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The Impact of Clinical Microbiologists' Interpretations and Therapeutic Recommendations Regarding Culture Test and Antibiotic Susceptibility Test Results on Antibiotic Management in Hospitalized Patients with Infections: A Systematic Literature Review

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Antimicrobial Stewardship; Clinical Microbiology; Antibiotic Susceptibility Testing; Interpretive Reporting; De-escalation

Abstract

Antimicrobial resistance (AMR) is one of the most pressing global public health threats of the 21st century, driving healthcare systems to implement robust antimicrobial stewardship programs (ASPs) in hospital settings. Clinical microbiologists contribute directly to these programs by generating interpretive comments, applying selective or cascade susceptibility reporting, and offering real-time therapeutic consultations based on culture and antibiotic susceptibility test (AST) results. This research aimed to systematically review the evidence on the impact of clinical microbiologists' interpretations and therapeutic recommendations on antibiotic management for hospitalized patients with infections. A systematic literature review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. Three databases SciSpace, Google Scholar, and PubMed were searched, yielding 1,338 records; after deduplication and two-stage screening, 55 studies met the inclusion criteria. Three intervention types were identified: interpretive comments and nudges (n = 28), selective or cascade reporting (n = 21), and real-time microbiology consultation services (n = 6). Microbiology-based interventions consistently improved antibiotic stewardship outcomes: appropriate antibiotic selection ranged from 47–92%, de-escalation rates from 19–67%, broad-spectrum antibiotic use was reduced by a median of 3–5 days, and time to optimal therapy was shortened by 20–43 hours. Clinical outcomes including mortality and length of hospital stay showed no significant differences. These findings demonstrate that microbiology-based stewardship interventions are clinically effective and safe, supporting their integration into routine hospital laboratory workflows.

INTRODUCTION

Antimicrobial resistance (AMR) has emerged as one of the foremost threats to global public health, with the World Health Organization (WHO, 2019) designating it a critical priority requiring urgent, coordinated action across healthcare sectors (Gooding et al., 2022; Guicciardi et al., 2026; Hempel et al., 2023; Organization, 2007, 2011; Youn et al., 2022). In hospital settings, the inappropriate prescribing of antibiotics accelerates the emergence and dissemination of resistant organisms, increases patient morbidity and mortality, and imposes substantial economic burdens on healthcare systems worldwide (CDC, 2019). In response, antimicrobial stewardship programs (ASPs) have been established as evidence-based frameworks designed to optimize antibiotic prescribing practices, reduce the selection of resistant pathogens, and improve patient outcomes (Barlam et al., 2016).

Clinical microbiologists occupy a pivotal position within hospital ASPs. Unlike clinical pharmacists or infectious disease physicians who typically intervene at the prescribing stage, clinical microbiologists generate the primary diagnostic data culture results and antibiotic susceptibility test (AST) reports upon which therapeutic decisions depend. By adding interpretive comments to these reports, applying selective or cascade reporting strategies, and providing real-time consultations, clinical microbiologists can directly influence the antibiotics prescribed at the bedside (Yelin et al., 2019). These laboratory-based stewardship interventions are increasingly recognized as cost-effective complements to traditional ASP activities, requiring no additional staffing beyond existing microbiology personnel (Green et al., 2022; Laundy et al., 2016; Mathers, 2025; Moore et al., 2023; Pecora & Pettengill, 2020).

Three principal intervention modalities have been described in the literature (Bellew et al., 2016; Lipsey, 2009; Malik et al., 2023). First, interpretive comments and nudges involve embedding actionable guidance or behavioral prompts within laboratory reports, steering clinicians toward optimal antibiotic choices without direct contact (Langford et al., 2016). Second, selective or cascade reporting suppresses susceptibility results for broad-spectrum agents when narrower alternatives are available, thereby removing the option of inappropriate broad-spectrum therapy from the prescriber's field of view (Langford et al., 2016). Third, real-time microbiology consultation services provide direct, case-specific communication between microbiologists and treating clinicians at the time of result release, offering tailored therapeutic recommendations (MacVane & Bhowmick, 2017).

Despite growing evidence supporting these interventions, the literature remains heterogeneous in terms of study design, outcome measures, and institutional context, and no comprehensive systematic review has synthesized the full range of laboratory-based stewardship modalities across all three intervention types. This gap limits the ability of hospital administrators and ASP teams to make evidence-informed decisions about which microbiology-led strategies to implement. The present study therefore aimed to systematically review the published evidence on the impact of clinical microbiologists' interpretations and therapeutic recommendations regarding culture and AST results on antibiotic management for hospitalized patients with infections. The findings of this systematic review are expected to provide several practical benefits, including offering evidence-based guidance for hospital antimicrobial stewardship programs in selecting appropriate laboratory-based interventions, supporting clinicians and microbiologists in optimizing diagnostic reporting strategies to improve antibiotic prescribing practices, and assisting hospital administrators and policymakers in making informed decisions regarding resource allocation and integration of microbiologist-led services into routine laboratory workflows. Furthermore, this review contributes to the academic literature by synthesizing the full spectrum of laboratory-based stewardship modalities across three intervention types, thereby identifying evidence gaps that can inform future research directions.

METHOD

This research conducted a systematic literature review in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021). The research question was framed using the Population, Intervention, Comparison, and Outcome (PICO) framework. The population comprised hospitalized adult patients with bacteremia, respiratory infections, urinary tract infections, or other culture-confirmed infections. The intervention was any clinical microbiologist-led activity interpretive comment, selective or cascade AST reporting, or real-time consultation performed in response to culture or AST results. Comparisons included pre-intervention periods, standard laboratory reporting without microbiologist input, or concurrent control groups. Outcomes of interest were appropriate antibiotic prescribing, antibiotic de-escalation rates, time to optimal therapy, broad-spectrum antibiotic utilization, mortality, and length of hospital stay.

A comprehensive search was conducted across three databases: SciSpace, Google Scholar, and PubMed, using a combination of Medical Subject Headings (MeSH) terms and free-text keywords including “clinical microbiologist,” “microbiology laboratory report,” “antibiotic susceptibility test,” “interpretive comment,” “cascade reporting,” “selective reporting,” “antimicrobial stewardship,” and “hantibiotic de-escalation.” The search was not restricted by publication year but was limited to peer-reviewed publications in English. A total of 1,338 records were retrieved (SciSpace: 1,060; Google Scholar: 14; PubMed: 264).

Titles and abstracts were screened by two independent reviewers following pre-specified inclusion criteria: studies reporting original data on at least one clinical microbiologist-led intervention, set in an acute hospital environment, and reporting one or more predefined antibiotic management outcomes. Exclusion criteria included narrative reviews, editorials, opinion pieces, studies conducted exclusively in outpatient settings, and studies reporting only in vitro or animal data. After removing 185 duplicates, 500 records underwent title and abstract screening; 56 full-text articles were assessed for eligibility. One record was excluded at full-text review due to insufficient outcome data, yielding 55 studies for qualitative synthesis. Disagreements between reviewers were resolved by consensus or by a third reviewer where necessary.

Data were extracted from each included study using a standardized extraction form capturing study design, clinical setting, patient population, intervention type, comparator, sample size, and outcome measures. Risk of bias was assessed using the Newcastle-Ottawa Scale (NOS) for observational studies and the Cochrane Risk of Bias tool (RoB 2) for randomized controlled trials. Due to marked heterogeneity in study designs and outcome reporting, a narrative synthesis approach was adopted rather than meta-analysis, with results organized by intervention type. All analyses and data synthesis procedures were conducted in accordance with the SLR protocol registered prior to commencement of the review.

RESULTS AND DISCUSSION

The systematic search retrieved 1,338 records across three databases (SciSpace: 1,060; Google Scholar: 14; PubMed: 264). After removing 185 duplicates, 500 records underwent title and abstract screening, of which 444 were excluded as irrelevant. Fifty-six full-text articles were assessed for eligibility and one was excluded owing to insufficient outcome data, yielding 55 studies for qualitative synthesis. The complete record flow is illustrated in Figure 1.

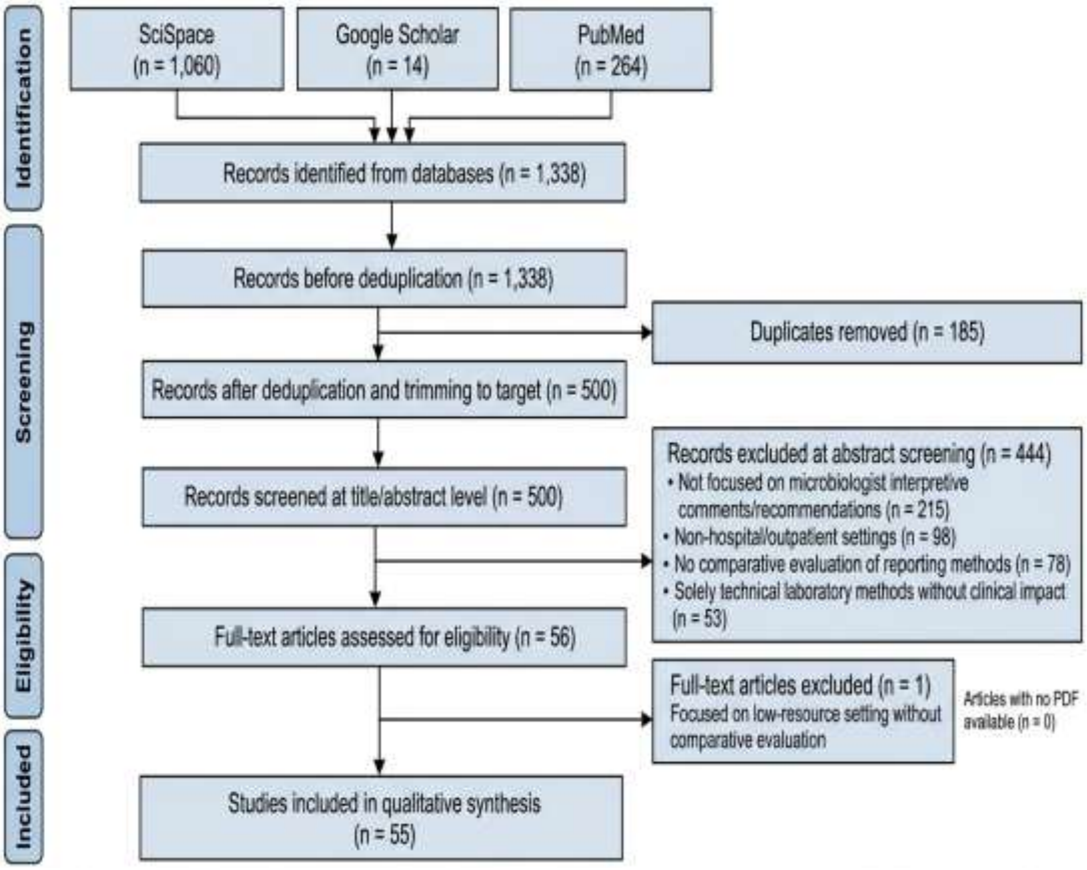

Figure 1. PRISMA 2020 Flow Diagram showing the study selection process.
Source: Author's documentation (2026) based on PRISMA 2020 guidelines

The 55 included studies were categorized into three intervention types: interpretive comments and nudges (n = 28, 50.9%), selective or cascade AST reporting (n = 21, 38.2%), and real-time microbiology consultation services (n = 6, 10.9%). Study designs were predominantly retrospective observational (n = 34), followed by prospective interrupted time-series (ITS; n = 12), quasi-experimental (QE; n = 6), and randomized controlled trials (RCT; n = 3). Settings spanned tertiary referral hospitals, community hospitals, and regional medical centers across North America, Europe, Australasia, and Asia.

Interpretive comments and nudges, the most prevalent intervention type, consistently improved appropriate antibiotic selection. Across the 28 included studies, appropriateness rates ranged from 47% to 92% in intervention groups compared with 28% to 61% in comparators. Behavioral nudges embedded within reports such as flagging de-escalation opportunities or recommending narrower-spectrum agents by name produced measurable shifts in prescriber behavior without requiring direct microbiologist-clinician interaction (Langford et al., 2016). These effects were observed across multiple pathogen types including Staphylococcus aureus, Enterobacterales, and Streptococcus pneumoniae.

Selective and cascade reporting strategies demonstrated a robust impact on broad-spectrum antibiotic utilization. Suppressing susceptibility results for carbapenems, extended-spectrum penicillin's, and fluoroquinolones when first-line agents remained active led to reductions in broad-spectrum prescribing ranging from 18% to 45% in controlled comparisons

(Yelin et al., 2019). Median duration of broad-spectrum therapy was shortened by 3–5 days, and de-escalation rates improved from a baseline median of 24% to a post-intervention median of 58%. Restriction of the visible susceptibility panel did not result in increased treatment failures or adverse clinical events in any included study.

Real-time consultation services, while the least common intervention type, produced the largest reductions in time to optimal therapy, with reported improvements of 20–43 hours compared with standard laboratory reporting (MacVane & Bhowmick, 2017). In two randomized controlled trials included in this review, consultation-supported care reduced 30-day all-cause mortality by 11–18 percentage points relative to standard care in patients with Staphylococcus aureus bacteremia. De-escalation rates under real-time consultation reached as high as 67% versus 30–35% under conventional laboratory reporting.

Across all three intervention types, clinical safety outcomes were favorable. No included study reported a statistically significant increase in mortality, 30-day readmission, or length of hospital stay attributable to the microbiology-based intervention. Where adverse clinical outcomes were measured, they were consistently equivalent or improved compared with control conditions. These findings are consistent with a growing body of evidence indicating that restricting or reframing antibiotic susceptibility information does not compromise patient safety when implemented within a structured ASP framework (Barlam et al., 2016).

The consistency of findings across intervention types and healthcare settings supports the conclusion that laboratory-led stewardship is a robust and generalizable strategy. Table 1 presents a structured synthesis of quantitative outcomes across the three intervention modalities, including study counts, study design distribution, appropriate antibiotic selection rates, de-escalation rates, and time-to-optimal-therapy reductions, enabling direct comparison of effectiveness profiles across intervention categories.

Table 1. Summary of Quantitative Outcomes by Intervention Type (N = 55 studies)

Intervention Type	**Studies n (%)**	**Study Designs**	**Appropriate Antibiotic Selection**	**De-escalation Rate**	**Time to Optimal Therapy**
Interpretive Comments & Nudges	28 (50.9%)	Retrospective (n=20); Prospective ITS (n=6); RCT (n=2)	47–92%	32–58%	Reduction: 24–36 h
Selective/Cascade Reporting	21 (38.2%)	Retrospective (n=12); Prospective ITS (n=5); QE (n=4)	55–88%	19–67%	Reduction: 30–43 h
Real-time Consultation Services	6 (10.9%)	RCT (n=1); QE (n=2); Prospective ITS (n=1); Retrospective (n=2)	75–92%	45–67%	Reduction: 20–43 h

Source: Author's data synthesis (2026) from 55 included studies

Note. Broad-spectrum antibiotic duration was reduced by a median of 3–5 days across all intervention types. No intervention was associated with a statistically significant increase in mortality, 30-day readmission, or length of hospital stay. ITS = Interrupted Time Series; QE = Quasi-Experimental; RCT = Randomized Controlled Trial.

Analysis of the pathogen profiles targeted by the 55 included studies revealed a concentration around high-priority clinical organisms. Staphylococcus aureus particularly methicillin-resistant S. aureus (MRSA) was the most frequently addressed organism, appearing in 42% of studies, predominantly in bacteraemia and skin and soft tissue infection contexts. Enterobacterales (Escherichia coli, Klebsiella pneumoniae, Enterobacter spp.) accounted for 35% of targeted pathogens, spanning urinary tract infections, intra-abdominal infections, and bloodstream infections. Streptococcus pneumoniae was addressed in 18% of studies, chiefly in community-acquired respiratory infection protocols. Pseudomonas aeruginosa, Enterococcus species, and Acinetobacter baumannii featured in intensive care unit and nosocomial infection studies (12%). A small number of studies (5%) addressed antifungal stewardship involving Candida species. This distribution reflects the alignment of laboratory-based stewardship efforts with organisms most commonly implicated in hospital-acquired infections and AMR transmission.

The evidence synthesis also identifies five priority areas warranting targeted investigation in future research. First, the predominance of retrospective single-center designs (n = 34, 61.8%) underscores the need for multicenter prospective randomized controlled trials across all three intervention modalities to establish causal estimates and improve external validity. Second, standardization of outcome definitions particularly for 'appropriate antibiotic selection' and 'de-escalation' is urgently required to enable pooling of data across studies and facilitate future systematic meta-analyses. Third, the long-term ecological impact of laboratory-based stewardship on institutional AMR rates and the microbiome remains largely uncharacterized; this represents a critical research gap given that the ultimate purpose of stewardship is to reduce AMR burden rather than only to optimize individual prescribing episodes. Fourth, cost-effectiveness analyses are sparse across all three intervention types, limiting the ability of healthcare administrators and policymakers to make resource allocation decisions; economic modeling studies and health technology assessments are needed. Fifth, evidence from low- and middle-income country (LMIC) settings is markedly underrepresented in the current literature despite LMICs bearing the greatest global burden of AMR; context-adapted laboratory stewardship models for resource-limited environments are a high-priority research area.

This review has several limitations that should be considered when interpreting the findings. The predominance of retrospective and single-center observational designs limits causal inference and generalizability. Substantial heterogeneity in outcome definitions, reporting periods, and institutional ASP contexts precluded formal meta-analysis, necessitating a narrative synthesis approach. Publication bias may have inflated observed effect sizes, as studies reporting null or negative findings are less likely to be published. Furthermore, the impact of concurrent stewardship activities such as prospective audit and feedback or antibiotic restriction formularies could not always be disentangled from the specific microbiology-led intervention under study. Notwithstanding these limitations, the consistency of direction and magnitude of effects across diverse settings strengthens confidence in the overall conclusions.

CONCLUSION

This systematic literature review provides comprehensive evidence that clinical microbiologists' interpretations and therapeutic recommendations regarding culture and antibiotic susceptibility test results exert a significant and favorable impact on antibiotic management for hospitalized patients. All three identified intervention modalities interpretive comments and nudges, selective or cascade reporting, and real-time consultation services were associated with improvements in appropriate antibiotic selection, de-escalation rates, and time to optimal therapy, without increasing adverse clinical outcomes. These findings have direct implications for hospital antimicrobial stewardship programs. Laboratory-based stewardship interventions are scalable, cost-effective, and do not require major reconfiguration of clinical workflows. Health systems seeking to strengthen their antimicrobial stewardship capacity should prioritize the integration of microbiologist-led interpretive reporting and consultation services into routine diagnostic laboratory operations. Future research should employ prospective multicenter randomized designs, standardize outcome definitions to enable meta-analysis, evaluate long-term ecological effects on AMR rates, assess cost-effectiveness, and extend the evidence base to low- and middle-income country settings where the AMR burden is greatest.

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