Archives of Microbiology (2024) 206:409
https://doi.org/10.1007/s00203-024-04131-z

REVIEW

Phenotypic and genotypic perspectives on detection methods for bacterial antimicrobial resistance in a One Health context: research progress and prospects

Bingbing Yang[1,2] · Xiaoqi Xin[1,2] · Xiaoqing Cao[3] · Lubanga Nasifu[3,4] · Zhenlin Nie[3] · Bangshun He[1,3]

Received: 29 July 2024 / Revised: 3 September 2024 / Accepted: 4 September 2024 / Published online: 20 September 2024

Abstract

The widespread spread of bacterial antimicrobial resistance (AMR) and multidrug-resistant bacteria poses a significant threat to global public health. Traditional methods for detecting bacterial AMR are simple, reproducible, and intuitive, requiring long time incubation and high labor intensity. To quickly identify and detect bacterial AMR is urgent for clinical treatment to reduce mortality rate, and many new methods and technologies were required to be developed. This review summarizes the current phenotypic and genotypic detection methods for bacterial AMR. Phenotypic detection methods mainly include antimicrobial susceptibility tests, while genotypic detection methods have higher sensitivity and specificity and can detect known or even unknown drug resistance genes. However, most of the current tests are either genotypic or phenotypic and rarely combined. Combining the advantages of phenotypic and genotypic methods, combined with the joint application of multiple rapid detection methods may be the trend for future AMR testing. Driven by rapid diagnostic technology, big data analysis, and artificial intelligence, detection methods of bacterial AMR are expected to constantly develop and innovate. Adopting rational detection methods and scientific data analysis can better address the challenges of bacterial AMR and ensure human health and social well-being.

Keywords Antimicrobial resistance · Genotypic detection methods · Phenotypic detection methods · Resistance testing

Introduction

Since the discovery of penicillin by Alexander Fleming in 1928 (Fleming 2001), antimicrobials have been key drugs in clinical to deal with bacterial infection. Mechanically, antimicrobials can kill or inhibit bacterial growth by inhibiting the construction of the bacterial cell wall, destroying the integrity of the cell membrane, affecting the metabolism of dihydrofolate or nucleic acid, and acting on the 30–50 S subunit of the bacterial ribosome to inhibit protein synthesis, etc. (Coates et al. 2002; Kohanski et al. 2010). Antimicrobials have been widely used in the medical field to treat various diseases caused by bacterial infections, such as diarrhea, tuberculosis and sepsis (Ben et al. 2019; Kaushal et al. 2023). Antimicrobials have saved countless lives due to their powerful antibacterial activity. However, the overuse and misuse of antimicrobials have led to the development of resistance in the targeted bacteria (Spagnolo et al. 2021). Due to specific structure or activity, some bacteria present intrinsic resistance to certain types of antimicrobials,

Communicated by Yusuf Akhter.

✉ Zhenlin Nie
zhenlinnie@126.com

✉ Bangshun He
bhe@njmu.edu.cn

[1] Department of Laboratory Medicine, Nanjing First Hospital, China Pharmaceutical University, Nanjing 210006, China

[2] Department of Clinical Pharmacy, School of Basic Medicine and Clinical Pharmacy, Pharmaceutical University, Nanjing 211198, China

[3] Department of Laboratory Medicine, Nanjing First Hospital, Nanjing Medical University, Nanjing 210006, China

[4] Department of Biology, Muni University, Arua, Uganda