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Antimicrobial Stewardship: Integrating Diagnostics and Data-Driven Solutions for a Resilient Future

Editorial by :

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The landscape of healthcare is rapidly evolving, with diagnostic innovation, health equity, and the strategic value of laboratory services emerging as critical focal points. These themes, prominently featured at the Association for Diagnostics and Laboratory Medicine (ADLM) 2024 conference, are not only influencing the future of laboratory medicine but also have profound implications for global health challenges. Among these challenges, antimicrobial resistance (AMR), which is primarily driven by the excessive use of antimicrobials, stands out as an urgent concern that threatens to undermine decades of medical progress. A recent nationwide survey conducted in China from 2017-2019 found that 70.5% of all outpatient antibiotic prescriptions were inappropriately prescribed.[1]

To combat AMR, antimicrobial stewardship (AMS) initiatives have been developed to ensure availability of lifesaving drugs for current and future populations, and often take shape as formalized programs within hospital settings.[2] Evidence indicates that robust AMS programs around the globe were associated with a 10.5% reduction in all-cause mortality and an 11.3% decrease in infection-related mortality.[3]

Diagnostic-Driven Innovation

Fast and accurate diagnostic technologies are critical for informed clinical decision-making and optimized antimicrobial therapy, spurring AMS success. By swiftly identifying the causative pathogens and their resistance profiles, clinicians can initiate appropriate treatments much earlier – often within hours instead of days, thereby reducing unnecessary antibiotic usage and facilitating informed de-escalation of therapy.[4]

Recent advancements in molecular identification, antimicrobial susceptibility testing (AST), and multiplex PCR tests have significantly enhanced AMS initiatives, promoting more judicious prescribing practices.[5]

These innovative technologies aim to minimize delays and reduce misdiagnoses, ultimately enhancing antibiotic prescribing among healthcare providers and improving patient outcomes. One study demonstrated that the integration of fast molecular diagnostics identification with AMS programs resulted in antibiotic de-escalation occurring 19 hours sooner than traditional testing methods, leading to a 25% reduction in broad-spectrum antibiotic days of therapy.[6]

The scientific community has also increasingly recognized machine learning (ML) and artificial intelligence (AI) as pivotal advancements for AMS success. ML algorithms can analyze patterns in antimicrobial usage and resistance data to forecast which microorganisms are likely to develop resistance, facilitating the timely initiation of targeted therapies. Concurrently, AI models can process extensive datasets on antimicrobial use and resistance to identify emerging resistance trends and outbreaks.[7] For example, the adoption of real-time antibiogram data has demonstrated significant advantages. Access to timely antibiogram data allows for the ongoing monitoring of resistance patterns and localized trends, enabling healthcare providers to make informed decisions regarding patient therapy and antimicrobial prescribing.[8]

Data & IT analytics are also empowering AMS program efficiency by streamlining the monitoring of key processes and outcomes metrics, which helps pinpoint areas for improvement and assess the impact of interventions. The integration of these technologies into clinical practice is expected to enhance decision-making, leading to more effective patient therapy management and improved outcomes.[9]

Despite the potential benefits, because AMS maturity varies by region and even location, the adoption and integration of AI and ML can vary considerably. Traditional regression techniques, such as linear and logistic regression, have long been the foundation of predictive modeling in this domain. As AMS programs continue to evolve, exploring the unprecedented potential of AI and ML could significantly enhance predictive capabilities and improve patient care around the globe.[10]

Health Equity in Antimicrobial Stewardship

Budgetary constraints often pose serious barriers to the adoption of diagnostic and data-driven solutions for AMS, particularly in resource-limited healthcare settings or low- and middle-income countries (LMICs). Due to the global implications of AMR, ensuring access to fast and actionable diagnostic tools, along with adequate training and staffing in low-resource settings, is vital for improving patient outcomes and mitigating further risks. Investment in these areas is essential to prevent the global spread of AMR through international trade and travel.[11]

Recent studies highlight disparities in antimicrobial prescribing associated with geography, healthcare setting, and patient characteristics, exemplifying the need for adaptable AMS solutions.[12] To address these disparities, analysis of local needs, prescription patterns, and use of interventions that serve available resources, point-of-care (POC) diagnostics are emerging as powerful tools — helping democratize access to timely diagnosis and targeted antibiotic prescribing in resource-limited settings by reducing barriers to testing across patient populations and minimizing variation in prescribing practices.[12]

Strategic Value of Diagnostics and Data for Antimicrobial Stewardship

Diagnostic stewardship, which involves ensuring that the right tests are ordered for the right patients at the right time, serves as the upstream lever that drives appropriate antibiotic prescribing, distribution, and AMS initiatives. Leveraging accurate and timely diagnostic results can aid clinicians in making informed therapy decisions about when and what antibiotics are appropriate for a particular patient, reducing unnecessary use or misuse and helping combat AMR.

The integration of diagnostics and data with comprehensive AMS programs has shown substantial benefits, including lower mortality rates, reduced hospital length of stay,[3] and fewer adverse drug events[14] associated with antibiotic overuse. In addition to enhancing clinical outcomes, recent studies indicate that the implementation of diagnostic tools yielded organizational economic advantages in 71.3% of cases.[15]

Integrating laboratory data and next-generation sequencing (NGS) with multiplex PCR testing into clinical decision support systems (CDSS) represents a promising approach to mitigating AMR.[16] For example, alerts triggered by confirmed laboratory results could be utilized alongside standardized order sets and treatment algorithms, creating opportunity for healthcare providers to make more timely, informed decisions regarding antimicrobial therapy, thereby enhancing patient safety. Employing predictive analytics for proactive AMS interventions also allows for early identification of at-risk patients, optimizing empiric therapy and forecasting treatment outcomes.[15]

It is important to note that the impact of fast and accurate diagnostics varies depending on local resistance rates, antibiotic prescribing practices, patient populations, and the availability of stewardship programs. To fully realize the benefits of diagnostic stewardship, we must integrate these efforts with robust AMS programs.

An effective AMS program should include representation from various disciplines, and clinical microbiology labs should be recognized for their pivotal role — providing essential diagnostic and surveillance data. The involvement of laboratory staff in AMS teams enhances communication of critical results, improves interpretation of complex microbiological data, and supports clinicians in making informed therapy decisions.[17] Within healthcare systems, clinicians, pharmacists, and laboratory professionals should work together to establish guidelines that drive appropriate diagnostics use, reporting, and AMS best practices, enabling better understanding and optimization of antibiotic therapies for improved patient outcomes.

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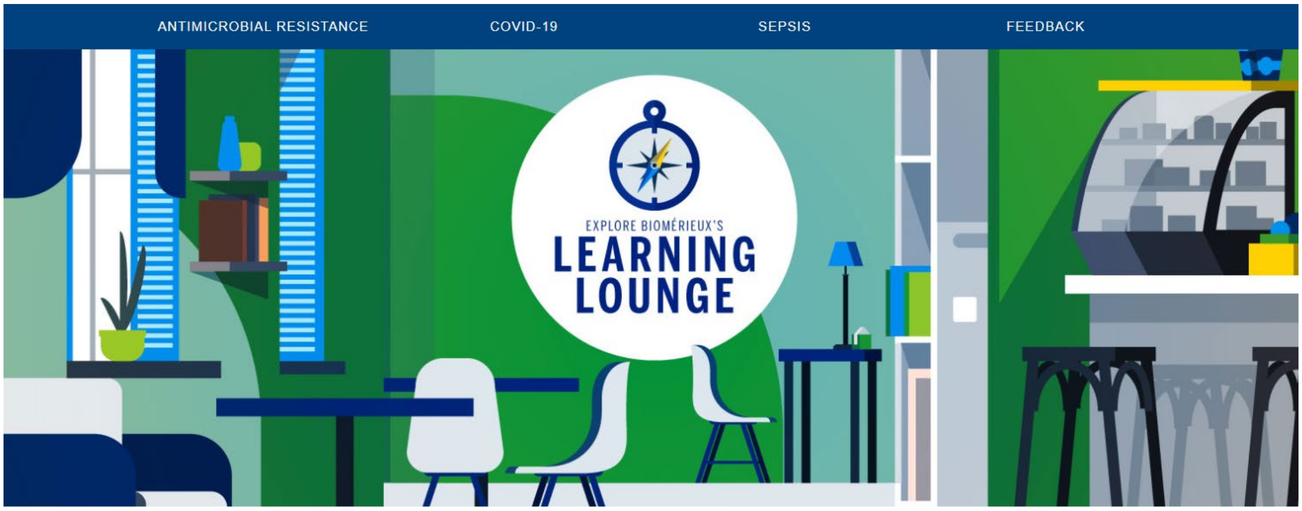

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