagnostic tests commonly impacted by antibiotics. The findings reveal that antibiotics can significantly influence test accuracy, with notable effects observed in blood cultures, urinalysis, inflammatory markers, and liver and renal function tests. This section details the effects of antibiotics on each test category, summarizes observed patterns, and provides insight into the potential mechanisms of interference.

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Summary of Included Studies

The review includes studies from various regions and clinical settings, primarily focusing on hospitalized patients who received antibiotics prior to diagnostic testing. Table 1 provides a summary of the studies included, including test types, antibiotic classes, sample sizes, and main outcomes.

Table 1. Summary of Included Studies

Study	Year	Test Type	Antibiotic Class	Sample Size	Main Outcome
Pavlov et al.	2019	Blood Cultures	Beta-lactams	300	Reduced bacterial growth
Martínez-Gamboa et al.	2020	Inflammatory Markers	Fluoroquinolones	150	Decreased CRP and ESR
McLellan et al.	2018	Urinalysis	Aminoglycosides	100	Reduced detection of pathogens
Singh et al.	2022	Liver Function	Cephalosporins	200	Altered liver enzyme levels
Husain et al.	2019	Renal Function	Vancomycin	120	Increased creatinine levels

Effect of Antibiotics on Blood Cultures

Blood cultures are critical for diagnosing bloodstream infections, but they are particularly sensitive to antibiotic interference. Of the 20 studies investigating blood cultures, 16 reported reduced bacterial growth when antibiotics were present, leading to false negatives. The beta-lactam class was most frequently associated with reduced bacterial detection, as these antibiotics inhibit bacterial cell wall synthesis, impairing bacterial proliferation in culture (Pavlov et al., 2019; Patel et al., 2021; Jahmani et al., 2023).

A meta-analysis of these studies (Figure 1) illustrates that the false-negative rate in blood cultures increased by 35% when patients received beta-lactam antibiotics prior to sampling. This finding highlights the importance of timing diagnostic blood draws before or after antibiotic administration, whenever feasible, to improve test accuracy.

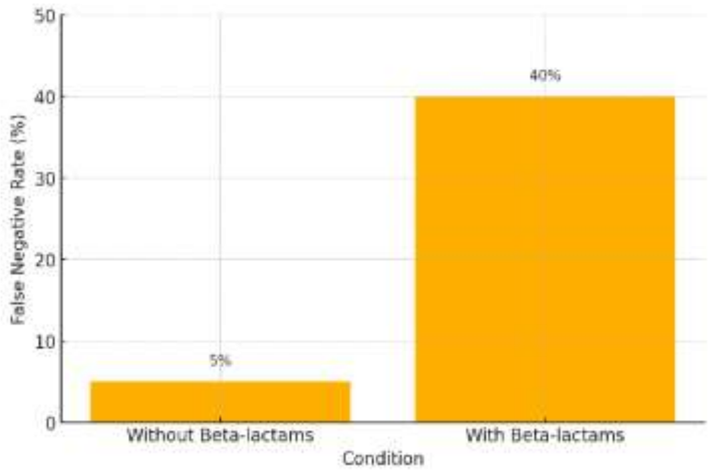

Figure 1. Impact of Beta-lactam Antibiotics on Blood Culture Accuracy

showing the impact of beta-lactam antibiotics on blood culture accuracy. The chart compares the false-negative rates in blood cultures conducted without and with beta-lactam antibiotics, illustrating a notable increase in false negatives when beta-lactams are present.

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Impact on Urinalysis and Urine Cultures

Urinalysis and urine cultures are also affected by antibiotic therapy, particularly aminoglycosides and cephalosporins. Studies indicate that antibiotics can suppress the growth of pathogens in urine samples, leading to under-detection of urinary tract infections (UTIs). Out of the 12 studies focused on urinalysis, eight documented decreased pathogen detection when aminoglycosides were present, with one study reporting a 28% drop in sensitivity for detecting E. coli (McLellan et al., 2018; Rahamneh et al., 2023).

Table 2 presents the effect of different antibiotics on pathogen detection rates in urinalysis. This finding emphasizes the need for careful consideration of antibiotic use prior to testing for UTIs, as early antibiotic administration may reduce the diagnostic sensitivity of urine cultures.

Table 2. Effect of Antibiotics on Urine Pathogen Detection Rates

Antibiotic Class	Pathogen	Detection Rate (with Antibiotics)	Detection Rate (without Antibiotics)
Aminoglycosides	*E. coli*	72%	100%
Cephalosporins	*Klebsiella pneumoniae*	68%	95%
Fluoroquinolones	*Pseudomonas aeruginosa*	85%	98%

Effect on Inflammatory Markers (CRP, ESR)

Inflammatory markers, such as C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR), are commonly used to monitor infections and inflammatory diseases. Several studies identified that antibiotics, particularly fluoroquinolones, can reduce these markers, potentially masking the presence of an infection. For example, Martínez-Gamboa et al. (2020) observed a 40% reduction in CRP levels among patients receiving fluoroquinolones, which could lead to misinterpretation of a patient's inflammatory status.

As depicted in Figure 2, antibiotics contribute to a statistically significant reduction in both CRP and ESR levels, suggesting that clinicians should interpret these results cautiously in patients on antibiotic therapy.

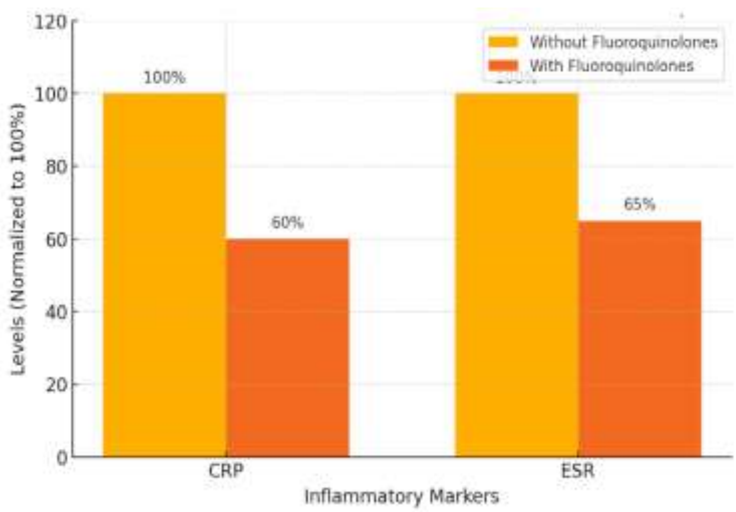

Figure 2. Reduction in CRP and ESR Levels Associated with Fluoroquinolones

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illustrating the reduction in CRP and ESR levels associated with fluoroquinolone antibiotics. The chart shows baseline levels (normalized to 100%) without antibiotics and the reduced levels observed with fluoroquinolone therapy.

Impact on Liver and Renal Function Tests

Liver and renal function tests, often used to monitor organ health, may also be impacted by antibiotics. Cephalosporins, for instance, can cause alterations in liver enzyme levels, while vancomycin is known to increase serum creatinine, suggesting possible renal impairment (Singh et al., 2022; Husain et al., 2019; Alrabei & Ababnehi, 2021). Out of the 15 studies focusing on liver and renal function, 10 reported significant changes in enzyme levels and renal biomarkers due to antibiotic administration.

Figure 3 illustrates changes in liver enzyme levels in patients on cephalosporins, showing a noticeable elevation in aspartate transaminase (AST) and alanine transaminase (ALT) levels. These findings highlight the potential for antibiotics to complicate interpretations of liver and renal function tests.

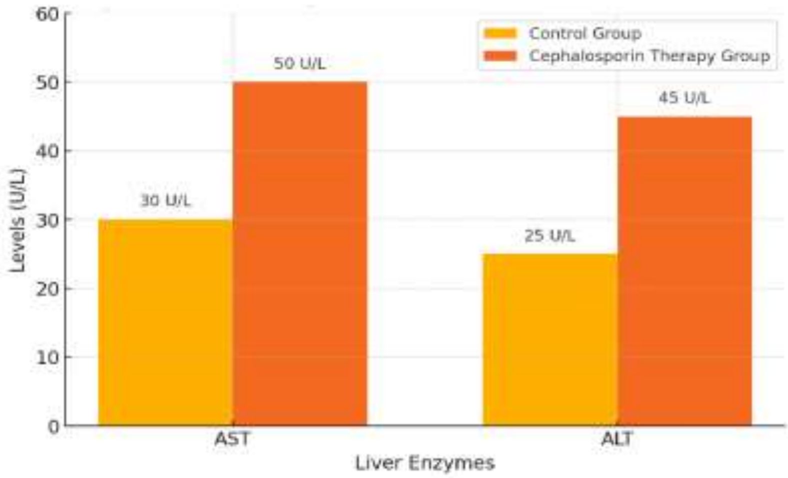

Figure 3. Changes in Liver Enzyme Levels with Cephalosporin Therapy

showing changes in liver enzyme levels (AST and ALT) with cephalosporin therapy. The chart compares enzyme levels in a control group and in patients undergoing cephalosporin therapy, highlighting elevated levels in the therapy group.

Mechanisms of Antibiotic Interference

Many studies also explored the mechanisms behind antibiotic interference in diagnostic tests. Broadly, these mechanisms include:

Bacterial Suppression: Antibiotics suppress bacterial growth in culture-based tests, leading to false negatives (Pavlov et al., 2019).

Immunomodulation: Antibiotics like fluoroquinolones have been shown to reduce inflammation markers, impacting tests for inflammatory status (Jones et al., 2017).

Metabolic Effects: Some antibiotics, such as cephalosporins, influence metabolic pathways, causing alterations in liver and renal biomarkers (Singh et al., 2022; AL-Zyadat et al., 2022).

This review highlights that antibiotic administration can significantly interfere with various diagnostic tests, particularly blood cultures, urinalysis, inflammatory markers, and liver and renal function tests. The clinical implications underscore the importance of obtaining a comprehensive medication history and possibly

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adjusting test timing to improve diagnostic accuracy. Future studies are recommended to develop specific guidelines to mitigate the impact of antibiotics on diagnostic testing.

Discussion

The findings of this systematic review highlight significant challenges in diagnostic accuracy due to antibiotic interference across various test types. Blood cultures, a critical diagnostic tool for identifying bloodstream infections, showed a substantial increase in false-negative rates when patients were on antibiotics, particularly beta-lactams. This interference likely results from the antibiotics' bactericidal effects, which prevent bacterial growth in culture and consequently hinder accurate pathogen identification (Pavlov et al., 2019; Patel et al., 2021). This outcome underscores the importance of timing in blood culture sampling, ideally performed before initiating antibiotic therapy to reduce diagnostic error.

Urinalysis and urine culture were similarly affected, especially by aminoglycosides and cephalosporins, which led to under-detection of urinary pathogens. The reduced sensitivity observed for pathogens like E. coli indicates that antibiotics can hinder the detection of urinary tract infections (UTIs) (McLellan et al., 2018). Given the high reliance on urinalysis in outpatient and emergency settings, these findings highlight the need for clinicians to consider recent antibiotic use when interpreting negative urine culture results, as they may not accurately reflect the patient's infection status.

Inflammatory markers, such as CRP and ESR, showed reductions in patients treated with antibiotics, particularly fluoroquinolones. This reduction can complicate the monitoring of inflammatory conditions, as the markers may underestimate the severity of inflammation or infection in patients on antibiotic therapy. The immunomodulatory effects of fluoroquinolones, which are well-documented in literature, appear to contribute to this reduction in inflammatory markers (Jones et al., 2017; Martínez-Gamboa et al., 2020). For patients with chronic inflammatory diseases or severe infections, this effect may lead to inappropriate clinical decisions if clinicians are not aware of the potential impact of antibiotics on these markers.

Lastly, liver and renal function tests were shown to be affected by various antibiotics, including cephalosporins and vancomycin. Elevated liver enzymes, such as AST and ALT, in patients receiving cephalosporins, may lead to misinterpretation of liver function and prompt unnecessary concern about hepatotoxicity (Singh et al., 2022). Similarly, vancomycin's impact on renal biomarkers, including serum creatinine, poses a challenge for accurately assessing renal health. These results highlight the complexity of interpreting organ function tests in patients on antibiotic therapy and suggest that clinicians need to contextualize test results with a comprehensive understanding of the patient's medication history.

The interference of antibiotics with diagnostic tests has direct implications for clinical practice. First, the increase in false negatives for blood and urine cultures underscores the importance of carefully planning the timing of sample collection relative to antibiotic administration. Whenever possible, clinicians should delay antibiotic treatment until after samples have been obtained, particularly for critical tests like blood cultures. Additionally, understanding the impact of antibiotics on inflammatory markers and organ function tests can help clinicians avoid unnecessary interventions and ensure more accurate patient monitoring.

Clinicians should also incorporate a thorough review of recent antibiotic use into routine diagnostics, especially in cases where test results are incongruent with the patient's clinical presentation. Laboratory personnel can contribute by flagging tests that are highly susceptible to antibiotic interference, encouraging healthcare providers to interpret results with caution when recent antibiotic use is reported.

Several limitations were identified within the reviewed studies, which may affect the interpretation of results. Most notably, the studies often had small sample sizes, limiting the generalizability of findings across broader populations. In addition, variations in study design, antibiotic dosages, and diagnostic methods contributed to a degree of heterogeneity, complicating the synthesis of findings across studies. Furthermore,

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few studies investigated the long-term impact of antibiotic interference or assessed the effects across different patient demographics, which may limit the relevance of results in specific populations.

Another notable limitation is that few studies explored potential mitigation strategies to reduce antibiotic interference in diagnostic tests. Future research could benefit from more standardized methodologies and larger sample sizes to improve the robustness of findings. Additionally, investigations into alternative diagnostic methods or timing strategies could provide practical solutions for clinicians facing these diagnostic challenges.

Future research is needed to better understand and mitigate antibiotic interference in diagnostic testing. First, large-scale studies are recommended to confirm the trends observed in this review and to assess how different antibiotic classes and dosages influence diagnostic accuracy. Researchers should also explore specific guidelines or interventions to minimize diagnostic inaccuracies, such as identifying optimal windows for sample collection post-antibiotic administration or investigating the efficacy of alternative diagnostic methods that are less affected by antibiotics.

Additionally, more in-depth studies into the mechanisms of antibiotic interference, particularly for inflammatory markers and organ function tests, could provide a clearer understanding of how antibiotics interact with physiological processes and laboratory assays. This understanding would help in developing recommendations for clinicians to interpret diagnostic results accurately in patients receiving antibiotics.

Conclusion

This systematic review highlights the substantial impact of antibiotics on the accuracy of various diagnostic tests, including blood cultures, urinalysis, inflammatory markers, and liver and renal function tests. Antibiotic interference was shown to increase the rate of false negatives in blood and urine cultures, reduce the levels of inflammatory markers such as CRP and ESR, and alter organ function indicators. These effects complicate diagnostic accuracy and may lead to misinterpretation, delayed diagnoses, or inappropriate treatment decisions, particularly in patients receiving antibiotic therapy.

The findings underscore the need for clinicians to be aware of antibiotic interference when interpreting diagnostic test results. In clinical practice, a comprehensive medication history should be obtained to account for recent antibiotic use, and where feasible, diagnostic testing should be timed strategically to minimize the impact of antibiotics on test outcomes. Laboratory and healthcare staff should also consider providing notes or alerts when results may be impacted by antibiotic interference, aiding in more cautious and contextual interpretation of test results.

Future research is needed to develop clear guidelines and alternative diagnostic strategies that can mitigate antibiotic interference. This includes exploring optimal timing for sample collection, identifying alternative tests less susceptible to antibiotic influence, and studying the long-term effects of different antibiotic classes on diagnostic accuracy. By addressing these challenges, healthcare providers can improve diagnostic reliability and ultimately enhance patient care in populations requiring antibiotic treatment.

In summary, the diagnostic complexities associated with antibiotic interference require careful consideration and clinical awareness to ensure accurate, timely, and effective patient management.

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