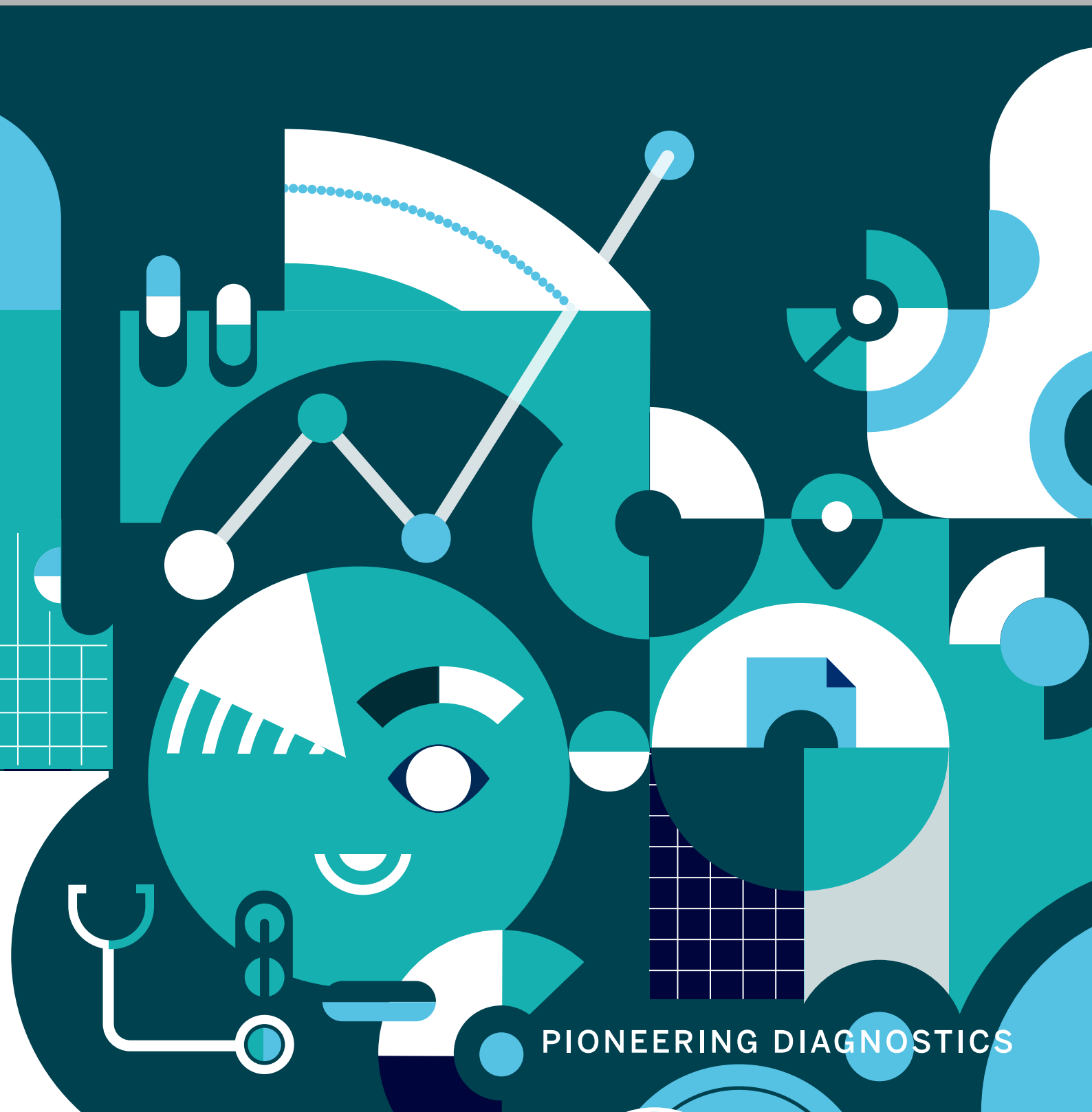
BIOMÉRIEUX

COST-EFFECTIVE DIAGNOSTICS FOR HOSPITAL INFECTION MANAGEMENT

Selection of publications

2025 EDITION



PIONEERING DIAGNOSTICS

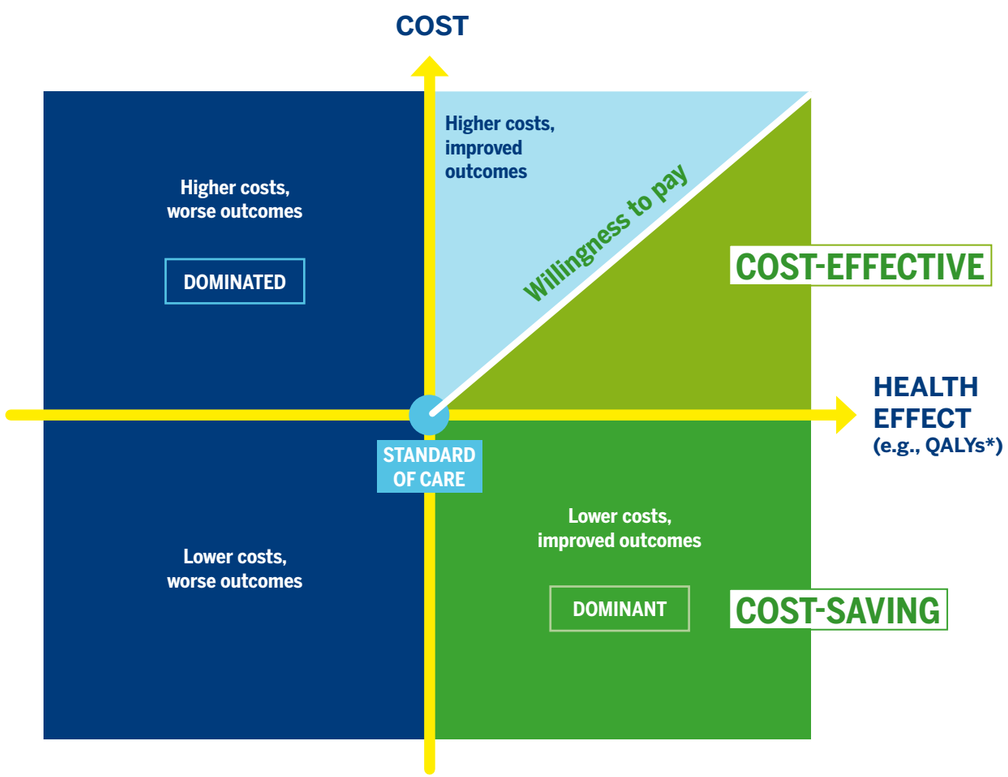
“Accurate and early diagnosis is essential to optimize health outcomes and reduce long-term costs. Economic evaluation of new diagnostic technologies should therefore be a priority for health systems.”

Professor **Lieven Annemans**

THE BASIS OF HEALTH ECONOMICS: *BEST HEALTH VALUE FOR MONEY*

The cost-effectiveness plane is a simple and widely used graphic that compares costs (and savings) with the health effects of alternative interventions.

Figure 1. Cost-effectiveness plane: quadrant strategies



*QALY : Quality-Adjusted Life Years

PREFACE

The overall goal of health systems is to make the **best use of the limited healthcare funds available** in order to **enhance health and provide optimal healthcare**[1]. To achieve that goal, it is recommended that health systems should follow 3 crucial guiding principles[2]:

- Promote **high quality of care**, with a focus on a *preventive* approach wherever possible and with closer *coordination* between all those involved;
- Ensure **universal access** to care for people's health, based on principles of *fairness* and *solidarity*;
- Guarantee the **financial sustainability** of the system, by ensuring *proper funding*, applying a *sustainable growth rate of expenditure* and improving the *effectiveness and efficiency* of the system.

The underlying principle can be seen as **maximizing value for money** by selecting the optimal mix of services subject to the budget constraints faced by the system.

This **Selection of Publications** provides an extensive overview of the **value for money provided by fast innovative diagnostics in the field of infectious diseases,** in particular in the hospital setting. The general rationale is that better diagnostics lead to better clinical decisions and patient outcomes, whereas the enhanced rapidity leads to better patient flows and faster decision-making. Both features eventually lead to better outcomes for patients and cost-savings for hospitals or healthcare systems. This is confirmed in the large majority of the selected papers, which cover a variety of healthcare settings, types of infections, and target populations across the globe. Hence, several types of study designs have been applied and, in most studies, the aim was to reflect the real-life situation as much as possible.

Of importance, in most of the papers, **sensitivity analyses** have been conducted in order to demonstrate the robustness of the outcomes. In low and middle income countries (LMICs), the impact might be larger because the more challenges the current standard of care faces, the larger the potential room for improvement when better diagnosis and care is applied. A particular benefit that was addressed in some of the studies is the **appropriate use of antibiotics**, hence contributing to limit antimicrobial resistance (AMR). Of note, in those studies where, in addition to better diagnostics, antimicrobial stewardship (AMS) was also involved, better health economic outcomes were systematically observed.

A key challenge with such assessments, however, is the **impact of different perspectives**. For instance, if readmissions to the hospital can be avoided, this may be beneficial from a healthcare payer perspective, such as a health insurer or a national health service, but not from the hospital perspective since the new admission might again be a source of income. It is therefore crucial for efficient health systems that **the financial incentives for all stakeholders are aligned.** A possible payment model is Pay for Performance, whereby good practice and desired outcomes are rewarded[3].

Hence, the current selection is of **relevance for clinicians, hospital administrators, and health policy makers**. It is their joint task to co-create better health systems for the benefit of all.

Professor Lieven Annemans,
Senior Professor of Health Economics,
Faculty of Medicine, Ghent University, Belgium

[1] Thomas R. and Chalkidou K. Health system efficiency. How to make measurement matter for policy and management. Chapter 6. Cost-effectiveness analysis. Editors: Cylus J., Papanicolas I. and Smith P.C. European Observatory on Health Systems and Policies, 2016. https://www.ncbi.nlm.nih.gov/books/NBK436888/ Accessed January 9, 2025.

[2] Commission of the European Communities. COM 304. Modernising social protection for the development of high-quality, accessible and sustainable health care and long-term care: support for the national strategies using the "open method of coordination". 2004. https://ec.europa.eu/employment_social/soc-prot/healthcare/com_04_304_en.pdf Accessed January 9, 2025

[3] Vokes RA, Bearman G, Bazzoli GJ. Hospital-Acquired Infections Under Pay-for-Performance Systems: an Administrative Perspective on Management and Change. *Curr Infect Dis Rep.* 2018;20 (9):35. doi: 10.1007/s11908-018-0638-5

THE CRUCIAL ROLE OF DIAGNOSTICS FOR COST-EFFECTIVE MANAGEMENT OF HOSPITAL INFECTIONS

1. THE BURDEN OF INFECTIONS IN HOSPITALS

The management of infections plays a significant role in today's hospital activities. This involves both the care of a certain number of patients presenting with suspected community-acquired infections (CAIs), such as acute respiratory diseases or acute urinary tract infections, as well as hospital-acquired infections (HAIs).

- It is estimated that **CAIs are the 3rd top reason for Emergency Department (ED) visits** resulting in hospital admission[1].
- On the other hand, **HAIs affect more than 1.4 million patients worldwide every year** at any time in developed and developing countries[2].

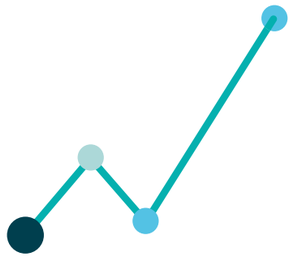
HAIs are the most frequent adverse event in healthcare, leading to prolonged hospital stays, long-term disability, increased resistance of microorganisms to antimicrobials, additional costs for health systems as high as €7 billion per year in the EU, and unnecessary deaths[3].

The burden of HAIs is particularly severe in low- and middle-income countries (LMICs), where the incidence rates are several times higher than in high-income countries (HICs). For instance, out of every 100 patients in acute-care hospitals, fifteen patients will acquire at least one HAI during their hospital stay in LMICs, versus seven in HICs. On average, one in every ten affected patients will die from their HAI[4].

The impact of HAIs extends beyond patient health, contributing to the rise of antimicrobial resistance (AMR), which complicates treatment and increases healthcare costs. Moreover, these infections can cause sepsis, a severe and life-threatening medical emergency that affects approximately 48.9 million people worldwide each year and results in around 11 million deaths[5].

Managing both CAIs and HAIs places significant organizational and financial challenges on hospitals, particularly in the current context of growing constraints, such as the rising turnover and shortage of healthcare workers, increasing care demands (ageing population, chronic diseases, higher patient expectations, etc.) and higher costs of medicines.

As a result, **both hospital managers and healthcare policy makers are challenged to ensure financial sustainability by controlling their expenditures, while achieving the best health value for money when managing infectious diseases**.



2. HOW INNOVATIVE *IN VITRO* DIAGNOSTICS CAN ENHANCE INFECTION MANAGEMENT

Clinical diagnosis is the first step clinicians must focus on to best manage their patients and hospital resources. Examining the pattern of symptoms, reviewing medical records, and performing **diagnostic tests** are key for clinicians to make better informed decisions on the best course of action.

When it comes to infections, ***in vitro* diagnostics (IVD)** provides essential information on the nature of the causative pathogen and its susceptibility to antimicrobial agents, as well as the immunological status of the patient, in order to best guide individual therapy. Additionally, such tests also help to protect the hospital community (other patients and healthcare workers) by preventing and controlling transmissible infections caused, for example, by respiratory viruses or multidrug-resistant organisms (MDROs).

Historically, IVD for bacterial infections has largely relied on culture-based diagnostic and susceptibility testing, performed in specialized laboratories and requiring days to provide results. As **diagnostic speed and accuracy** are the key requirements for maximum medical impact **if acted on rapidly**, significant technological evolutions in the last 30 years have resulted in innovative rapid solutions, mostly molecular-based (MALDI-TOF* and PCR**). These evolutions have further leveraged multiple advances in system and reagent engineering, such as microfluidics, integration, portability for point-of-care testing (POCT). One of the more recent innovations is highly multiplexed pathogen testing, enabling a syndromic approach (using one test to simultaneously target multiple pathogens)[6].

The concept of **'maximum medical impact'** focused on patient care improvement is now becoming a reality, and stakeholders are gradually realizing that it also generates **additional values** (described below) for patients & family, healthcare professionals, hospitals, healthcare systems, public health, and society as a whole[7].

* MALDI-TOF: matrix assisted laser desorption ionization-time of flight mass spectrometry. **PCR: polymerase chain reaction.

3. VALUE FOR WHOM? THE IMPORTANCE OF THE STAKEHOLDER PERSPECTIVE

Diagnostics not only play a crucial role in supporting hospital infection management, but also bring additional values which may differ according to the stakeholders, as illustrated in **Figure 1**.

Figure 1. Value means different things from different perspectives[7]
Source: bioMérieux adapted from Wurcel V., *et al*. *Public Health Genomics* 2019;22(1-2):8-15

AMR: Antimicrobial Resistance; AMS: Antimicrobial Stewardship

4. VALUE FOR WHOM? FOCUS ON THE HOSPITAL PERSPECTIVE

When focusing on the **hospital managers** as a stakeholder, it's clear that they are increasingly recognizing how diagnostic innovations not only enhance the **quality of care** but also **operational efficiency**. Moreover, these improvements can lead to significant cost savings, contributing to the **financial sustainability** of the hospital.

However, the benefits are not limited to the hospital. The **wider healthcare system** can also benefit (for instance, by avoiding unnecessary admissions and readmissions to hospital, reduced healthcare use) as well as **society** (for instance, via improved productivity, better quality of life and reduced AMR).

Regarding **health outcomes,** it is important to consider the perspective used. The **hospital perspective** will favor health outcomes within its short-term responsibility, e.g., patient stay and time to discharge, whereas the **societal perspective** will focus on the life-long impact on patients, populations and society as a whole, e.g., quality of life and life expectancy.

Figure 2. Innovative diagnostics for infection management in hospitals and beyond: a medico-economic value framework[8]

Source: bioMérieux adapted from Trevas D, *et al. Clinical Infectious Diseases* 2021;72(11):e893–e900

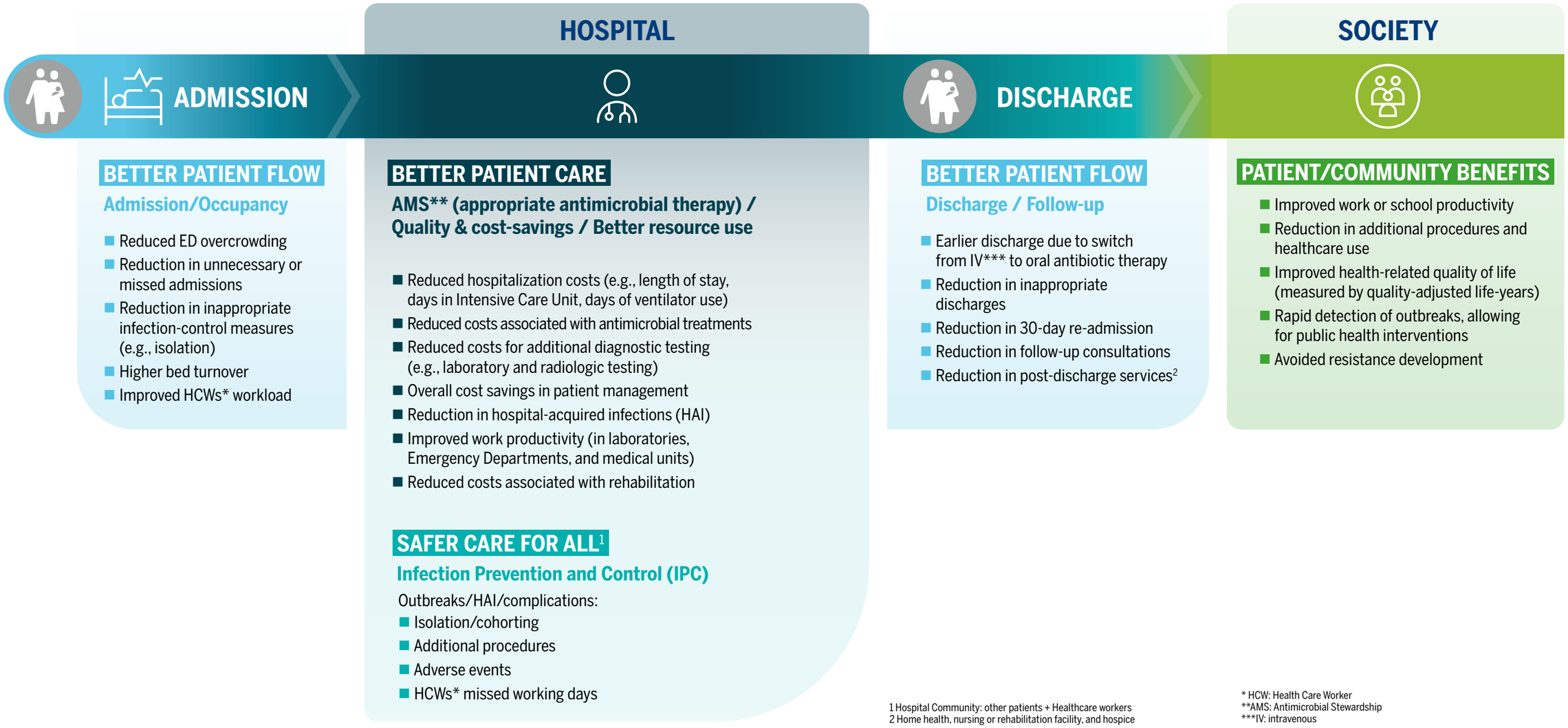


Figure 2 provides a complete overview of the different benefits from different perspectives, both within the hospital and beyond.

The importance of contextualization in health-economics: healthcare system, stakeholder and setting matter!

Most selected publications in this document result from studies performed in high income countries. It is obvious that results and conclusions might differ depending on the country and the maturity of the healthcare systems examined. Metrics might differ considerably at local/national levels, for example:

- **economic metrics,** such as Willingness To Pay or unit costs of resources, e.g., cost of antibiotics, cost of staff, cost per day in the hospital;
- **clinical metrics**, such as the risk of nosocomial infections, MDRO incidence, mortality rates.

Therefore, a critical interpretation of studies is essential, as is engaging in productive discussions with decision-makers who can contextualize these findings.

1 Hospital Community: other patients + Healthcare workers
2 Home health, nursing or rehabilitation facility, and hospice

* HCW: Health Care Worker
**AMS: Antimicrobial Stewardship
***IV: intravenous

5. THE CASE FOR INVESTMENT IN DIAGNOSTICS: HEALTH ECONOMICS AT PLAY

Historically, diagnostics have been evaluated based on their laboratory performance, rather than their impact on patient management and health economic benefits, such as optimizing healthcare resource use, improved patient outcomes, and associated cost-savings along the continuum of care.

Local healthcare providers are increasingly recognizing the health economic value that new, albeit often more expensive, diagnostics can offer to **improve infection management**. Furthermore, due to significant budget constraints, hospital management and payers are required to make difficult yet necessary decisions on how to allocate their resources effectively. To make the best-informed decisions, they therefore require solid health economic evidence[9,10]. **Their goal is to ensure that investments provide the best value for money, maintaining affordability while optimizing outcomes**.

In this context, health economic evaluations serve as a crucial strategic decision-making tool. These evaluations provide a comprehensive analysis of the cost-effectiveness and budget impact of different healthcare interventions.

By integrating these insights, decision makers can better allocate resources, ensuring that investments in diagnostics and other innovations not only improve patient outcomes, but also support long-term financial sustainability.

This Selection of Publications illustrates the diverse health economic benefits that innovative *in vitro* diagnostic solutions can offer to improve infection management.

1. Weiss AJ, Jiang HJ. Agency for Health Research and Quality (AHRQ). Most Frequent Reasons for Emergency Department Visits, 2018. Statistical brief #286. https://hcup-us.ahrq.gov/reports/statbriefs/sb286-ED-Frequent-Conditions-2018.jsp Published December 2021. Accessed January 9, 2025.
2. World Health Organization. Global patient safety challenge: 2005-2006. World Alliance for Patient Safety https://www.who.int/publications/i/item/9241593733 Published May 5, 2005. Accessed January 9, 2025.
3. World Health Organization 2011. Report on the Burden of Endemic Health Care-Associated Infection Worldwide. https://iris.who.int/bitstream/handle/10665/80135/9789241501507_eng.pdf?sequence=1 Accessed January 9, 2025.
4. World Health Organization. 2024 Global Report on Infection Prevention and Control. https://www.who.int/publications/i/item/9789240103986 Published November 29, 2024. Accessed January 9, 2025.
5. Rudd KE, Johnson SC, Agesa KM, *et al*. Global, regional, and national sepsis incidence and mortality, 1990-2017: analysis for the Global Burden of Disease Study. Lancet. 2020;395(10219):200-211. doi: 10.1016/S0140-6736(19)32989-7
6. Miller MB, Atrzadeh F, Burnham CA, *et al*. Clinical utility of advanced microbiology testing tools. *Journal of Clinical Microbiology* 2019;57:e00495-19. doi: 10.1128/JCM.00495-19
7. Wurcel V, Cicchetti A, Garrison L, *et al*. The Value of Diagnostic Information in Personalised Healthcare: A Comprehensive Concept to Facilitate Bringing This Technology into Healthcare Systems. *Public Health Genomics* 2019;22(1-2):8-15. doi: 10.1159/000501832
8. Trevas D, Caliendo AM, Hanson K, *et al*. for the Infectious Diseases Society of America. Diagnostic Tests Can Stem the Threat of Antimicrobial Resistance: Infectious Disease Professionals Can Help. *Clinical Infectious Diseases* 2021;72(11):e893–e900. doi. 10.1093/cid/ciaa1527
9. Abel L, Shinkins B, Smith A, *et al*. Early Economic Evaluation of Diagnostic Technologies: Experiences of the NIHR Diagnostic Evidence Co-operatives. *Medical Decision Making* 2019;39(7):857-866. doi: 10.1177/0272989X19866415
10. Graziadio S, Winter A, Lendrem BC, *et al*. How to Ease the Pain of Taking a Diagnostic Point of Care Test to the Market: A Framework for Evidence Development. *Micromachines* 2020;11(3):291. doi: 10.3390/mi11030291

KEY DEFINITIONS AND CONCEPTS

The following key definitions and concepts are commonly used in the emerging field of Health Economics applied to diagnostics.

Health Economics

A field of economics that focuses on the analysis and understanding of **efficiency, effectiveness, values and behaviors** involved in the production and consumption of health and healthcare. This includes the design of healthcare systems, economic evaluation of health technologies, and the impact of incentives on health-related behaviors[1].

Health Economic Evaluation (HEE)

A sub-discipline of health economics, that consists of the **comparative analysis of alternative courses of action** (for instance, a new diagnostic *versus* the standard of care diagnostic practice), in terms of **costs and health consequences**[2,3,4] HEEs aim to provide evidence-based information to assist decision-makers in allocating healthcare resources efficiently. They typically involve methods such as cost-effectiveness analysis, cost-utility analysis, and cost-benefit analysis, depending on the objective:

- **Economic focus:**
  Cost-benefit analysis (CBA) is an economic evaluation tool used to compare the costs and health effects of alternative interventions. CBA measures both costs and effects of interventions in monetary terms. This usually involves placing a monetary value on health benefits. e.g., faster recovery, less complications or days in an intensive care unit using an alternative innovative testing strategy[3,5].
  Another form is the **cost-minimization analysis** where the intent is to achieve an equal health effect for less money, or a purely **cost-savings analysis**, which does not consider the health effect.

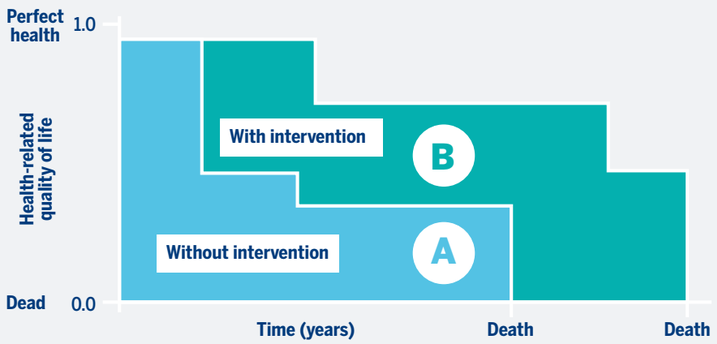
- **Health-effectiveness focus:**
  Cost-effectiveness analysis (CEA) is an economic evaluation tool used to compare the costs (or savings) and health effects of alternative interventions, both in monetary and health effects terms (e.g., improved cure rate, life saved, disability days saved, life years gained...)[3].
  A simple and popular graphical representation is the "**cost-effectiveness plane**" (see page 2) using data that are typically collected during **clinical trials** or by designing **cost-effectiveness models**[3,4].
  Cost-utility analysis (CUA) is a derived form of cost-effectiveness analysis where the **QALY** (Quality Adjusted Life Year) is the exclusive health outcome unit used.

Quality-Adjusted Life Year (QALY)

The QALY is one form of health outcome designed to **combine quantity and quality of life**. One QALY is equal to 1 year of life in perfect health. QALYs are calculated by estimating the years of life remaining for a patient following a particular treatment or intervention and weighting each year with a quality-of-life (also called 'utility') score (on a 0 to 1 scale).

Demonstration of QALYs for two individuals. Individual A (who did not receive an intervention) has fewer QALYs than individual B (who received an intervention)

Source: Wikipedia https://en.wikipedia.org/wiki/Quality-adjusted_life_year#/media/File:QALY_graph-en.svg CC BY-SA 3.0



Incremental Cost-Effectiveness Ratio (ICER)

The ICER is the key metric to **compare alternative interventions** in the upper right quadrant of a cost-effectiveness plane (higher costs, improved outcomes).

It is the net difference in cost (C) between two possible interventions, divided by the difference in their effect (Eff). The ICER provides a ratio of extra cost per "extra unit of health effect". The numerator of the ratio, the cost difference, is a net cost, accounting for the possible savings of the new intervention compared to the current standard of care.

$$ICER = \frac{C_{new} - C_{current}}{Eff_{new} - Eff_{current}}$$

The higher the ICER, the less satisfactory the result (because this means a bigger difference in costs and/or a smaller difference in effect). Conversely, the lower the ratio, the better the result.

An example of ICER use can be found in the study by Pliakos E, *et al.* (see page 24)[6].

Health Economics and Outcomes Research (HEOR)

HEOR is concerned with **understanding, measuring, and valuing the outcomes of healthcare interventions.** This includes clinical outcomes, patient-reported outcomes and economic outcomes. It encompasses a broad range of studies, including real-world evidence, observational studies, and patient registries[7].

What is the difference between HEE and HEOR?

While HEOR is broader and focuses on various outcomes of healthcare interventions, HEE is more specific and focuses on the health-economic evaluation of these interventions to **determine their cost-effectiveness**[7].

Cost-effectiveness plane

The cost-effectiveness plane is used to visually represent the **differences in costs and health outcomes between treatment alternatives in two dimensions,** by plotting the costs against effects on a graph (see page 2). Health outcomes (effects) are usually plotted on the x axis and costs on the y axis.

Willingness To Pay (WTP)

WTP is the amount a healthcare system or payer is **ready to pay for an improved health outcome** e.g., for prolonging life in good health, avoiding an outbreak, or gaining a QALY.

Sensitivity analysis

This type of analysis is used to **test the robustness of a model using a "what-if" analysis** to show how different values of an independent variable affect a dependent variable under a given set of assumptions. For example, how variation of mortality probabilities, length of stay, unit costs of specific resources affect the economic model output. Two modalities can be used: either deterministic or probabilistic. An example of a probabilistic sensitivity analysis is provided in the paper by Boughazi HE, *et al.* (see page 28)[8].

1. York Health Economics Consortium 2016. https://yhec.co.uk/glossary/health-economics/ Accessed January 9, 2025.
2. Abbas K. Economic Evaluation in Healthcare. International Health Economics Association https://healtheconomics.org/wp-content/uploads/2022/09/Economic-Evaluation-in-Health-Care-full-9b4ff446cf578aa898b72f8d5170c91d.pdf Accessed January 9, 2025.
3. Drummond MF, Schulpher MJ, Torrance GW, *et al*. Methods for economic evaluation of health care programmes. 3rd ed. Oxford: Oxford University Press; 2005. https://academic.oup.com/book/54294 Accessed January 9, 2025.
4. Annemans L. Health economics for non-economists. Principles, methods and pitfalls of health economic evaluations. Antwerpen, Belgium: Pelckmans Pro; 2018.
5. Cost benefit analysis: health economic studies. UK Government Office for Health Improvement and Disparities https://www.gov.uk/guidance/cost-benefit-analysis-health-economic-studies Published November 9, 2020. Accessed January 9, 2025.
6. Pliakos E, Adreatos N, Shehadeh F, *et al*. The Cost-Effectiveness of Rapid Diagnostic Testing for the Diagnosis of Bloodstream Infections with or without Antimicrobial Stewardship. *Clin Microbiol Rev.* 2018:W31(3):e00095-17. doi. 10.1128/CMR.00095-17
7. International Society for Pharmacoeconomics and Outcomes Research (ISPOR). What is HEOR? An important resource to meet the moment. https://www.ispor.org/heor-explained Accessed January 9, 2025.
8. Boughazi HE, Textoris J, Vandepitte S. Explorative cost-effectiveness analysis of a rapid ID and rapid AST solution for patients with bloodstream infection. *Value in Health* 2023;26(12):S176. Poster presented at ISPOR Europe 2023, Copenhagen.

CONTENTS

The next sections of this publication illustrate the health-economic benefits of fast innovative diagnostics supporting infection management in hospitals either through trial-based or model-based studies, according to the three different areas of benefit seen previously:

- better patient flow;
- better patient care;
- safer care for all.

BETTER PATIENT FLOW

BETTER PATIENT CARE

**ISPOR: International Society for Pharmacoeconomics and Outcomes Research*

SAFER CARE FOR ALL

ADDITIONAL RECOMMENDED READING

BETTER PATIENT FLOW

Improved Diagnostic Policy for Respiratory Tract Infections Essential for Patient Management in the Emergency Department.

Poelman R, van der Meer J, van der Spek C, Riezebos-Brilman A, Knoester M, Van Leer-Buter C, Friedrich AW, Niesters HG.
FUTURE MICROBIOLOGY 2020;15(8):623–632. doi: 10.2217/fmb-2019-0119

Routine molecular point-of-care testing for respiratory viruses in adults presenting to hospital with acute respiratory illness (ResPOC): a pragmatic, open-label, randomised controlled trial.

Brendish NJ, Malachira AK, Armstrong L, Houghton R, Aitken S, Nyimbili E, Ewings S, Lillie PJ, Clark TW.
LANCET RESPIRATORY MEDICINE 2017;5(5):401–411. doi: 10.1016/S2213-2600(17)30120-0

Relationship between Diagnostic Method and Pathogen Detection, Healthcare Resource Use, and Cost in U.S. Adult Outpatients Treated for Acute Infectious Gastroenteritis.

Moon RC, Bleak TC, Rosenthal NA, Couturier B, Hemmert R, Timbrook TT, Brown H, Fang FC.
JOURNAL OF CLINICAL MICROBIOLOGY 2023;61(2):e0162822. doi: 10.1128/jcm.01628-22

Clinical Impact of Multiplex Molecular Diagnostic Testing in Children With Acute Gastroenteritis Presenting to an Emergency Department: A Multicenter Prospective Study.

Pavia AT, Cohen DM, Leber AL, Daly JA, Jackson JT, Selvarangan R, Kanwar N, Bender JM, Dien Bard J, Festekjian A, Duffy S, Larsen C, Holmberg KM, Bardsley T, Haaland B, Bourzac KM, Stockmann C, Chapin KC, Leung DT.
CLINICAL INFECTIOUS DISEASES 2024;78(3):573–581. doi: 10.1093/cid/ciad710

BETTER PATIENT CARE

Impact of Delayed Appropriate Antibiotic Therapy on Patient Outcomes by Antibiotic Resistance Status from Serious Gram-negative Bacterial Infections.

Bonine NG, Berger A, Altincatal A, Wang R, Bhagnani T, Gillard P, Lodise T.
THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES 2019;357(2):103-110. doi: 10.1016/j.amjms.2018.11.009

Rapid Diagnostic Tests and Antimicrobial Stewardship Programs for the Management of Bloodstream Infection: What Is Their Relative Contribution to Improving Clinical Outcomes? A Systematic Review and Network Meta-analysis.

Peri AM, Chatfield MD, Ling W, Furuya-Kanamori L, Harris PNA, Paterson DL.
CLINICAL INFECTIOUS DISEASES 2024;79(2):502–515. doi.org/10.1093/cid/ciae234

Mathematical model of the cost-effectiveness of the BioFire FilmArray Blood Culture Identification (BCID) Panel molecular rapid diagnostic test compared with conventional methods for identification of *Escherichia coli* bloodstream infections.

Mponponsuo K, Leal J, Spackman E, Somayaji R, Gregson D, Rennert-May E.
JOURNAL OF ANTIMICROBIAL CHEMOTHERAPY 2022;77(2):507–516. doi: 10.1093/jac/dkab398

A SELECTION OF HEALTH ECONOMICS RESOURCES

ON-LINE RESOURCES

World Health Organization (WHO) – Health Financing
Guidance and reports on global health financing and health systems
https://www.who.int/health-topics/health-financing

Office of Health Economics (OHE)
Research, consultancy, and policy analysis in health economics and outcomes research
https://www.ohe.org/

International Society for Pharmacoeconomics and Outcomes Research (ISPOR)
Free webinars, training, and guidelines on health economics and outcomes research
https://www.ispor.org/

Global Burden of Disease (GBD) – Institute for Health Metrics and Evaluation (IHME)
Open-access data for economic research in global health
https://www.healthdata.org/

Organization for Economic Cooperation and Development (OECD)
Health statistics data on healthcare systems and expenditure
https://www.oecd.org/en/data/datasets/oecd-health-statistics.html

National Institute for Health and Care Excellence (NICE) - UK
Guidelines and cost-effectiveness assessments for healthcare technologies
https://www.nice.org.uk/

York Health Economics Consortium (YHEC)
Comprehensive glossary of health economics terms, ideal for beginners to understand key concepts
https://yhec.co.uk/resources/glossary/

BOOKS

Health Economics for Non-economists: Principles, Methods and Pitfalls of Health Economic Evaluations
Lieven Annemans.
First Edition. Pelckmans Pro, 2018. ISBN:↿ 9789463371131

Methods for the Economic Evaluation of Health Care Programmes
Michael F. Drummond, Mark J. Sculpher, Karl Claxton, Greg L. Stoddart, and George W. Torrance.
Fourth Edition. Oxford University Press, 2015. ISBN: 9780199665884

Applied Methods of Cost-effectiveness Analysis in Health Care
Alistair M. Gray, Philip M. Clarke, Jane Wolstenholme, and Sarah Wordsworth.
Handbooks in Health Economic Evaluation. Volume 3. Oxford University Press, 2011. ISBN: 9780199227280

Decision Modelling for Health Economic Evaluation
Andrew H. Briggs, Karl Claxton, Mark J. Sculpher.
Oxford University Press, 2006. ISBN: 9780198526629

Bringing Value to Healthcare: Practical steps for Getting to a Market-Based Model
Rita E. Numerof, Michael Abrams.
Productivity Press, 2021. ISBN: 978-0367737368

Redefining Health Care: Creating Value-Based Competition on Results
Michael E. Porter, Elizabeth Olmsted Teisberg.
Harvard Business Review Press; 1st edition, 2006. ISBN: 978-1591397786

BETTER PATIENT FLOW

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WHITE PAPER, HICT 2024
POSTER* PRESENTED AT THE 2024 INTERNATIONAL SYMPOSIUM ON MOLECULAR DIAGNOSTICS (ISMD)
CLIN CHEM LAB MED 2024; 62(6):EA188–EA211 HTTPS://DOI.ORG/10.1515/CCLM-2024-0438

Exploring the value of high-plex respiratory point-of-care diagnostic testing in acute respiratory infections.

Vandepitte S, Ndolumingo M, Textoris J.

OBJECTIVE

Emergency Departments (EDs) face the critical challenge of diagnosing acute respiratory infections swiftly and accurately. This model-based study explored the potential health-economic benefits of high-plex point-of-care testing (POCT) in the ED for diagnosing community-acquired acute respiratory tract infections (ARTI) from a German hospital payer perspective. The primary objective was to assess the impact of implementing this high-plex solution on cost savings, health-related outcomes, and operational efficiency compared to lab-based testing and low-plex POCT systems.

STUDY DESIGN

An early-decision analytic model** **(Figure 1)** compared high-plex PCR POCT with a turnaround time (TAT) of 15 minutes*** with three diagnostic methods:

1. Lab-based testing with a TAT ≥12 hours;
2. Lab-based testing with a TAT of 2-3 hours;
3. Low-plex POCT with a 30-minute TAT.

Two critical patient groups were analyzed:

1. Children < 5 years;
2. High-risk adults, including individuals over 80 years and those with comorbidities, such as immunosuppression or chronic obstructive pulmonary disease (COPD).

Primary outcome: net costs or savings from a hospital perspective.

Secondary outcomes: exploration of operational and health-related outcomes such as hospital length of stay (LOS), ED discharge rates, antibiotic (AB) use, and the occurrence of AB-induced adverse events (AEs).

RESULTS

The early model suggests significant health-economic benefits from adopting high-plex POCT over both low-plex POCT and lab-based testing methods in specific patient populations:

- **Cost Savings:** Implementing high-plex POCT would result in net savings of approximately €213.5 per pediatric patient and €226.8 per adult high-risk patient compared to lab-based testing (12h+). Switching from low-plex to high-plex POCT would result in net savings of €153.2 and €149.4 per pediatric and high-risk adult patient, respectively.
- **Operational Efficiency**: High-plex POCT reduced ED LOS by 67.5 minutes compared to lab-based testing (2-3 hours). Improved discharge rates were observed in both patient groups, with discharge rates of 0.55 in children and 0.77 in high-risk adults.
- **Health-Related Outcomes**: High-plex POCT reduced antibiotic use for viral causes by 15% in children and 10.2% in high-risk adults. This led to fewer AB-induced AEs (-3.4% in children and -3.8% in high-risk adults).

CONCLUSIONS

Based on this analysis, high-plex POCT demonstrates significant potential for reducing healthcare costs, particularly in terms of hospitalization (reduced LOS and higher discharge rates) and antibiotic use. Also, ED efficiency can be improved through reduced ED LOS using POCT vs lab-based testing (2-3 hours). This analysis concludes that high-plex POCT could play a critical role in improving both operational and health outcomes in EDs, while also reducing antimicrobial resistance through more appropriate antibiotic use. Real-world evidence is needed to validate these model-based findings in clinical settings.

* More details of this study will be provided in a full paper, to be published in a peer-reviewed journal (in progress).
** The model assumes comparable diagnostic accuracy across all methods. Data sources included peer-reviewed literature, KOL expert input, and German healthcare system costs.
*** High-plex PCR TAT based on the BIOFIRE® SPOTFIRE® R/ST panel.

Figure 1. Structure of the decision-analytic model showing which parameters could differ across the different comparators/ patient groups
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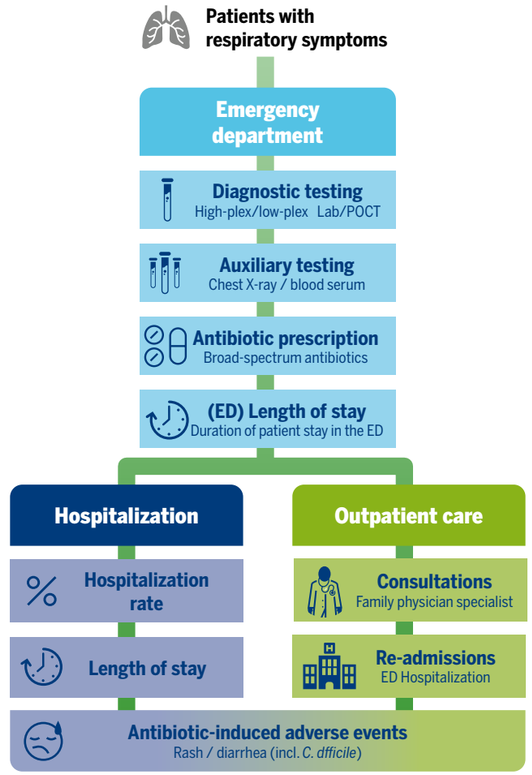


"For many years, clinicians had to deal with uncertainties when patients with severe respiratory symptoms arrived. Broad-spectrum antibiotics were systematically used but often were obsolete because the infection was viral. Now, high-plex POCT allows fast assessment of the causal pathogen, improving medical management and cost-effectiveness."

KEY FINDINGS

- **Cost-savings:** High-plex POCT offers substantial savings compared to lab-based testing and low-plex POCT, with savings potentially exceeding €200 per patient in specific populations.
- **Improved operational outcomes:** High-plex POCT could reduce ED length of stay, facilitating faster decision-making and patient turnover.
- **Reduced antibiotic use:** High-plex POCT could lead to more appropriate antibiotic prescribing by identifying viral versus bacterial infections quickly, thus helping to combat antimicrobial resistance (AMR).
- **Fewer adverse events:** The reduction in unnecessary antibiotic use may also decrease the occurrence of antibiotic-induced adverse events, potentially improving patient outcomes and further reducing costs.
- **Hospital impact:** Two-thirds of cost-savings are likely to stem from decreased hospitalization rates and length of stay, contributing to more efficient resource utilization in healthcare systems.

CLICK TO ACCESS ARTICLE

JOURNAL OF INFECTION
2023;86(5):462-475. DOI: 10.1016/J.JINF.2023.03.005

Rapid multiplex PCR for respiratory viruses reduces time to result and improves clinical care: Results of a systematic review and meta-analysis.

Clark TW, Lindsley K, Wigmosta TB, Bhagat A, Hemmert RB, Uyei J, Timbrook TT.

OBJECTIVE

The study aimed to evaluate the clinical impact of rapid multiplex PCR tests for respiratory tract infections (RTIs) on hospital length of stay (LOS), antibiotic use, and overall costs, among other endpoints, compared to routine diagnostic methods.

STUDY DESIGN

This systematic literature review included randomized controlled trials (RCTs), quasi-randomized controlled clinical trials (CCTs), and comparative observational studies to assess the clinical and economic impacts of rapid multiplex PCR testing. The inclusion criteria focused on studies comparing clinical impact outcomes between multiplex PCR testing and standard testing when searching databases from 2012 onwards and conference proceedings from 2021 in adults ≥18 years of age with suspected acute respiratory tract infection.

RESULTS

- In total, 27 studies involving 17,321 patient encounters were included. Studies were conducted in the United States, Europe, Asia, Argentina, Australia and Canada, with sample sizes ranging from 45 to 2,523 patients.
- Rapid multiplex PCR testing significantly reduced the time to results by approximately 24 hours and decreased LOS by nearly a day compared to routine testing, leading to savings, and potentially also lowering the risk of nosocomial infections.
- For influenza-positive patients, there was an increase in antiviral administration and these patients were 1.55 times more likely to be appropriately assigned to isolation facilities when tested with a rapid multiplex PCR test. This is also of importance in the prevention of nosocomial transmission, which can be costly for hospitals.
- In addition to the tested outcomes, reviewers reported overall cost savings due to shorter LOS in four studies, as well as lower medication costs with antivirals or antibiotics in five other studies, making rapid multiplex PCR a valuable tool in healthcare settings.
- No significant differences in inpatient mortality or antibiotic use were observed between the multiplex PCR and the routine testing group.

CONCLUSIONS

The evidence supports the routine use of rapid "sample-to-answer" multiplex PCR testing for respiratory viruses in hospitals due to its positive impact on clinical outcomes, including reduced time to results, shorter hospital stays, and improved management of influenza-positive patients.

"In addition to improvement in time to results, rapid sample-to-answer multiplex PCR was associated with a reduction in hospital LOS."

KEY FINDINGS

- Rapid multiplex PCR testing for suspected RTIs led to faster diagnosis and appropriate treatment, reducing hospital LOS and associated costs.
- This could result in economic benefits, not only due to shorter LOS, but also due to lower medication costs, as well as potential savings generated through the prevention of costly nosocomial transmission.

CLICK TO ACCESS ARTICLE

PEDIATRIC QUALITY AND SAFETY
2022;7(1):E517. DOI: 10.1097/PQ9.0000000000000517

Improving Care for Children with Bloody Diarrhea at Risk for Hemolytic Uremic Syndrome.

Burns CS, Rubin J, Sardesai T, Klein EJ, Vora SB, Kearney R, Rutman L.

OBJECTIVE

The study aimed to evaluate the impact of a clinical pathway designed to identify children at risk for hemolytic uremic syndrome (HUS) and guide their initial management in the pediatric Emergency Department (ED).

STUDY DESIGN

A retrospective cohort study conducted at a US tertiary children's hospital of 350 inpatients beds analyzing the impact of a clinical pathway designed to standardize diagnostic workup procedures, including testing with the BIOFIRE® FILMARRAY® Gastrointestinal (GI) Panel, and the management of pediatric patients (from 4 months to 19 years of age) with an increased risk of hemolytic uremic syndrome (HUS).

Researchers performed a chart review of eligible episodes between September 2015 and July 2020 to determine how the implementation of the clinical pathway in January 2018 impacted the incidence of hospital admission for patients presenting to the ED with bloody diarrhea.

Additionally, researchers analyzed changes in IV fluid administration, ED and hospital length of stay (LOS), ED and hospital charges, rates of readmission, stool PCR utilization and the diagnosis of Shiga toxin-producing *Escherichia coli* (STEC), acute kidney injury (AKI), and HUS.

RESULTS

- Within the study period, there were 305 encounters with children who visited the ED with bloody diarrhea or other eligible HUS risk factors (109 pre-implementation of the clinical pathway, and 196 post-implementation).
- When the BIOFIRE GI Panel was introduced, it was utilized in 83% of episodes and its use was sustained throughout the implementation of the pathway. After this intervention, there was a decrease in the rate of patients admitted to the hospital (49% to 30%), and an increase in the mean duration of ED stay for patients (209 to 277 minutes) as well as ED-related charges ($2,651 to $3,524).
- There was no significant difference in the LOS or charges for hospitalized patients, the rate of ED return visits or hospital readmission, or rates of diagnosis of STEC, AKI, or HUS.
- Mean overall charges, including charges for discharged and hospitalized patients, decreased after implementation, from $7,715 to $6,797. Implementation of stool PCR testing correlated with increased laboratory testing charges but decreased healthcare costs overall.

CONCLUSIONS

The introduction of a fast stool PCR test and clinical pathway helped reduce hospitalizations and overall costs for children presenting to the ED with bloody diarrhea without negatively impacting patient outcomes.

"The introduction of a rapid stool PCR diagnostic test and clinical pathway for management of patients with bloody diarrhea at an increased risk for HUS led to a significant and sustained increase in rapid stool PCR testing, and a decrease in hospitalization and mean total hospital charges."

KEY FINDINGS

- The implementation of a fast stool PCR diagnostic test such as the BIOFIRE GI Panel, together with guidelines, may drive behavior changes in patient management.
- A timely intervention in managing children at risk for hemolytic uremic syndrome (HUS) led to a decrease in hospitalizations (-19% absolute risk reduction) and mean overall hospital charges (-$873), although a modest increase in ED length of stay and ED-related charges was observed.
- A clinical pathway guiding decisions to discharge patients from the ED, admit them to the hospital, and discharge them from the hospital did not increase rates of ED revisits or readmission, indicating the criteria were appropriate.

BETTER PATIENT CARE

CLICK TO ACCESS ARTICLE

CLINICAL MICROBIOLOGY REVIEW
2018:31(3):E00095-17. DOI: 10.1128/CMR.00095-17

The Cost-Effectiveness of Rapid Diagnostic Testing for the Diagnosis of Bloodstream Infections with or without Antimicrobial Stewardship.

Pliakos E, Andreatos N, Shehadeh F, Ziakas,PD, Mylonakis E.

OBJECTIVE

This study evaluated the cost-effectiveness of competing strategies for the diagnosis of patients with suspected bloodstream infection, when used alone or combined with an antimicrobial stewardship program (ASP).

STUDY DESIGN

A decision-analytic model comparing 12 strategies for the diagnosis of bloodstream infection was constructed with the main arms comparing the use of molecular rapid diagnostic tests (mRDTs) and conventional laboratory methods with or without an ASP.

Based on the availability of data in the literature, the cost-effectiveness of 7 mRDT* subcategories was assessed: PCR, MALDI-TOF, PNA-FISH, BC-GN, BC-GP with an ASP; PCR and PNA-FISH without an ASP.

The outcome for the analysis was either cost and health gains for a cost-saving strategy or the Incremental Cost-Effectiveness Ratio (ICER) for a cost-effective strategy.

RESULTS

- In the base-case analysis, mRDT analysis with an ASP was the most effective strategy, resulting in net savings of $24,657, a gain of 0.54 QALY (Quality-Adjusted Life Years), and the prevention of 1 death per 25 patients with suspected bloodstream infection tested compared to conventional laboratory methods without an ASP.
- Within this pool of mRDTs, the subcategory MALDI-TOF with an ASP was the most effective strategy, resulting in net savings of $27,537, a gain of 0.94 QALY, and the prevention of 1 death per 14 patients.
- mRDTs associated with an ASP had an 80.0% chance of being cost-effective, while mRDTs without an ASP had only a 41.1% chance.

CONCLUSIONS

This study found that mRDTs were cost-effective for the diagnosis of patients with suspected bloodstream infection, could reduce healthcare expenditures, and lead to gains in QALYs **(Figure 1)**.

In addition, the ASP team is well placed to ensure that diagnostic tests are tailored to the clinical problem at hand, mRDT results are interpreted correctly, and antimicrobial agents are appropriately prescribed, thereby limiting the use of unnecessary empirical therapy.

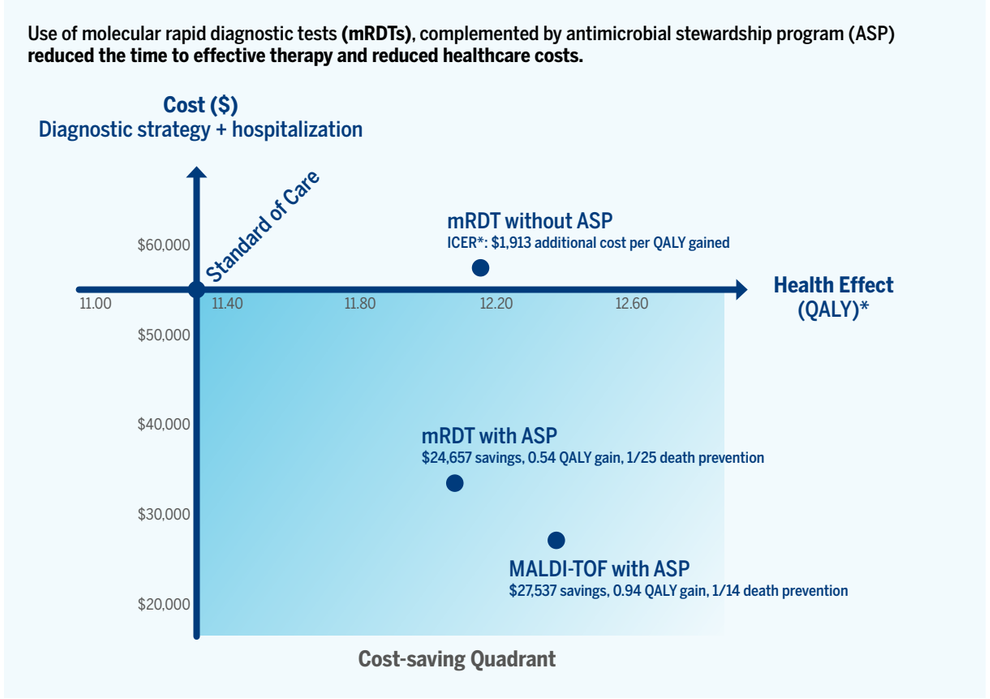
*PCR: Polymerase Chain Reaction; MALDI-TOF: Matrix Assisted Laser Desorption Ionization Time of Flight; PNA FISH: Peptide Nucleic Acid Fluorescent in situ Hybridization; BC GN/ BC GP: Blood Culture nanotechnology microarray system for Gram negative and positive bacteria.

"... the use of 'molecular' rapid diagnostic tests [...] was a cost-effective strategy that was associated with high therapeutic effectiveness and healthcare cost savings."

KEY FINDINGS

- This study found that the use of 'molecular' rapid diagnostic tests for the diagnosis of patients with suspected bloodstream infection was cost-effective and associated with high therapeutic effectiveness and healthcare cost savings.
- MALDI-TOF analysis with an Antimicrobial Stewardship Program (ASP) was the most cost-effective strategy. The other cost-effective options were PCR and BC-GN, both with an ASP, and PNA-FISH without an ASP.
- Even though mRDT-based strategies appear to be less cost-effective in the absence of an ASP, they still remain more cost-effective compared to conventional laboratory methods without an ASP.

Figure 1. Improving cost-effectiveness in the diagnosis of bloodstream Infections
Reproduced with permission from Elsevier. Pliakos E, *et al. Clinical Microbiology Review* 2018:31(3):e00095-17



*ICER: Incremental Cost-Effectiveness Ratio; QALY: Quality Adjusted Life Years

MICROBIAL BIOTECHNOLOGY
2022;15(10):2667–82. DOI: 10.1111/1751-7915.14124

MALDI-TOF mass spectrometry rapid pathogen identification and outcomes of patients with bloodstream infection: A systematic review and meta-analysis.

Yo CH, Shen YH, Hsu WT, Mekary RA, Chen ZR, Lee WTJ, Chen SC, Lee CC.

OBJECTIVE

The study aimed to evaluate the effectiveness of rapid microbial identification by MALDI-TOF MS* from blood cultures isolates with and without antibiotic stewardship teams (AST), on clinical outcomes for patients with bloodstream infections (BSI).

STUDY DESIGN

A systematic literature review and meta-analysis was conducted to compare studies using MALDI-TOF MS for microorganism identification versus conventional phenotypic methods. Studies were included if they analyzed efficiency measures (e.g., time to bacteriology identification), clinical outcomes (e.g., hospital length of stay), or economic measures (e.g., hospitalization costs). Studies without a comparison group were excluded.

RESULTS

In total, 21 studies were retained, mostly from North America and Europe, as well as Japan, Korea, and Israel, involving 14,515 patients.

MALDI-TOF MS used to support BSI management was associated with impactful improvements in 3 areas:

- **In-hospital mortality**: significantly reduced by 23% (risk ratio 0.77, 95% CI 0.66 to 0.90). The highest reductions were observed when MALDI-TOF was restricted to adult studies or co-implemented with AMS (35% reduction; RR 0.65, 95% CI 0.49 to 0.86; 6 studies). The low heterogeneity in mortality outcome estimates enhances the reliability of the pooled effect estimates, supporting the robustness of the findings.
- **Efficiency of patient management**: the use of MALDI-TOF significantly reduced time to pathogen identification by 22.86 hours, time to effective antibiotic therapy by 5.07 hours, and hospital stay duration by 0.73 days, but had no impact on duration of ICU stay.
- **Economic impact**: the technology also resulted in net cost savings, with a net reduction in direct hospitalization costs per patient of $4,140 on average.

CONCLUSIONS

Rapid pathogen identification by MALDI-TOF MS from blood cultures isolates, with or without AST, improves clinical outcomes and may be cost-effective for patients with BSI, reducing both the clinical and economic burden. Future studies should focus on formal cost-effectiveness analyses and the implementation of antimicrobial stewardship programs to maximize benefits.

* MALDI-TOF MS: Matrix Assisted Laser Desorption Ionization - Time of Flight Mass Spectrometry

"Implementing rapid microbial identification using MALDI-TOF MS not only improves clinical outcomes but also results in substantial cost savings, and may be cost-effective among patients with BSI."

KEY FINDINGS

Use of MALDI-TOF MS to support bloodstream infection management:

- Reduced mortality in patients with BSI by 23% compared to conventional methods.
- Accelerated identification of microorganisms causing the infection by 22.86 hours, leading to earlier and more accurate treatment decisions.
- Improved time to effective antibiotic therapy by approximately 5.07 hours, enhancing the treatment reponse.

JOURNAL OF PHARMACY PRACTICE
2022;35(5):722-729. DOI: 10.1177/08971900211000686

Impact of a Rapid Blood Culture Diagnostic Panel on Time to Optimal Antimicrobial Therapy at a Veterans Affairs Medical Center.

Chiasson J, Smith WJ, Jodlowski TZ, Kouma MA, Cutrell JB.

OBJECTIVE

The study aimed to evaluate the clinical impact of implementing a fast blood culture identification (BCID) panel within an Antimicrobial Stewardship Program (ASP) with limited personnel resources.

STUDY DESIGN

This single-center retrospective pre- and post-intervention cohort study included adult patients with at least one positive blood culture. A comparison of outcomes was made before and after the implementation of the BIOFIRE® FILMARRAY® Blood Culture Identification (BCID) panel. The BCID intervention was accompanied by educational guidance on the panel and recommended therapy prior to its implementation and a daily review of BCID results via clinical decision support software (once daily from Monday to Friday) by the ASP team. BCID results were automatically uploaded in the medical records but without additional real-time notifications from the lab.

Primary outcome: time to optimal therapy from blood culture collection.

Secondary outcomes: days of therapy (DOT), hospital length of stay (LOS), 30-day mortality, readmission rates.

RESULTS

- **Time to Optimal Therapy**: The introduction of the BCID panel significantly reduced the median time to optimal therapy from 73.8 hours to 34.7 hours (p<0.001). This shorter identification time allowed clinicians to tailor antibiotic treatment more promptly, potentially improving patient outcomes.
- **Antibiotic Duration and Hospitalization**: The total antibiotic days of therapy were reduced in the post-BCID period (median DOT 8 vs 10 (p=0.018); more specifically from 4 to 3 DOT for vancomycin (p<0.001) and 3.5 to 2 DOT for piperacillin-tazobactam (p<0.007). Additionally, the median LOS decreased from 11 to 9 days (p=0.031). Reduced LOS was associated with decreased cost, positively impacting resource utilization and patient management despite increased laboratory costs.
- **Observed patient safety events**: acute kidney injuries and *C. difficile* infections were similar overall between study groups.
- **Mortality Trends**: Although not statistically significant, there was a trend towards lower mortality rates in the post-intervention phase (12% vs 5% (p=0.086). While this warrants further investigation, it highlights the potential benefit of fast diagnostics in patient care.

CONCLUSIONS

In summary, the BCID panel associated with limited ASP engagement not only enhances clinical care but also has potential economic benefits. Further research should explore its long-term impact and cost-effectiveness.

"This study highlights the potential benefit of rapid diagnostics even in settings without resources for real-time alerts and continuous ASP member review."

KEY FINDINGS

From a health economic standpoint, the BCID panel's impact extends beyond clinical outcomes:

- The introduction of the BCID panel into the daily workflow of the Antimicrobial Stewardship Program (ASP) led to a significant reduction in median time to optimal therapy, from 3 days to 1.5 days. This reflects the potential benefits of fast diagnostics even in settings with limited ASP resources.
- It was also observed that continued education of pharmacists and physicians, combined with a daily review of BCID results by ASP, had a significant and positive impact on patient care, reducing total length of antimicrobial therapy, use of broad-spectrum antibiotics and hospital length of stay. These factors may all be associated with decreased cost, demonstrating the potential cost-effectiveness of fast diagnostics when combined with ASPs.

CLICK TO ACCESS ARTICLE

VALUE IN HEALTH
2023;26(12):S176
Poster presented at the 2023 ISPOR Europe conference, Copenhagen

Explorative cost-effectiveness analysis of a rapid ID and rapid AST solution for patients with bloodstream infection.

Boughazi HE, Textoris J, Vandepitte S.

OBJECTIVE

This model-based study assessed both the clinical outcomes and the economic impact of implementing a fast identification and antibiotic susceptibility testing (ID/AST) solution versus standard of care (SoC) in the management of patients with bloodstream infections (BSI). The goal was to explore the potential of this faster diagnostic method to help reduce mortality and healthcare costs by enabling earlier administration of appropriate treatment.

STUDY DESIGN

A decision analytic model was developed, from a French payer perspective, to compare the health outcomes and direct healthcare costs for a hypothetical cohort of 20,000 hospitalized patients diagnosed with BSI.

The cohort was divided into two groups:

- **Control Arm (SoC)**: conventional ID/AST methods were used, for which results are typically available within 24 to 48 hours. According to literature, about 19% of these patients received inappropriate antibiotic treatment, and 42% of them progressed to sepsis.[1]
- **Intervention Arm (Fast ID/AST)**: a fast diagnostic solution was used, providing results within 6 hours, which would enable clinicians to administer appropriate antibiotics within a single work shift. The hypothesis was that this method could reduce the proportion of patients progressing to sepsis to 28.4%.

The model estimated the cost per death averted and used average costs of BSI, sepsis, and septic shock based on data from published literature and expert clinical validation. A short-term time horizon was applied, focusing on the period from the onset of BSI to hospital discharge or death. The robustness of the model was tested through one-way sensitivity analyses.

RESULTS

Using this explorative model, results* showed potential reductions in the rates of sepsis (-8.9%), septic shock (-4.6%), and mortality (-3.8%) **(Table 1)**. Furthermore, the estimated total net cost savings per patient were €992, with a 1.5-day reduction in average length of hospital stay and a 1.1-day reduction in average Intensive Care Unit (ICU) stay.

One-way sensitivity analyses confirmed the robustness of these results, showing that the model's outcomes were stable across various assumptions **(Figure 1)**.

* The results shown in Table 1 and Figure 1 have been updated since the published abstract of the 2023 ISPOR poster.

CONCLUSIONS

This analysis provides valuable evidence for healthcare decision-makers, suggesting that investment in fast diagnostic tools not only improves patient outcomes but also generates significant cost savings, thereby enhancing the overall efficiency of healthcare systems. This aligns with global health recommendations, such as those from the World Health Organization (WHO) regarding use of fast AST methods direct from blood culture.[2]

1. Kadri SS, *et al*. *Lancet Infect Dis.* 2021;21(2):241-251 doi 10 .1016/S1473-3099(20)30477-1
2. WHO Global Research Agenda for AMR in Human Health Policy Brief 2023

"The use of a rapid ID/AST solution was cost-saving and life-saving when compared to standard of care in BSI management by starting earlier with appropriate treatment."

Table 1. Differences in main outcomes between SoC arm and Fast ID/AST arm
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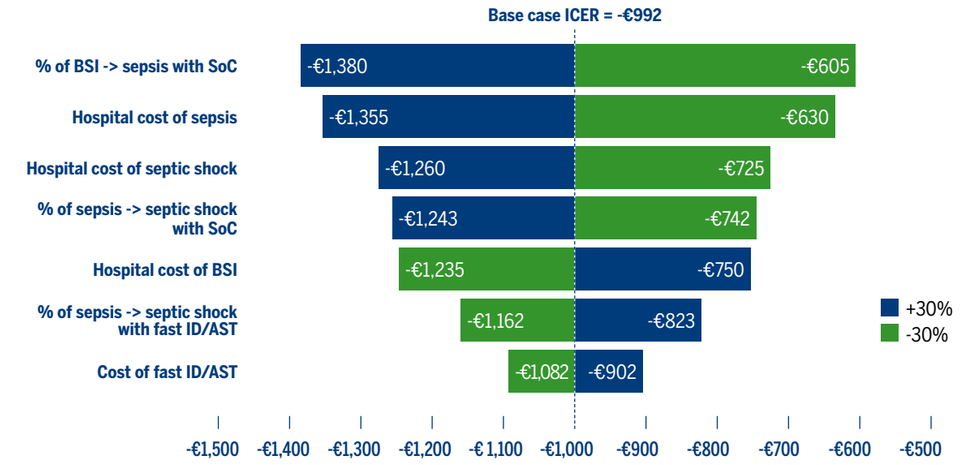
	STANDARD OF CARE	FAST ID/AST	DIFFERENCE
Health outcomes			
Sepsis cases (%)	27.7	18.8	-8.9
Septic shock cases (%)	14.3	9.7	- 4.6
Overall mortality (%)	11.7	7.9	- 3.8
Economic outcomes			
Average LoS per patient (days)	11.6	10.1	- 1.5
Average ICU stay (days)	3.4	2.3	- 1.1
Total cost per patient (€)	9,951	8,959	- 992

*Of note, the savings of €992 take into account the cost of the fast ID/AST and are thus net savings.

Figure 1. Tornado diagram – net cost savings per patient when +/- 30% variation is applied for each variable
Reproduced with permission from Boughazi HE.



BSI: bloodstream infection; ID/AST: identification/antimicrobial susceptibility testing; SoC: standard of care

KEY FINDINGS

- Clinical benefits associated with the explorative model:
  - Use of a fast ID/AST solution could reduce the risk of progression from BSI to sepsis and septic shock, by providing timely actionable results.
  - Mortality rates could be lowered by 3.8% when using fast ID/AST compared to SoC.
- Economic benefits associated with the explorative model:
  - Average hospital and ICU length of stay could be shortened, leading to lower healthcare resource utilization.
  - Total cost of care could be reduced by nearly €1,000 per patient.

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BMJ OPEN
2021;11(12):E047515. DOI: 10.1136/BMJOPEN-2020-047515

Cost-utility Analysis of Antimicrobial Stewardship Programme at a Tertiary Teaching Hospital in Ethiopia.

Gebretekle GB, Mariam DH , Mac S, Abebe W, Alemayehu T, Degu WA, Libman M, Yansouni CP, Fenta TG, Semret M, Sander B.

OBJECTIVE

The objective of this study was to assess the cost-utility of implementing a 2-step intervention, consisting of a strengthening of laboratory capacity with a concurrent pharmacist-led antimicrobial stewardship (AMS) program compared with usual care (empirical initiation of antibiotic therapy in the absence of strong laboratory and AMS) in a low-resource setting tertiary teaching hospital in Ethiopia*.

STUDY DESIGN

In this study, a major focus of the laboratory strengthening intervention was on performing blood culture testing routinely for all patients with fever or signs of sepsis hospitalized in medicine and pediatric wards, to enable reliable diagnoses of BSIs and detection of antimicrobial resistance. For this purpose, a newly donated BACT/ALERT® automated blood culture system was integrated in the laboratory.

The researchers developed a combination of a decision-tree with a Markov cohort model to assess the cost-utility of this 2-step intervention compared with usual care from a healthcare payer perspective. This perspective included all direct medical costs but not productivity loss or other costs. Direct medical costs include cost paid by any party, e.g., medication cost, investigation/procedural cost, microbiology/culture and sensitivity test cost (including the total cost of the BACT/ALERT investment as well as consumables and technologist training costs, amounting to US$ 97,464), staff time cost, admission and other hospitalization costs. The team used a lifetime time horizon and discounted health outcomes and cost at 3% annually.

It is worth noting the bloodstream infection treatment cost per hospital stay per patient used in the model is US$ 1,872 for the usual care versus US$ 289 for the intervention [1,2]. This large cost reduction during the AMS intervention was primarily due to the reduced use of very costly antibiotics (vancomycin, meropenem, third-generation and fourth-generation cephalosporins) by:

1. changing the large volume of broad-spectrum prescriptions to narrow-spectrum antibiotics (generally less costly);
2. significantly reducing treatment duration;
3. frequent discontinuation of incorrectly/unnecessarily prescribed antibiotics (e.g., vancomycin, which accounted for 30% of the antibiotics budget recommended to be discontinued in 60% of cases with good acceptance).

Another contributor to this cost reduction was the reduced duration of hospitalization.

Outcome measures were expected life-years, quality-adjusted life-years (QALYs), direct medical costs (US$ 2018) and incremental cost-utility in terms of cost/QALY.

Deterministic and probabilistic sensitivity analyses were performed to assess parameter uncertainty and test robustness of the model.

RESULTS

- The study found that laboratory-supported, pharmacist-led AMS was the dominant strategy, being more effective and less costly than usual care.
- Lab strengthening + AMS was associated with an expected incremental gain of 38.8 quality-adjusted life-years (QALYs) at lower expected cost (net cost savings: US$ 82,370) per 1000 patients compared with usual care **(Table 1)**.
- Findings were robust to all assumptions made: sensitivity analysis to medication cost, infection-associated and AMS-associated mortality reduction did not change the dominance of this intervention (less costly and better health outcome).
- Probabilistic sensitivity analysis demonstrated that AMS program was likely to be cost-effective at 100% of the simulations compared with usual care at 1%–51% of gross domestic product/capita.

These large cost savings were obtained in the first year of the intervention. Considering potential objections that this economic benefit might not be sustainable over a longer time, two additional scenarios were assessed based on the following assumptions:

1. a strong microbiology capacity already exists;
2. AMS has no significant impact on mortality and a marginal impact on treatment duration.

Both scenarios were still shown to be cost-saving, i.e., dominant, and sustainable.

* Tikur Anbessa Specialised Hospital (TASH) is Ethiopia's largest referral and teaching hospital with 800 beds and approximately 20,000 admissions annually.

1. Yansouni CP, *et al*. A Feasible Laboratory-Strengthening Intervention Yielding a Sustainable Clinical Bacteriology Sector to Support Antimicrobial Stewardship in a Large Referral Hospital in Ethiopia. *Front. Public Health* 2020;8:258. doi: 10.3389/fpubh.2020.00258
2. Gebretekle GB, *et al*. Half of Prescribed Antibiotics Are Not Needed: A Pharmacist-Led Antimicrobial Stewardship Intervention and Clinical Outcomes in a Referral Hospital in Ethiopia. *Front. Public Health* 2020;8:109. doi: 10.3389/fpubh.2020.00109

CONCLUSIONS

This is the first study to investigate the cost-utility of a laboratory-supported antimicrobial stewardship (AMS) intervention for inpatients in a low-resource setting in Africa. The study concludes that laboratory-supported, pharmacist-led AMS can result in improved health outcomes and substantial healthcare cost savings, demonstrating its economic and medical advantage in a tertiary care hospital, despite greater upfront investments. These findings should guide improvements in the standards of healthcare for low-resource settings.

Table 1. Model health and economic outcomes results

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OUTCOME MEASURE	USUAL CARE	AMS INTERVENTION	DIFFERENCE (AMS vs. USUAL CARE)
Expected Life-Years (LYs) per Patient	17.86	17.91	+0.05 LYs
Expected QALYs per Patient	13.24	13.28	+0.04 QALYs
Total Cost per Patient (US$)	**124.37**	**42.00**	**-82.37 (Cost Saving)**
Total Life-Years Gained per 1,000 Patients	-	-	**+52.2 LYs**
Total QALYs Gained per 1,000 Patients	-	-	**+38.8 QALYs**
Total Cost Savings per 1,000 Patients (US$)	-	-	**82,370 Saved**
ICER (Incremental Cost-Effectiveness Ratio)	-	**Dominant (Better outcomes, lower costs)**	-

Nota bene: cost per patient averages both patients with or without BSI, i.e., the hospital patient population.

"Our analysis suggested that the implementation of a laboratory-supported pharmacist-led AMS programme at a tertiary care hospital in a low-resource setting was dominant (saving costs and improving health) compared with usual care. Our findings support implementation of AMS in similar settings."

KEY FINDINGS

- Laboratory-supported, pharmacist-led AMS interventions in low-resource settings result not only in significant clinical benefits to individual patients but are economically advantageous.
- Substantial savings in healthcare costs can be achieved, even accounting for significant upfront investments in equipment and training.
- AMS was associated with an expected incremental gain of 38.8 QALYs at lower expected cost (incremental cost savings: US$ 82,370) per 1,000 patients compared with usual care.

CLICK TO ACCESS ARTICLE

ANTIBIOTICS
2022;11(27):1-15. DOI: 10.3390/ANTIBIOTICS11010027

Diagnostic Testing for Sepsis: A Systematic Review of Economic Evaluations.

Rojas-Garcia P, van der Pol S, van Asselt ADI, Postma MJ, Rodríguez-Ibeas R, Juárez-Castelló CA, González M, Antoñanzas F.

OBJECTIVE

The objective was to perform a systematic review of economic evaluations to analyze the cost-effectiveness of diagnostic methods in sepsis and to draw lessons on the methods used to incorporate antimicrobial resistance (AMR) in these studies.

STUDY DESIGN

The study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and uses the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) checklist for data extraction. The articles included compared at least two different diagnostic strategies for sepsis.

RESULTS

From a total of 306 articles identified, the final review included 16 cost-effectiveness articles (14 of which used a decision model), mostly based on retrospective data and published between January 2000 and December 2020. Some studies focused on cost per case and savings (i.e., considering an identical health impact) without calculating Incremental Cost-Effectiveness Ratios (ICERs), highlighting a gap in comprehensive economic evaluation. Analyses were most often made from the healthcare center's perspective, with a few from the healthcare payer's and societal perspective. The modelled time horizons included length of hospital stay (LOS), periods of 30 days, six months, one year, or projected life expectancy. Although sepsis can have long-term effects on mortality and quality of life, analyses were not able to explore long-term costs and effects beyond two years.

Health economic outcome metrics included average savings per patient, savings in hospital, average savings per case avoided, costs per life year, costs per additional correct diagnosis, costs per death averted, and costs per quality-adjusted life-year (QALY). Diagnostic testing for sepsis, particularly using procalcitonin (PCT) and polymerase chain reaction (PCR) tests, was systematically found to significantly improve clinical outcomes and be cost-effective compared to standard care, which usually consists of a blood culture and initial empiric treatment with broad-spectrum antibiotics.

Selected cost-savings outcomes from a hospital perspective in the review include:

- **Per-patient savings**: Total hospital care costs per patient decreased by up to €9,970 with use of PCR tests, due to the shortening of ICU stay and use of fewer antibiotics.
- **Cost per death averted**: depending on the LOS decrease (from 0 to 4 days) PCR as an adjunct to the blood cultures was either cost-saving or cost-effective given a willingness to pay of less than $3,000 per death averted.
- **Episode-based savings**: Using PCR tests, each episode saw an estimated saving of €430, on average.
- **Reduced hospital stays**: Diagnostic strategies reduced hospital stays by 4 to 8 days, by saving the use of one type of antibiotic or reducing the broad-spectrum treatment in 80% of the patients (improving the clinical efficacy of antibiotics).

Nine models included **antimicrobial resistance (AMR)** and showed that diagnostic tests enabling targeted antibiotic treatment can reduce the use of broad-spectrum antibiotics and the incidence of resistant infections, demonstrating that incorporating AMR into economic evaluations of sepsis diagnostics is essential to understand the full benefits of diagnostic strategies.

CONCLUSIONS

This first systematic review of the economic evaluation of sepsis diagnostic methods found that using rapid, accurate diagnostic techniques to detect sepsis early is generally cost-effective compared to standard care, even when only considering the short-term horizons of sepsis episodes.

"PCR and PCT are more efficient than standard care, as QALY gains have been found together with savings for the health system."

KEY FINDINGS

- Using a diagnostic technique to detect sepsis early on was found to be systematically and significantly cost-effective compared to standard care.
- PCR and PCT tests were shown to provide hospital cost-savings due to improved patient management, and quality-adjusted life year (QALY) gains.
- These findings suggest that investing in early diagnostic tools can save both lives and resources for healthcare systems.

CLICK TO ACCESS ARTICLE

JOURNAL OF INFECTION AND CHEMOTHERAPY
2020;26(1):82-85. DOI: 10.1016/J.JIAC.2019.07.014

The impact analysis of a multiplex PCR respiratory panel for hospitalized pediatric respiratory infections in Japan.

Kitano T, Nishikawa H, Suzuki R, Onaka M, Nishiyama A, Kitagawa D, Oka M, Masuo K, Yoshida S.

OBJECTIVE

The study assessed the impact and cost-effectiveness of implementing a multiplex PCR (mPCR) respiratory panel for pediatric respiratory infections in a Japanese community hospital, by comparing the outcomes associated with mPCR testing versus routinely used rapid antigen tests (RATs).

STUDY DESIGN

The study utilized a retrospective pre-post design. During the RAT period (March 1, 2012 to March 25, 2018), rapid antigen tests were routinely used for diagnosing respiratory infections in pediatric patients. Subsequently, the hospital transitioned to the mPCR respiratory panel, BIOFIRE® FILMARRAY® Respiratory Panel (March 26, 2018 to April 10, 2019).

Primary outcomes were days of antimicrobial therapy (DOT) and length of stay (LOS). **Secondary outcomes** included net cost, pathogen detection rate, and treatment failure. No Antimicrobial Stewardship Program (ASP) was available during the study.

RESULTS

A total of 1,132 patients were analyzed during the RAT period and 149 during the mPCR period*.

Primary outcomes:

- **DOT per case was significantly reduced** from 12.82 days in the RAT group to 8.56 days in the mPCR group ($p<0.001$).
- **LOS was also reduced** from 8.18 days in the RAT group to 6.83 days in the mPCR group ($p=0.032$).

Secondary outcomes:

- **Microbiological detection rates were significantly higher** in the mPCR group (87.2%) compared to the RAT group (30.2%) ($p<0.001$).
- **Treatment failure rates** were not significantly different between the two groups (2.6% vs 2.1%, p=0.661).
- **Total costs during admissions were lower** in the mPCR group (243,841 yen) compared to the RAT group (258,824 yen). The higher cost of mPCR tests was offset by a reduction of the hospitalization cost (driven by LOS) and social cost associated with parental work absence.

Other reported outcome:

- **In the mPCR group, 10% of cases were not admitted** even though the pediatrician judged that they should be admitted at time of presentation (before the test was conducted). This could mean that the mPCR test reduced the number of admissions, thereby further improving the cost-effectiveness of mPCR testing.

* The mPCR group was 1.1 year younger, and no adjustments were made to make the pre- and post-groups more comparable.

CONCLUSIONS

The mPCR respiratory panel was dominant compared to RATs, improving health and reducing costs. The reduction in both days of antimicrobial therapy and length of hospital stay led to lower overall hospitalization and social costs. The higher initial cost of mPCR tests is offset by the reduction in hospitalization and social costs, making it a financially viable option for managing pediatric respiratory infections. The study highlights the importance of implementing an ASP to further optimize antimicrobial use and enhance cost-effectiveness.

"Compared with conventional RATs, the mPCR has contributed to the reduction in DOT and LOS in a Japanese community hospital for admission-requiring pediatric respiratory infections."

KEY FINDINGS

- First study to evaluate the impact and cost of the mPCR respiratory panel in Japan.
- Significant reduction in DOT and LOS with the use of mPCR compared to RATs.
- Higher pathogen detection rate with mPCR (87.2%) compared to RATs (30.2%).
- Lower total costs during admissions in the mPCR group despite higher test costs

CLICK TO ACCESS ARTICLE

EUROPEAN JOURNAL OF CLINICAL MICROBIOLOGY AND INFECTIOUS DISEASES
2020;39(12):2379-2386. DOI: 10.1007/S10096-020-03986-6

Impact of cerebrospinal fluid syndromic testing in the management of children with suspected central nervous system infection.

Posnakoglou L, Siahanidou T, Syriopoulou V, Michos A.

OBJECTIVE

This study aimed to evaluate the impact of the BIOFIRE® FILMARRAY® Meningitis/Encephalitis (BIOFIRE ME) panel, for fast automated cerebrospinal fluid (CSF) testing of 14 common pathogens, on the management of children with suspected central nervous system (CNS) infections.

STUDY DESIGN

A prospective cohort study was conducted over one year (April 2018-2019) on children ≤16 years old admitted to a tertiary pediatric hospital with possible CNS infection and CSF pleocytosis (>15 cells/mm³). Children were randomized 1:1 to either BIOFIRE ME panel or the standard of care (SOC) at that moment: bacterial culture and/or singleplex PCR testing, ordered at the discretion of the attending pediatrician.

Key metrics included length of hospital stay (LOS), duration of antimicrobials, and total cost of hospitalization.

RESULTS

- 142 CSF samples were tested with the BIOFIRE ME Panel (n=71) or SOC methods (n=71).
- The BIOFIRE ME panel group had more positive detections than the SOC group overall (37 (52.1%) vs 16 (22.5%), $p<0.001$) and more positive viral detections (27/61 (44.2%) vs 11/66 (16.7%) $p<0.001$).
- Patients with a positive viral detection by the BIOFIRE ME Panel had fewer days of antimicrobial therapy (median 4 vs 7), fewer days of acyclovir (median 3 vs 5) and reduced median LOS (5 days vs 8) **(Figure 1)**. A sub-analysis of patients aged <3 months showed a greater reduction in median LOS (5 days vs 9). All previously mentioned findings were statistically significant (p<0.001).
- Median hospitalization costs were 31.5% lower overall in the BIOFIRE ME Panel group (€1,042 vs €1,522), and 36% lower for patients aged <3 months (€1,042 vs €1,632). The overall cost reduction for the group of children who had their CSF tested with BIOFIRE ME (n=71) was €22,834.

CONCLUSIONS

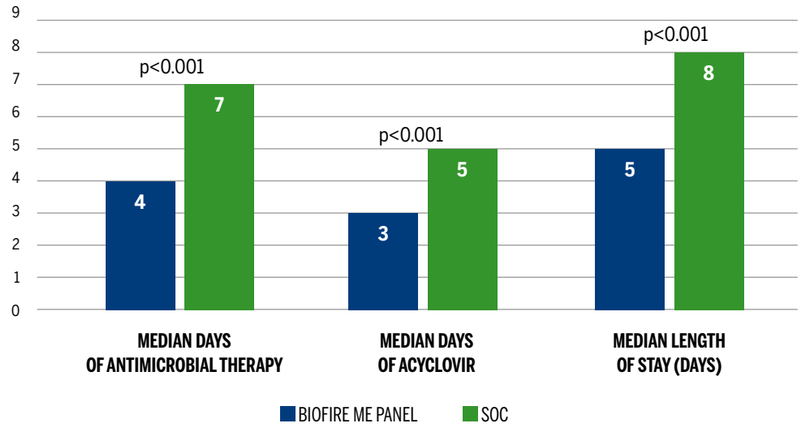
The use of the BIOFIRE ME panel significantly reduced the duration of antimicrobial therapy, length of hospital stay, and overall hospitalization costs in children with suspected CNS infections.

"The use of BIOFIRE-ME was able to reduce significantly the use of antimicrobials, the hospitalization days, and the total cost comparing to the control group in children with suspected CNS infection."

KEY FINDINGS

- Patients tested with the BIOFIRE ME Panel benefited from a doubled detection yield *versus* the control group (52.1% vs 22.5%), with more viruses and bacteria detected and no false negative results.
- The increased sensitivity of bacterial detection (especially after initiation of empiric antibiotics) and fast testing capacity are critical to more targeted and effective treatment of bacterial meningitis.
- Use of the BIOFIRE ME panel was able to significantly reduce the use of antimicrobials, as well as the number of hospitalization days.
- These benefits translated into a significant 31.5% reduction in overall hospitalization costs per patient (€1,042 vs €1,522).

Figure 1. Overall impact of implementation for aseptic meningitis
Source: BioFire Diagnostics



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ANTIBIOTICS
2022;11(12):1732. DOI: 10.3390/ANTIBIOTICS11121732

Epidemiology and Economic Outcomes Associated with Timely versus Delayed Receipt of Appropriate Antibiotic Therapy among US Patients Hospitalized for Native Septic Arthritis: A Retrospective Cohort Study.

Balada-Llasat JM, Stamas N, Vincent T, Timbrook T, Saiontz-Martinez C, Hemmert RB, Berger A.

OBJECTIVE

The study aimed to assess the impact of timely versus delayed receipt of appropriate antibiotic therapy on the epidemiology and economic outcomes among US patients hospitalized for native septic arthritis (SA).

STUDY DESIGN

This retrospective cohort study utilized data from the Premier Healthcare Database, covering the period from January 1, 2017, to December 31, 2019. The study included patients hospitalized with a final diagnosis of SA, comparing those who received timely appropriate antibiotic therapy (within two days of admission) to those who received delayed therapy, using matching techniques. Duration, de-escalation, length of stay, and costs were used as outcomes.

RESULTS

- A total of 18,597 patients had at least one hospital admission for SA. After application of all inclusion criteria, the study sample size comprised 517 patients.
- For 93.8%, SA was monomicrobial; methicillin-susceptible *S. aureus* (MSSA) was the most identified organism (50.9%); followed by methicillin-resistant *S. aureus* (MRSA) (12.6%), *S. epidermidis* (6.8%), *S. viridans* (5.8%), *S. agalactiae* (3.3%) and *P. aeruginosa* (2.7%).
- Vancomycin and ceftriaxone were the most common initial therapies administered.
- 26/517 patients (5.0%) received delayed appropriate therapy, which was significantly associated with an additional 1.1 days of antibiotic therapy, 1.4 days in length of stay (LOS), and an additional $3,531 in hospital costs per patient **(Table 1)**.
- If providers at hospitals included in the study had utilized fast microbiology testing for the 38.5% of patients in whom an ESKAPE* pathogen was detected and appropriate therapy delayed, it may have resulted in a cumulative reduction of 14 days in hospital, 11 days of antibiotic therapy, and $35,310 (i.e., $3,531 per patient) in total in-hospital costs.
- Patients with timely appropriate antibiotic therapy (receipt of appropriate antibiotic within 2 days of admission) were more likely to have antibiotic therapy de-escalation (36.3% vs 15.4% until day 5 or 54.8% vs 34.6% until discharge) and less likely to have antibiotic therapy escalation (4.3% vs 23.1% until day 5 or 9.6% vs 23.1% until discharge).

* ESKAPE organisms: *Enterococcus faecium, S. aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa, Enterobacter* spp.

CONCLUSIONS

Timely administration of appropriate antibiotic therapy for SA was associated with better clinical outcomes and significant cost savings. The study highlights the importance of fast pathogen identification and appropriate antibiotic stewardship to improve patient outcomes and reduce healthcare costs.

"Our findings indicate that receipt of timely appropriate antibiotic therapy for SA [septic arthritis] is associated with reduced exposure to antibiotics, shorter LOS, and an 18% reduction in costs to hospitals to render care."

KEY FINDINGS

- **Timely appropriate therapy for septic arthritis resulted in fewer days of antibiotic treatment and shorter lengths of stay for patients.**
- **This was associated with significant cost savings, reducing total in-hospital costs by 18% or $3,531 on average per patient.**

Table 1. Multivariable-adjusted utilization and cost outcomes
Reproduced from Balada-Llasat JM, *et al*. *Antibiotics* 2022;11(12):1732. MDPI – Open Access

OUTCOMES	TIMELY APPROPRIATE THERAPY (n=412)	DELAYED THERAPY (n=26)	*p*-value
	Adjusted Mean (95% CI)		
Duration of in-hospital antibiotic therapy, days	7.3 (6.7-8.0)	8.4 (7.7-9.2)	0.02
Total in-hospital antibiotic exposure, days	10.5 (9.7-11.5)	11.6 (10.6-12.6)	0.11
Length of stay, days	6.9 (6.3-7.6)	8.3 (7.6-9.0)	0.11
In-hospital cost, $			
Antibiotics	$624 ($515-$756)	$1,534 ($1,286-$1,829)	<0.01
Other pharmacotherapies	$1,068 ($932-$1,223)	$1,639 ($1,438-$1,868)	<0.01
Medical care	$5,861 ($5,458-$6,294)	$6,521 ($6,085-$6988)	0.03
Room and board	$7,551 ($6,818-$8,362)	$7,975 ($7,223-$8,805)	0.44
Other costs	$659 ($535-$812)	$587 ($481-716)	0.44
Total in-hospital cost	$15,490 ($14,242-$16,846)	$19,021 ($17,528-$20,641)	<0.01

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JOURNAL OF MEDICAL MICROBIOLOGY
2022;71(6). DOI: 10.1099/JMM.0.001543

The Impact of VITEK 2 Implementation for Identification and Susceptibility Testing of Microbial Isolates in a Brazilian Public Hospital.

Decarli A, Vieira Nascimento L, Sayama Esteves LH, Arenas Rocha P, Midori V, Yuki G, Cieslinski J, Telles JP, Stadler V, Ribeiro T, Tuon FP.

OBJECTIVE

The objective of this study was to evaluate the clinical impact of an automated method for identification and susceptibility testing (ID/AST) of microbial isolates in a Brazilian public hospital.

STUDY DESIGN

This retrospective cross-sectional study analyzed results before and after the implementation period of a VITEK® 2 system in a Brazilian university hospital used for trauma and general surgery. The standard of care consisted of manual biochemical testing of microscopical observations for ID, and disc diffusion or ETEST® for AST.

The study included patients with a positive culture of clinical samples from January to July 2017 (conventional method) and from August to December 2017 (automated method). The study evaluated demographic data, hospitalization time, time interval between culture collection and results, culture results and site, susceptibility profile, minimum inhibitory concentration, and outcome data.

RESULTS

- In total, 836 adult patients were included: 219 patients in the pre-VITEK 2 system implementation group and 545 in the post-implementation group.
- The comparison between the two periods showed:
  - a significant reduction of 25% of the time to results release (from a median 4 days down to 3 days, p=0.03);
  - a significant 50% decrease of the hospital length of stay (from 33.5 to 17.0 days, p<0.001);
  - a significant 30% reduction in mortality (from 44.3 to 31.0%, p<0.05).
- Reduced hands-on time and short incubation times for ID/AST contributed to the faster time-to-results with the automated method.
- Patient mortality in this study was high in both periods, which is a characteristic of a Brazilian public hospital. This meant that faster identification had a greater impact on reducing mortality. If mortality had been low, the impact of the automated method would have been smaller.

CONCLUSIONS

The study concluded that the use of automated ID/AST systems can improve antimicrobial therapy, and positively impact clinical outcomes with a decrease in antimicrobial resistance, hospitalization time, costs, and mortality.

"The VITEK 2 system provided early access to appropriate antimicrobial therapy for patients and effected a positive clinical impact with a reduction in mortality and hospitalization time."

KEY FINDINGS

- The VITEK 2 system enabled early access to appropriate antimicrobial therapy for patients and had a significant positive clinical impact:
  - 25% shorter time to results release;
  - 50% decrease in hospital length of stay;
  - 30% reduction in mortality.

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JOURNAL OF ANTIMICROBIAL CHEMOTHERAPY
2017;72(3):933-940. DOI: 10.1093/JAC/DKW468

Sustained impact of a computer-assisted antimicrobial stewardship intervention on antimicrobial use and length of stay.

Nault V, Beaudoin M, Perron J, Moutquin JM, Valiquette L.

OBJECTIVE

This study aimed to evaluate the longitudinal impact of a novel computerized clinical decision support system, Antimicrobial Prescription Surveillance System (APSS), designed to assist an antimicrobial stewardship program (ASP) team with Prospective Audit and Feedback (PAF) on hospital length of stay (LOS), antimicrobial use and costs and quality of antimicrobial prescription.

STUDY DESIGN

Between 2008 and 2013, a retrospective cohort study was conducted at the Centre Hospitalier Universitaire de Sherbrook, Canada (677 beds), on hospitalized adult patients receiving antimicrobials (intravenous and oral). The ASP hospital intervention started in 2010, led by a pharmacist.

The APSS (Lumed Inc.) was able to receive and analyze clinical data from the electronic record system including demographics, admission, vital signs, pharmacy, radiology, laboratory and microbiology data. Using its knowledge base rules (derived from published and local guidelines), the APPS verified whether the antimicrobial treatment was appropriate according to drug-drug interactions, redundant spectrums, drug-bug mismatches, cheaper alternatives, dose adjustments, duration of treatment and switch from intravenous to oral therapy. Statistical analysis were performed by segmented regression analysis.

RESULTS

The APSS collected and reviewed 40,605 hospitalizations for 35,778 patients who received antimicrobials. The system generated 5,665 recommendations which were validated by pharmacists with a 91% acceptance rate by the prescribers.

Dosing adjustment (26%), switch from intravenous to oral therapy (16%) and immediate discontinuation of the treatment (13%) were the most frequent interventions generated.

Piperacillin/tazobactam (20%), vancomycin (18%), ciprofloxacin (17%) and meropenem (5%) were the most frequently prescribed antimicrobials targeted by recommendations.

A positive impact was observed on several outcomes after APSS implementation, persisting over 3 years post-intervention:

- A decrease in average LOS for patients receiving antimicrobial treatment (between -18.6% and -27.4% from conservative and maximum outcome prediction, respectively). This translated into 2.3 days average decrease in LOS, representing indirect savings of $2,085 per hospitalization in which the patient received antimicrobials.
- A reduction in antimicrobial consumption: for days of therapy per 1,000 inpatients days, the decrease was comprised between -11.0% and -21.8% (from conservative and maximum outcome prediction, respectively).
- A decrease in antimicrobial spending of around 28%, generating annual direct savings of $350,000, representing 20.5% of the hospital's antimicrobial budget **(Figure 1)**. Savings outweighed the cost of the intervention, which includes the APSS license, a full-time pharmacist and an hour a day of an infectious diseases physician.
- A reduction of the non-concordance with antimicrobial prescribing guidelines (between -4.2% and -5.5% from conservative and maximum outcome prediction, respectively).

CONCLUSIONS

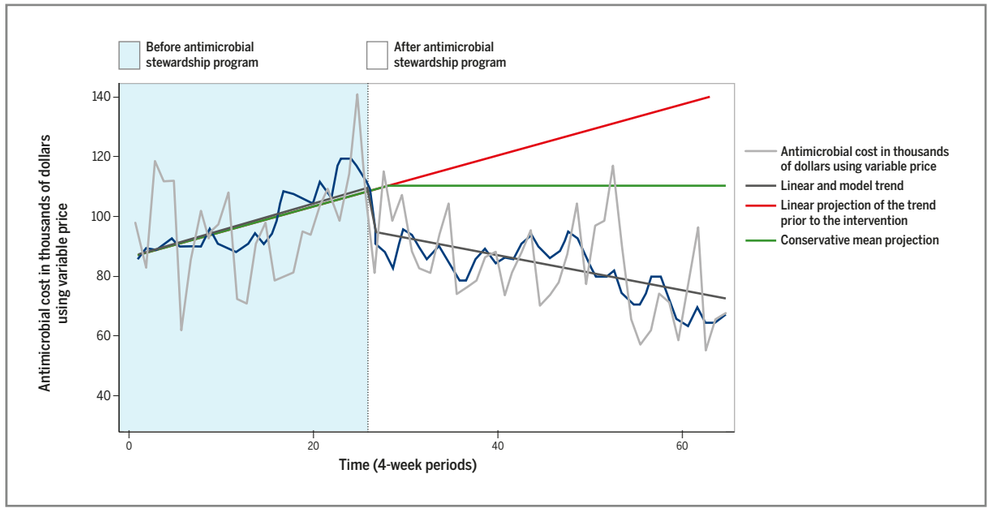
The implementation of APSS to support the ASP team demonstrated a sustainable positive impact for clinical and financial aspects on the prescription of antimicrobials in the hospital. The high rate of acceptance by prescribers played a key role in these results.

KEY FINDINGS

- One of the first studies to evaluate a Clinical Decision Support System (CDSS) able to demonstrate a sustainable reduction in LOS of patients receiving antimicrobials following a Prospective Audit and Feeback (PAF) initiative.
- The reduction in LOS results from a combination of interventions targeting the switch from intravenous to oral and the discontinuation and reduction in the duration of antimicrobial therapy.
- This study confirmed that clinical decision support can sustainably improve quality of antimicrobial prescribing.

CLINICAL DECISION SUPPORT SYSTEM (CDSS)

Figure 1. Antibiotic spending using variable pricing over a 4 week period
Adapted from Nault V, *et al. Journal of Antimicrobial Chemotherapy* 2017;72(3):933-940



"Our intervention was well received by the prescribing physicians. The impacts of the ASP articulated around APSS, a computerized clinical decision-support system that performs a systematic review of all prescribed antimicrobials, were financially and clinically significant for the hospital."

SAFER CARE FOR ALL

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CLINICAL INFECTIOUS DISEASES
2022;75(3):476-482. DOI: 10.1093/CID/CIAB946

Whole-Genome Sequencing Surveillance and Machine Learning of the Electronic Health Record for Enhanced Healthcare Outbreak Detection.

Sundermann AJ, Chen J, Kumar P, Ayres AM, Cho ST, Ezeonwuka C, Griffith MP, Miller JK, Mustapha MM, Pasculle AW, Saul MI, Shutt KA, Srinivasa V, Waggle K, Snyder DJ, Cooper VS, Van Tyne D, Snyder GM, Marsh JW, Dubrawski A, Roberts MS, Harrison LH.

OBJECTIVE

The study aimed to develop and evaluate the Enhanced Detection System for Healthcare-Associated Transmission (EDS-HAT), which combines whole-genome sequencing (WGS) and machine learning (ML) of electronic health records (EHR) to identify undetected outbreaks and the responsible transmission routes, respectively.

STUDY DESIGN

This clinical and economic impact modeling study was conducted at a US tertiary care hospital of 758 beds from November 2016 to November 2018.

- The **reference 'traditional' infection prevention practice** consisted of WGS performed in reaction to infection prevention (IP) requests for suspected outbreaks (reactive WGS).
- The **intervention** involved surveillance by WGS-clustering of select healthcare-associated bacterial pathogens every two weeks coupled to ML analysis of EHR data to identify transmission routes **(Figure 1)**.

The hypothetical effectiveness of this EDS-HAT (potential infections prevented, identification of transmission route) was compared to the reference. The economic model was conducted from a hospital perspective.

Outcomes were incremental costs per transmission averted, number of readmissions averted, and lives saved.

RESULTS

- Out of 3,165 clinical isolates identified by WGS, 2,752 were unique, of which 297 (10.8%) involved 99 clusters (i.e., suspected outbreaks). Clusters ranged from 2-14 patients. At least 1 transmission route was detected for 65 (65.7%) of clusters. Select high-impact or notable outbreaks are listed in **Table 1**.
- Simultaneously, traditional IP investigation prompted WGS for 15 suspected outbreaks involving 133 patients, for which transmission events were identified for 5 patients (3.8%).
- If EDS-HAT had been running in real time, 25 to 63 transmissions could have been prevented over the 2-year study period, as well as 3.1-8.0 fewer 30-day readmissions, and 1.6-3.3 fewer deaths. EDS-HAT could have saved $7,745 - $10,939 for each transmission averted.
- Using EDS-HAT, the increase in cost of sequencing would have been offset by treatment cost-savings, resulting in overall net savings of $192,408 to $692,532 over the study period.

CONCLUSIONS

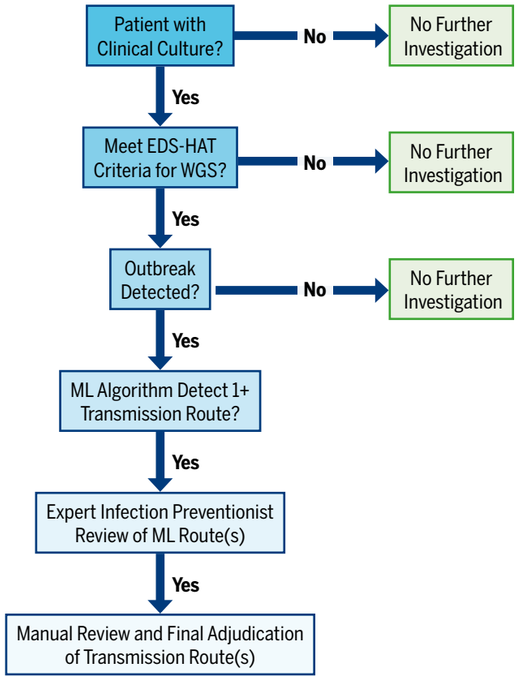
EDS-HAT may be more effective, and even cost-saving, compared to traditional IP methods. EDS-HAT may enhance patient safety by accurately detecting consequential outbreaks and transmission routes that were undetected by traditional IP practice, whereas the latter mostly identified suspected outbreaks that were not confirmed by reactive WGS.

"Taken together our results suggest that EDS-HAT represents a potential paradigm shift in how outbreaks are detected in hospitals. If instituted in real time, this approach can reduce overall healthcare-related costs from the hospital perspective and significantly improve patient safety."

KEY FINDINGS

- **EDS-HAT's combination of WGS and ML may significantly improve outbreak detection with potentially 25 to 63 outbreaks averted, worth $192,408-$692,532 cost-savings, with less deaths and re-admissions.**
- **EDS-HAT effectively identifies complex transmission routes that traditional methods miss.**
- **This approach to outbreak detection proved to be cost-saving, reducing healthcare-associated costs and improving patient outcomes, but relies on investments in hospital infrastructures for success.**

Figure 1. Flow diagram of the EDS-HAT outbreak detection process, from clinical culture through adjudication of transmission route(s)
Reproduced with permission from Oxford Academic. Sundermann AJ, *et al*. *Clinical Infectious Diseases* 2022;75(3):476-482



EDS-HAT: Enhanced Detection System for Healthcare-Associated Transmission; ML: machine learning; WGS: whole-genome sequencing

Table 1. High-impact or notable outbreaks detected by EDS-HAT
Reproduced with permission from Oxford Academic. Sundermann AJ, *et al*. *Clinical Infectious Diseases* 2022;75:476-482

HIGH-IMPACT OR NOTABLE OUTBREAKS DETECTED BY EDS-HAT
Vancomycin-resistant *Enterococcus faecium* outbreak associated with interventional radiology
Pseudomonas aeruginosa outbreak associated with gastroscopy
Outbreaks of multiple pathogens at the embedded chronic care facility
Outbreaks of multiple pathogens on an ICU
C. difficile outbreaks associated with wound care
MRSA infections associated with EEG

ICU: Intensive Care Unit; EEG: Electroencephalography; MRSA: methicillin-resistant *Staphylococcus aureus*.

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ANTIMICROBIAL RESISTANCE & INFECTION CONTROL
2022;11:117. DOI: 10.1186/S13756-022-01149-0

Cost-effectiveness of strategies to control the spread of carbapenemase-producing Enterobacterales in hospitals: a modelling study.

Kardas-Sloma L, Fournier S, Dupont JC, Rochaix L, Birgand G, Zahar J-R, Lescure F-X, Kernéis S, Durand Zaleski I, Lucet JC.

OBJECTIVE

This study aimed to evaluate the effectiveness and cost-effectiveness of various strategies combining several interventions to control the spread of Carbapenemase-Producing Enterobacterales (CPE) in a general hospital ward using a mathematical model.

STUDY DESIGN

A dynamic, stochastic model was used to simulate CPE transmission via healthcare workers' hands and the environment in a hypothetical 25-bed general ward, with a low 0.1% prevalence of CPE carriage at the time of hospital admission, reflecting a high-income country context.

The model compared 12 different strategies, combining interventions such as targeted or universal rectal screening, contact precautions, isolation, dedicated nursing staff for isolated/cohorted CPE carriers, and weekly screening of contact patients.

The time horizon was one year, and a hospital perspective was adopted to estimate costs, which included laboratory costs, single room, contact precautions, staff time, i.e., infection control nurse and/or dedicated nursing staff, and lost bed-days due to prolonged hospital stay of identified carriers.

Costs were estimated based on local and national French data. Targeted screening was defined as screening of patients at admission with a history of CPE infection or colonization, patients with a history of foreign hospital stay within the last year, and patients repatriated from a hospital abroad.

RESULTS

- The baseline standard contact precautions scenario resulted in 0.93 CPE acquisitions/1,000 admissions/year and cost €32,050/1,000 admissions.
- All intervention strategies increased costs but were effective in reducing CPE acquisitions with a relative reduction ranging between 16 and 98%, and with the most impactful strategies involving dedicated nursing staff.
- Two strategies (3 and 9) were shown to be the **most cost-effective (Figure 1)**:
  - **Targeted screening with dedicated nursing staff (TS+DNS)** was the most powerful: an ICER of €17,407 per avoided CPE case versus baseline, 64% reduction in CPE acquisition.
  - **Adding weekly screening (TS+DNS+WSC)** increased costs: €30,700 per avoided CPE case, 66% reduction in CPE acquisition.
- The **most effective** strategy (12) was **Universal screening combined with dedicated nursing staff and weekly screening (US+DNS+WSC)** but it was also the most expensive: €181,472 per avoided CPE case, 98% reduction in CPE acquisition.
- Of note, the sensitivity analysis provided the same findings when a higher prevalence of CPE carriage at admission was used (5% vs. 0.1%).

CONCLUSIONS

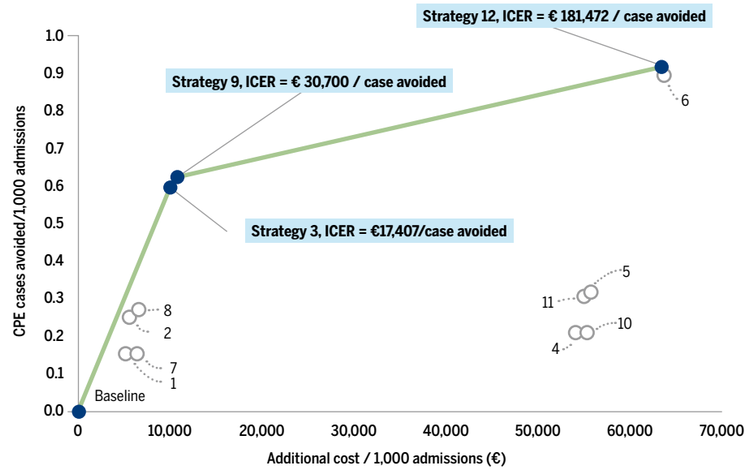
This study found that targeted screening of at-risk patients at admission combined with dedicated staff for identified CPE carriers, with or without weekly screening, were the most cost-effective interventions to control the spread of CPE. These findings support current recommendations from several high-income countries.

"Targeted screening at admission combined with dedicated nursing staff for identified CPE carriers with or without weekly screening were the most cost-effective options to limit the spread of CPE."

KEY FINDINGS

- **CPE-screening of patients at admission, whether targeted or universal, as well as dedicated nursing staff for isolated CPE-carriers, were the 2 key components of effective and cost-effective strategies for controlling CPE spread in a hospital, avoiding expensive stringent control measures and hospital organization disruption.**

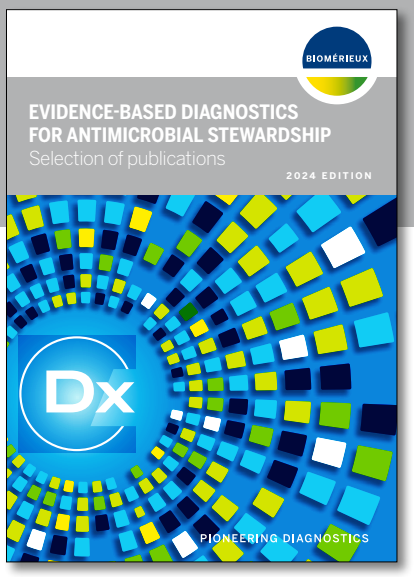
Figure 1. Cost-effectiveness plane showing incremental benefits and costs relative to the least expensive strategy (baseline)
Reproduced with permission from Kardas-Sloma *et al*. *Antimicrobial Resistance and Infection Control* 2022;11:117

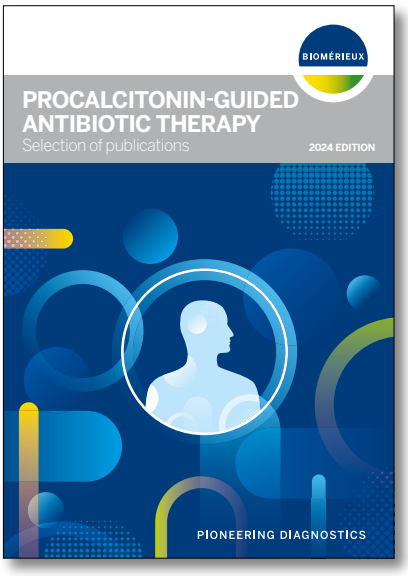


The green line represents the "efficiency frontier" for the 3 most effective strategies and the ICER between a specific strategy and the next, more costly, but more effective strategy is presented.

Other evidence-based Selection of Publications available

Contact your local bioMérieux representative to find out more about available literature





bioMérieux S.A. • 69280 Marcy l'Etoile • France • Tel.: + 33 (0)4 78 87 20 00 • Fax: +33 (0)4 78 87 20 90
www.biomerieux.com **www.biomerieux.com/en/education**