International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2025: 7.089

Blood Culture Identification (BCID) Biofire: A Promising Multiplex PCR Approach for Early Detection of Bloodstream Infection

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Abstract: ***Rapid identification of bloodstream pathogens is important for timely antimicrobial therapy and effective antimicrobial stewardship. The BioFire Blood Culture Identification Panel uses multiplex PCR to identify selected bacterial and fungal pathogens and antimicrobial resistance markers from positive blood cultures within a short turnaround time. Its major advantages include rapid organism identification, simultaneous detection of selected resistance markers, and potential support for earlier optimization of antimicrobial therapy. Important limitations include dependence on positive blood cultures, restricted target coverage, detection of nucleic acid from non-viable organisms, and cost considerations. Appropriate interpretation alongside conventional culture and antimicrobial susceptibility testing remains essential. Overall, the BCID approach provides a useful rapid molecular complement to conventional diagnostic methods for bloodstream infections.***

Keywords: Bloodstream infection; BioFire BCID; multiplex PCR; antimicrobial resistance; rapid diagnostics; antimicrobial stewardship

1. Introduction

The Biofire BCID (Blood Culture Identification) Panel is a rapid molecular diagnostic tool in clinical diagnostics, designed to quickly and accurately identify pathogens in blood cultures. This innovation is a game-changer in the field of microbiology, especially when it comes to the urgent need for early diagnosis of bloodstream infections (BSIs), which can lead to severe conditions like sepsis.

The Biofire BCID Panel is based on multiplex PCR technology, which allows it to identify a wide range of pathogens and resistance genes directly from positive blood cultures. Using Biofire's proprietary FilmArray platform, the panel provides results in just 1 to 1.5 hours, a significant improvement over traditional blood culture methods that can take anywhere from 24 to 72 hours or more.

This test can detect more than 29 different pathogens, including bacteria and fungi, as well as over 10 key antimicrobial resistance (AMR) markers. These include well-known resistance genes like mecA/C and MREJ (which confers methicillin resistance in staphylococci), CTX-M (ESBL resistance), mcr-1 (colistin resistance), van A/B (vancomycin resistance) and bla IMP/KPC/OXA-48/NDM/VIM (which is associated with carbapenem resistance) [1-2]

The panel covers most of the major organisms that are typically involved in bloodstream infections (BSIs).

2. Methodology

A comprehensive literature search was conducted using databases including PubMed, Scopus, and Google Scholar to identify relevant peer-reviewed studies, clinical guidelines, and technical documentation regarding multiplex PCR blood culture identification panels and conventional diagnostic workflows. Search terms included "blood culture identification panel," "multiplex PCR," "bloodstream infection," "antimicrobial stewardship," and "phenotypic susceptibility testing." Articles and manufacturer specifications were selected based on diagnostic accuracy, procedural methodology, relevance to bloodstream infection management, and technical specifications.

3. Key Features and Advantages:

1) Fast Results:
The BCID Panel provides results in under 1.5 hours, allowing for the timely identification of pathogens and the early initiation of appropriate treatment. This rapid turnaround is particularly critical for patients who are critically ill, as it helps prevent delays in the administration of life-saving therapies.

2) Comprehensive Pathogen Coverage:
The panel tests for a broad range of bacteria, fungi, and key resistance markers, which greatly reduces the chances of missing any significant pathogens. This comprehensive coverage ensures that clinicians have a full picture of what might be causing the bloodstream infection.

3) Detection of Resistance Genes:
One of the standout features of the BCID Panel is its ability to detect antimicrobial resistance (AMR) markers. This is crucial for guiding the selection of the right antibiotics, particularly in the era of rising antibiotic resistance. By identifying resistance patterns early, the panel supports targeted therapy and helps prevent the unnecessary use of broad-spectrum antibiotics.

4) User-Friendly System:
The FilmArray system is simple to operate, requiring minimal intervention from laboratory personnel. Once the sample is loaded into the system, the test runs autonomously, making it easy to integrate into daily clinical workflows without requiring extensive training or time-consuming steps.

5) Minimal Sample Volume:
The BCID Panel uses only a small amount of sample of 0.2µL from a positive blood culture bottle, making it less invasive for patients and more convenient for lab personnel. This smaller sample requirement also streamlines testing processes.

4. Clinical Impact and Importance:

The Biofire BCID Panel has the potential to significantly improve both patient outcomes and healthcare efficiency in hospitals:

1) Improved Patient Outcomes:
Timely and accurate identification of pathogens means that healthcare providers can begin appropriate treatment more quickly. This reduces the risk of complications and improves survival rates for patients with sepsis or other serious bloodstream infections.

2) Antimicrobial Stewardship:
The rapid detection of resistance genes supports the responsible use of antibiotics, promoting antimicrobial stewardship. By quickly identifying resistance patterns, clinicians can de-escalate unnecessary broad-spectrum antibiotic use, which in turn helps reduce the spread of antibiotic-resistant infections [3].

3) Operational Efficiency:
The speed of the BCID Panel also contributes to hospital efficiency. It shortens the length of patient stays, reduces the need for ICU admissions, and decreases the costs associated with prolonged antibiotic use and unnecessary diagnostic testing [4].

4) Public Health Benefits:
By aiding in the more judicious use of antibiotics, the BCID Panel also plays a role in the larger battle against antimicrobial resistance. It helps minimise the overuse of antibiotics, which is a significant global health challenge.

5. Challenges and Limitations

Despite its many benefits, the BCID Panel is not without its challenges:

1) Cost Considerations:
The upfront cost of the system and the per-test expenses can be quite high. This might limit its availability in resource-limited settings, particularly in lower-income countries or (tier2 or tier 3) smaller hospitals with tight budgets.

2) Dependence on Positive Blood Cultures:
The BCID Panel can only be used when blood cultures are positive, meaning it may not be effective for patients with low bacterial loads or those who do not have positive blood cultures. This could delay diagnosis in some cases.

3) Limited organism Detection:
BCID provides false positive results as it may contain non-viable organisms.

4) Limited Resistance Gene Detection:
While the BCID Panel tests for several key resistance genes, it does not cover every possible resistance mechanism. As bacterial resistance evolves, there may be emerging resistance markers that are not included in the current panel.

a) BCID can test blood culture media that contains charcoal which may contain non-viable organisms and / or nucleic acid.
b) A negative result doesn't exclude the possibility of blood stream infection as the sample can contain inhibitors, sample mix-up, technical errors or by an other pathogen that can not be detected by the panel.

6. Conclusion

The BioFire BCID Panel provides rapid molecular identification of selected bloodstream pathogens and antimicrobial resistance markers from positive blood cultures. Its short turnaround time can support earlier clinical decision-making and antimicrobial stewardship when results are interpreted together with conventional microbiological findings. Important limitations include restricted target coverage, dependence on positive blood cultures, potential detection of nucleic acid from non-viable organisms, and cost. Continued expansion and evaluation of molecular targets may further strengthen the clinical utility of rapid blood culture identification systems.

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