
Forum Risk Management
obiettivo sanità salute
26-29 NOVEMBRE 2024
AREZZO FIERE E CONGRESSI
19
Gli elementi chiave da acquisire per proteggere i pazienti fragili
Antibiotico resistenza ed infezioni correlate all'assistenza
26 NOVEMBRE - SALA MINERVA
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#ForumRisk19
www.forumriskmanagement.it

Chi sono le persone "fragili" e perché sono più a rischio se contraggono malattie infettive?

Tutti coloro che presentano condizioni morbose che espongono a un rischio maggiore di contrarre malattie infettive invasive e sviluppare in tal caso complicanze gravi

Severe newborn infections—including sepsis, meningitis, and pneumonia—are a major cause of morbidity and mortality among newborns in low- and middle-income countries.

Recent analyses estimate that globally, approximately 400,000 newborns die each year as a result of severe infections, over one-sixth of the total burden of newborn deaths. Most of these deaths could be averted through:

1. preventive measures, such as improving hygiene practices, and
2. timely and appropriate care for sick newborns.

17 percentage of neonatal deaths caused by severe bacterial infections

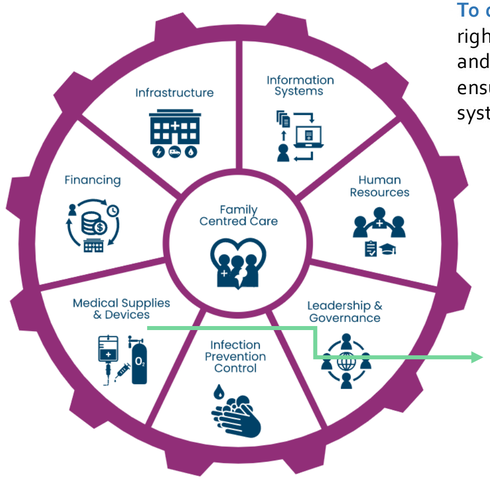
400K number of newborns who die each year as a result of severe infections

8 percentage of neonatal deaths caused by pneumonia

I bambini appena nati sono soggetti fragili perché devono ancora sviluppare il sistema immunitario, quindi più esposti per esempio al rischio di infezioni respiratorie e sistemiche

Date of update: 17 September 2022 HNN HEALTHY NEWBORN NETWORK

L'importanza della gestione clinica per la diagnostica microbiologia



To deliver high quality care for every small and sick newborn, we need to have the right space, the right people and the right supplies, backed by supportive leadership and data for action. This requires a package of care with families at the center ensuring zero separation between parents and their newborns. A whole health systems, country-led approach is required –which is what this toolkit aims to achieve.

Medical Supplies & Devices

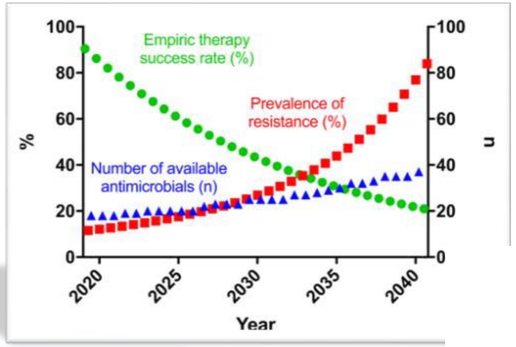
Laboratory Medicine

It is estimated that 70% of medical decisions (in high-resource settings) are based on clinical laboratory tests. As a result, diagnostic testing is critical **to saving the lives of many newborns**. Laboratory medicine provides meaningful, accurate results to diagnose conditions, follow-up and monitor treatments

Clinical laboratories are key to providing highly reliable diagnostic data to inform clinicians on the best medical care they should provide to the newborn. Management and improvement of quality in laboratories over time are essential to achieve this goal

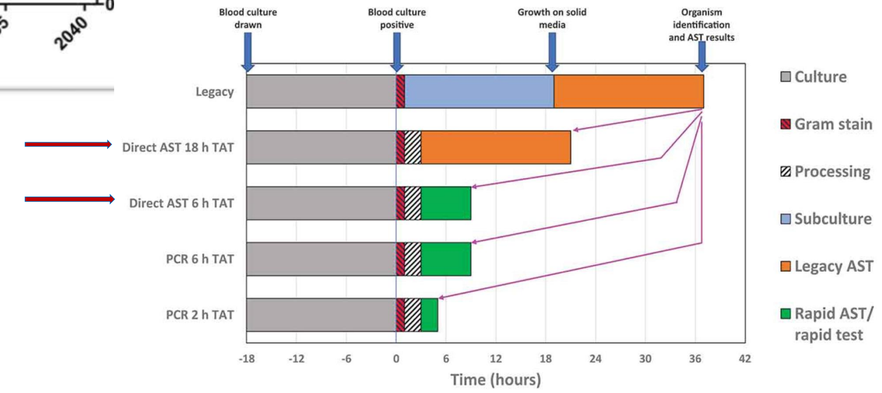
Date of update: 17 April 2022

unicef

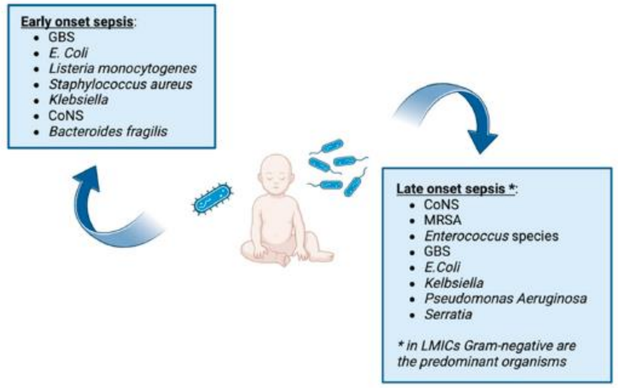


Loss of reliable empiric therapy

Timeline illustrating timing of blood culture results by legacy and rapid methods



Kenneth P. Smith et al. Clinics in Laboratory Medicine 2019
Michael R. Jacobs et al. Expert Review of Molecular Diagnostics 2021



*LMICs (low–middle-income countries)

Major bacterial species associated with neonatal sepsis

antibiotics
MDPI

Review

An Overview of Antibiotic Therapy for Early- and Late-Onset Neonatal Sepsis: Current Strategies and Future Prospects

Giovanni Boscarino [1], Rossana Romano [1], Carlotta Iotti [1], Francesca Tegoni [1], Serafina Perrone [2] and Susanna Esposito [1,*]

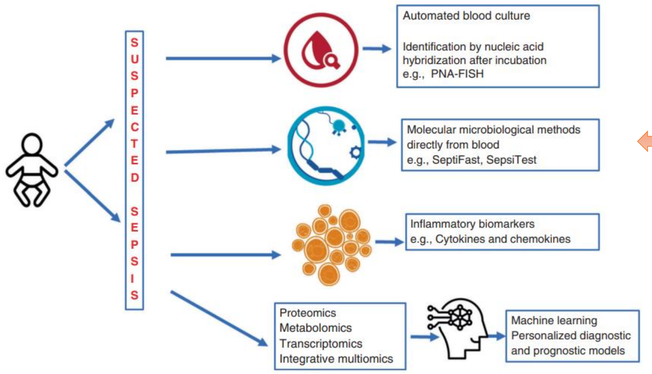
Empirical Antimicrobial Policies	Indication
β-lactam antibiotic + Aminoglycoside (Gentamicin)	Gram-positive and Gram-negative agents; this should be used in neonates non-colonized with MRSA to offer anti-staphylococcal coverage
β-lactam antibiotic + Aminoglycoside (Amikacin)	More resistant Gram-negative and some Gram-positive bacteria (i.e., *Staphylococcus aureus*); this could replace Gentamicin in selected cases (higher-risk preterm neonates or neonates with severe disease)
Glycopeptide + Aminoglycoside	Empiric Gram-positive and Gram-negative coverage; confirmed CoNS and MRSA
Piperacillin + Tazobactam or Ampicillin + Sulbactam	In combination or in alternative to aminoglycoside; Gram-positive and Gram-negative beta-lactamase-producing bacteria
Third- or fourth-generation Cephalosporin	In addition to empiric regimen; for severe penicillin-resistant Gram-negative sepsis or Gram-negative meningitis (no Ceftriaxone)
Carbapenems	ESBL and AmpC chromosomal beta-lactamase-producing Gram-negative; bacterial meningitis
Colistin	CRO

Common antibiotics for empirical therapy in suspected neonatal sepsis.

Antibiotics **2024**, 13, 250. https://doi.org/10.3390/antibiotics13030250

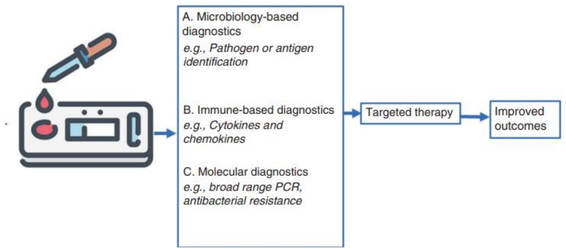
REVIEW ARTICLE

Diagnosis of neonatal sepsis: the past, present and future



Traditional methods of blood cultures have changed to automated blood culture monitoring for bacterial growth by CO2 detection.
Newer tests involve rapidly identifying organisms from positive cultures by fluorescent in situ hybridization techniques.
Molecular microbiological diagnostics using PCR for bacterial and fungal genes can be applied directly to blood specimens e.g., T2MR Bacteria and Candida.
Inflammatory biomarkers including CRP, procalcitonin, and cytokines are another category of adjunctive diagnostic tests.
Multiomic technology enables us to scour genome-wide gene expression, protein and metabolites for developing diagnostic tests and prognostic models.

Blood samples are drawn on suspicion of infection on laboratory chips that are microbiology, immune, or molecular-based diagnostics. The results enable us to initiate targeted therapy. The rapid results and targeted therapy will improve clinical outcomes.



Celik et al., Pediatr Res. 2022

Bartlett RC. 1974 *Medical microbiology: quality cost and clinical relevance*. Wiley, New York, NY

"Just because you can does not necessarily mean you should"

"More practical, economical, clinically meaningful approach"

Clinicians seek three basic truths:

Whether the patient is infected → If so, with what → and what will treat it

Guide the proper use of tests and the flow of results

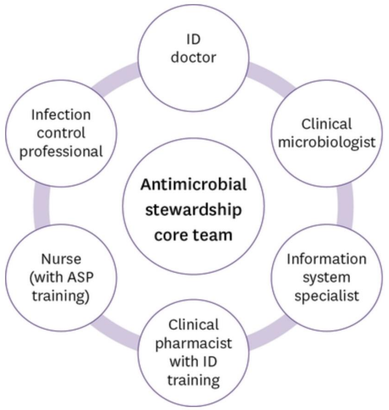
Help optimize empiric antibiotic prescribing by creating a facility **cumulative antibiotic resistance report or antibiogram**

Microbiology labs and stewardship programs can work together to optimize the use of r**apid diagnostic tests** and the communication of results

Cheong *et al. Infect Chemother* 2022

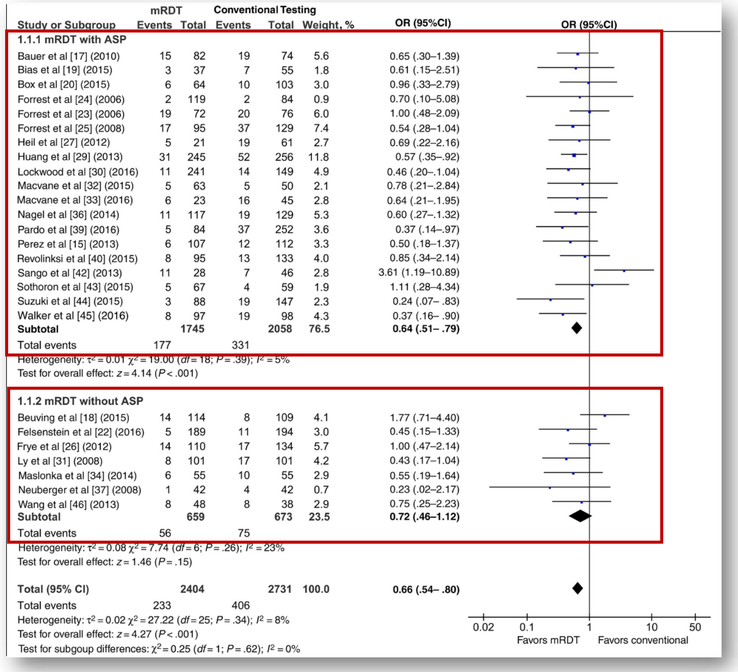
Cortegiani *et al. J Anesth Analg Crit Care 2023*

Multidisciplinary team responsible for implementing antimicrobial stewardship



Appropriate antimicrobial management includes:

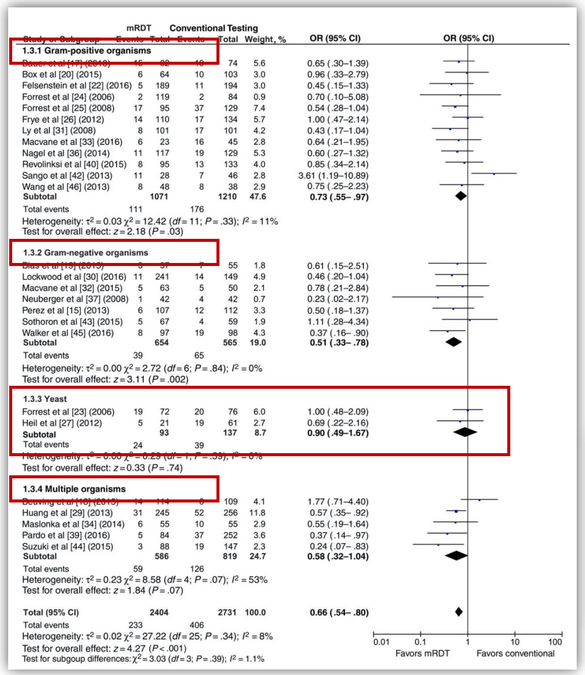
- Rapid identification of the pathogen and its susceptibility to antibiotics
- Treatment of the infection, choosing an optimized therapy
- Pursuit of rapid therapeutic action, aimed at avoiding prolonged therapy times



The Effect of Molecular Rapid Diagnostic Testing on Clinical Outcomes in Bloodstream Infections

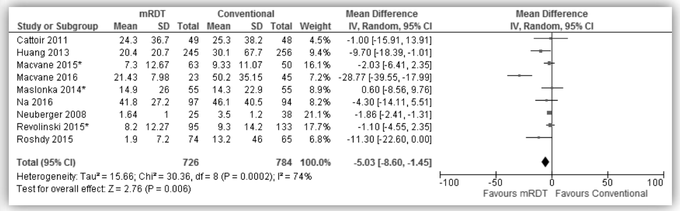
Mortality outcomes with molecular rapid diagnostic testing versus conventional testing in bloodstream infection

Tristan T. Timbrook et al. Clinical Infectious Diseases 2017

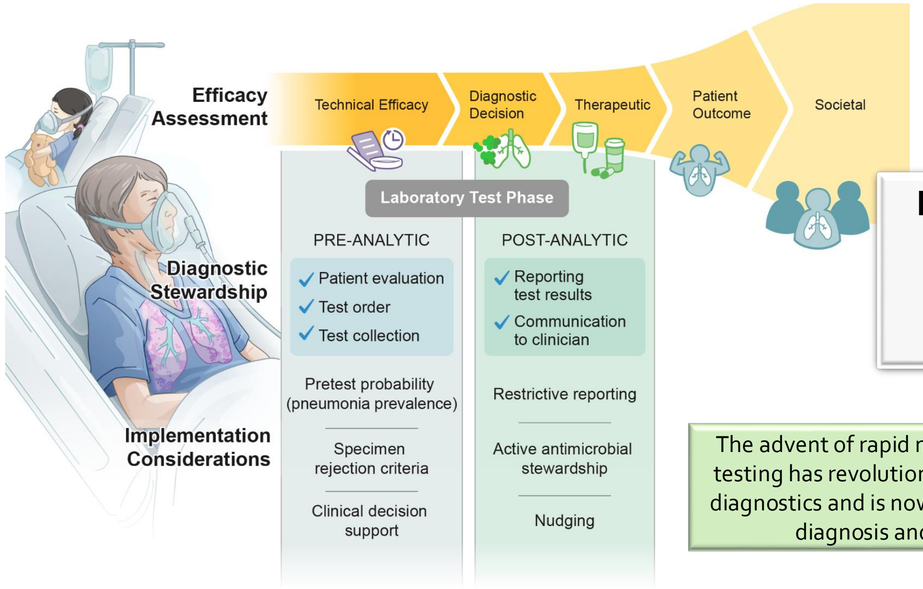


Mortality with molecular rapid diagnostic testing (mRDT) versus conventional testing by organism type in bloodstream infection

Length of stay with mRDT vs conventional testing in BSI



Tristan T. Timbrook et al. Clinical Infectious Diseases 2017



Diagnostic efficacy framework with implementation considerations

The advent of rapid molecular microbiology testing has revolutionized infectious disease diagnostics and is now impacting pneumonia diagnosis and management

The evolving landscape of microbiology testing yields substantial opportunities for clinical microbiologists and bedside providers to collaborate in developing implementation strategies to maximize the clinical utility of these advanced diagnostics in driving outcomes

Walker AM. et al., Diagnostics (Basel). 2024

- Right test
- Right patient
- Right time

Diagnostic stewardship

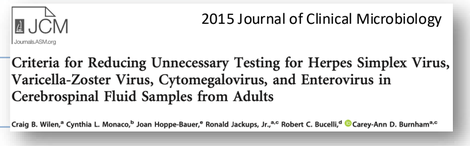
Key diagnostic stewardship considerations for implementation of rapid infectious disease diagnostics

1. Is the test appropriate for the clinical setting?

Evaluation of test performance, laboratory feasibility, and cost versus value

2. Will the clinical care of the patient be affected by the test result?

Directing testing toward the right patients

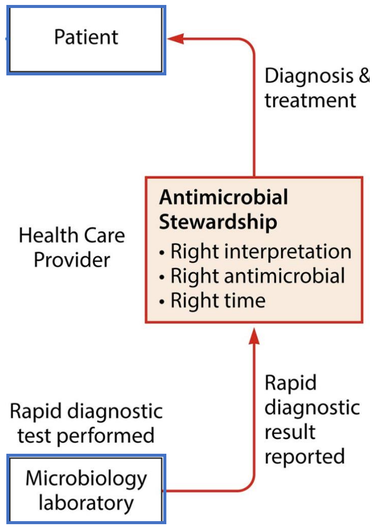


3. Will the result be available in time to optimally affect care?

The time to receive the sample in the clinical microbiology lab and the time to report the results

Messacar K. et al. J Clin Microbiol 2017

Antimicrobial stewardship



Key antimicrobial stewardship considerations for implementation of rapid infectious disease diagnostics

1. Will the clinician understand the test result?

Result report language, selective reporting of relevant results

2. Will the clinician appropriately modify antimicrobials based on test result?

Clinical practice guidelines, EMR-based decision support with result reporting

3. Will the clinician act upon the test result promptly?

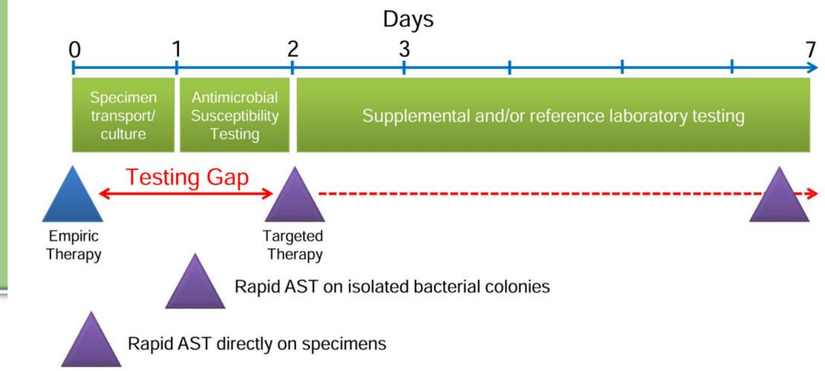
EMR reporting, AS real-time decision support

EMR: electronic medical record
AS: antimicrobial stewardship

Messacar K. et al. J Clin Microbiol 2017

- **Time (together with reliability) is one of the most important factors in defining the clinical relevance of the diagnostic tests in microbiology**

  - Respiratory infections
  - Sepsis
  - AMR
  - Meningitis



If not timely provided to the clinician, in most cases the result is useless

Rapid Susceptibility Testing Methods Kenneth P. Smith, PhD, James E. Kirby, MD
Clin Lab Med 2019

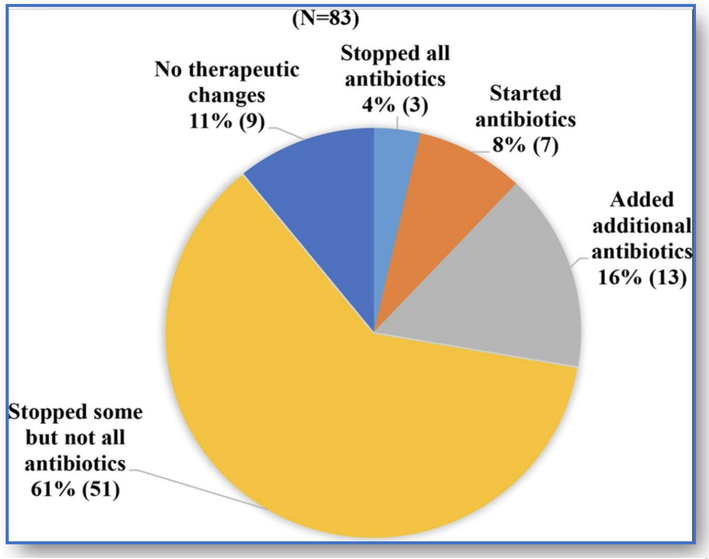
AMERICAN SOCIETY FOR MICROBIOLOGY | Journal of Clinical Microbiology®

Linsey M. *et al.*, Journal of Clinical Microbiology 2017

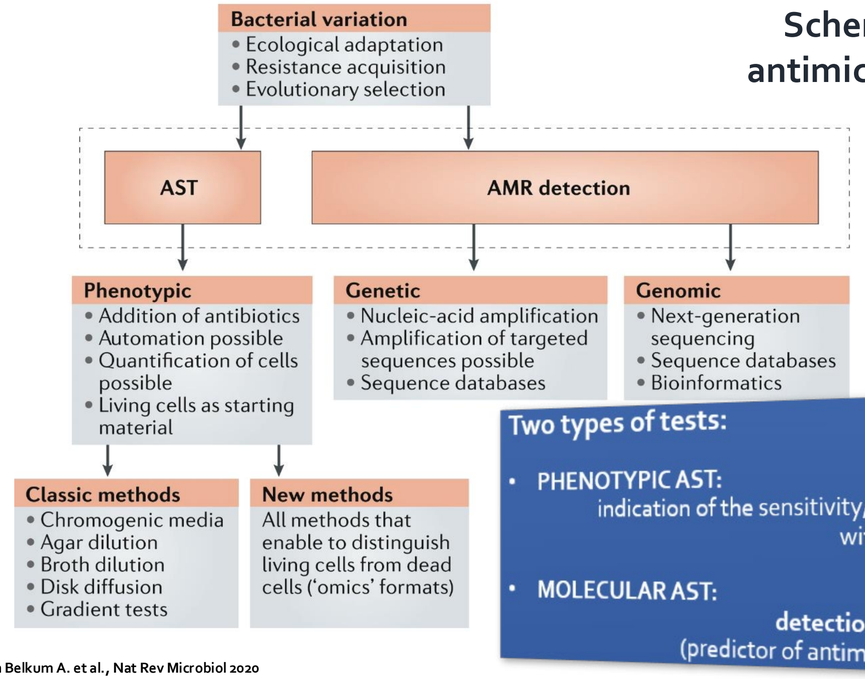
Assessment of Rapid-Blood-Culture-Identification Result Interpretation and Antibiotic Prescribing Practices

Self-reported changes in antibiotic therapy frequently made based on BCID results

Blood culture result interpretation



Schematic overview of antimicrobial susceptibility testing (AST)



Two types of tests:

- **PHENOTYPIC AST:**
  indication of the sensitivity/resistance of a microorganism with accurate MIC determination
- **MOLECULAR AST:**
  detection of selected amr mechanism (predictor of antimicrobial resistance phenotype)

van Belkum A. et al., Nat Rev Microbiol 2020

Rapid phenotypic AST methods for testing positive blood cultures

Ritu Banerjee et al., Frontiers in Medicine 2021

It is mandatory to promptly report accurate MIC values

Test	AST technology	TTR
PhenoTest BC (Accelerate Diagnostics)	Time-lapse imaging of bacterial cells under dark-field microscopy. Morphological and kinetic changes analyzed.	7 h
Alfred (AliFAX)	Light scattering to detect bacterial growth in liquid culture broth.	3–5 h
dRAST (QuantaMatrix)	Time-lapse imaging of bacterial cells on micropatterned plastic microchips.	6 h
Reveal AST (Specific Diagnostics)	Sensor array for volatile organic compounds emitted during microorganism growth.	4.5 h
ASTar (Q-linea)	Time-lapse imaging of bacterial growth in broth.	3–6 h
Fastinov	Flow cytometry applying fluorescent dyes that reveal cell damage during treatment.	80 min
LifeScale (Affinity Biosensors)	Mass measurement using a microcantilever.	4 h

Method	Resistance genes
Alifax Molecular Mouse System GRAM NEG RESIST	bla_{CTX-M}, bla_{SHV}, $bla_{CMY-1/MOX}$, bla_{CMY-2}, bla_{IMP}, bla_{NDM}, bla_{KPC}, bla_{VIM}, bla_{OXA-23}, bla_{OXA-48}, mcr-1, mcr-2
BioFire FilmArray Blood Culture Identification 2 (BCID2), Pneumonia plus (PNplus) panels and Joint Infection (JI) Panel	bla_{CTX-M}, bla_{NDM}, bla_{KPC}, bla_{VIM}, bla_{IMP}, bla_{OXA-48}, mcr-1
Eplex BCID-GN Panel	bla_{CTX-M}, bla_{NDM}, bla_{KPC}, bla_{VIM}, bla_{IMP}, bla_{OXA-23} bla_{OXA-48}
Eurospital Sepsis Flow Chip Kit Eurospital MDR Flow Chip Kit	bla_{CTX-M}, $bla_{CMY-1/MOX}$, bla_{SHV}, bla_{CMY}, bla_{DHA}, bla_{IMP}, bla_{NDM}, bla_{KPC}, bla_{VIM}, bla_{OXA-23}, bla_{OXA-48}, $bla_{NCM/IMI}$, bla_{GIM}, bla_{OXA-23}, bla_{OXA-24}, bla_{OXA-51}, bla_{OXA-58}, mcr-1, mcr-2
Unyvero Cartridge (Blood Culture, Hospitalized Pneumonia, Implant & Tissue Infection, Intra-Abdominal Infection, Urinary Tract Infection)	bla_{CTX-M}, bla_{SHV}, bla_{TEM}, bla_{NDM}, bla_{KPC}, bla_{VIM}, bla_{IMP}, bla_{OXA-23}, $bla_{OXA-24/40}$, bla_{OX--48}, bla_{OXA-58}
Verigene Gram-Negative Blood Culture test	bla_{CTX-M}, bla_{NDM}, bla_{KPC}, bla_{VIM}, bla_{IMP}, bla_{OXA-48}
Cefeide Xpert Carba-R	bla_{NDM}, bla_{KPC}, bla_{VIM}, bla_{IMP}, bla_{OXA-48}
Eazyplex® SuperBug CRE	bla_{NDM}, bla_{KPC}, bla_{VIM}, bla_{OXA-48}, bla_{OXA181}, $bla_{CTX-M-1}$, $bla_{CTX-M-9}$
Eazyplex® SuperBug complete C	bla_{CTX-M}, bla_{NDM}, bla_{KPC}, bla_{VIM}, bla_{IMP}, bla_{OXA-48}, bla_{OXA181}
Eazyplex® SuperBug AmpC	bla_{acc}, bla_{DHA}, bla_{CMYII}, bla_{MOX}
Hologic Novodiag® CarbaR+ Assay	bla_{NDM}, bla_{KPC}, bla_{VIM}, bla_{IMP}, $bla_{OXA-48/181}$, bla_{oxa23}, bla_{oxa24}, bla_{oxa51}, bla_{oxa58}, mcr-1

Molecular-genetic techniques for detection of gram negative resistance genes

Genetic and genomic detection of MRSA

Molecular Method Used	Principle of the Method	On Culture/on Clinical Sample	TAT [1]	Brief Advantages/Disadvantages +/−	No. and Type of *S. aureus* Analyzed [2]	Major Diagnostic Performance [3]
Xpert® SA Nasal Complete (Cepheid)	Real-time PCR for *mecA/C, spa* and SCC*mec-orfX*	Nasal samples	3 h	+ Clinical outcomes analyzed − 56 invalid results not further analyzed	10 MRSA in 605 nasal samples	Sensitivity 100% Specificity 98.8% PPV 58.8% NPV 100% TAT 41 h shorter
			85 m	− Unusual reference method	27 MRSA in 500 nasal samples	Sensitivity 51.8% Specificity 100%
Xpert® MRSA/SA BC Assay (Cepheid)	Real-time PCR for *mecA/C, spa* and SCC*mec-orfX*	Positive blood cultures	1.7 h	+ Clinical outcomes analyzed − More resistant isolates needed	1 MRSA 38 MSSA in 264 blood cultures	Sensitivity 100% specificity 100% TAT 24 h shorter, earlier changes in patient management
			n.a.	+ Clinical outcomes analyzed − Sensitivity/specificity not calculated	37 MRSA 64 MSSA	Time to optimal therapy 20 h shorter, duration of vancomycin therapy 18 h shorter
Xpert® MRSA/SA SSTI (Cepheid)	Real-time PCR for *mecA/C, spa* and SCC*mec-orfX*	BAL samples	68 m	+ Clinical outcomes analyzed − Method not validated in BAL samples	23 MRSA 25 MSSA in 247 BAL samples	Sensitivity 95.7% specificity 98.2% Time of linezolid/vancomycin treatment 40 h shorter
Hologic Panther Fusion® MRSA	PCR and Invader chemistries for *mecA/C, gap* and SCC*mec-orfX*	Nasal samples	<3 h	+ Can analyze 350 samples in 8 h − Need comparison with a similar method	30 MRSA 112 MSSA in 434 nasal swabs	Sensitivity 86.7%, specificity 98.8%, CA 97.9%
MRSA/SA ELITe MGB assay (ELITechGroup)	Real time PCR for *mecA/C* and a *S. aureus* specific sequence	Sputum, tracheal aspirate, BAL	<3 h	+ Accurate − Do not target SCC*mec-orfX* junction	23 MRSA 60 MSSA in 113 respiratory samples	Sensitivity 95.7% specificity 96.7% PPV 91.7% NPV 98.3%
Unyvero HPN Application	Multiple PCRs	BAL fluids	5 h	+ Detect 21 species and 19 resistance genes; mixed cultures detection − More resistant isolates needed	2 MRSA 1 MSSA in 84 BAL fluids	Sensitivity 100% specificity 98.7%

Molecular assays for detection of VRE

Method	Resistance genes
Alifax Molecular Mouse System GRAM POS RESIST	vanA, vanB
BioFire FilmArray Blood Culture Identification 2 (BCID2), Pneumonia plus (PNplus) panels and Joint Infection (JI) Panel	vanA/B
Eplex BCID-GN Panel	vanA, vanB
Eurospital Sepsis Flow Chip Kit Eurospital MDR Flow Chip Kit	vanA, vanB
Unyvero Cartridge (Blood Culture, Hospitalized Pneumonia, Implant & Tissue Infection, Intra-Abdominal Infection, Urinary Tract Infection)	vanA, vanB
Verigene Gram-Positive Blood Culture test	vanA, vanB
Eazyplex VRE	vanA, vanB

Antibiogramma cumulativo – materiali non invasivi anno 2023

Bambino Gesù Ospedale Pediatrico

3 GRAM - (Materiali non Invasivi	Total	Ampicillina	Amoxicillina/ clavulanato	Piperacillina/ tazobactam	Cefotaxime	Ceftazidime	Cefepime	Meropenem	Imipenem	Amikacina	Gentamicina	Ciprofloxacina	Trimetoprim/ sulfametoxazolo	Colistina	Ceftazidime/ avibactam	Ceftolozane/ tazobactam
Acinetobacter baumannii	37	R	R		R			88.6%	83.3%			80.6%	97.0%			
Enterobacter cloacae	163	R	R	74.6%	69.67%	71.53%	81.64%	93.78	92.80%	**96.9%**(1)	**93.9%**(1)	90.7%	81.3%		92.8%	81.7%
Escherichia coli	445			86.9%	79.9%	79.7%	84.3%	99.3%	98.3%	**97.3%**(1)	**84.0%**(1)	72.7%	59.0%		100.0%	93.1%
Klebsiella pneumoniae	278	R	67.9%	62.2%	50.0%	50.0%	50.7%	92.4%	91.1%	**99.1%**(1)	**71.9%**(1)	52.2%	50.0%		98.7%	78.1%
Proteus mirabilis	79		77.8%	100.0%	93.0%	69.0%	96.1%	97.4%	R	**100.0%**(1)	**96.0%**(1)	75.3%	56.9%	R	100.0%	74.1%
Pseudomonas aeruginosa	482	R	R	70.3%	R	76.5%	76.6%	79.3%	77.4%	**98.1%**(1)		81.0%	R		84.0%	81.7%
Serratia marcescens	90	R	R		84.5%	87.5%	96.6%	93.3%		**100.0%**(1)	**100.0%**(1)	98.8%	98.8%	R	97.7%	90.7%
Stenotrophomonas maltophilia	149	R	R	R	R			R	R	R	**R**		99.1%			

4 GRAM + (Materiali non Invasivi)	Total	Ampicillina	Penicillina	Oxacillina	linezolid	Daptomicina	Imipenem	Eritromicina	Levofloxacina	Teicoplanina	Vancomicina	Trimetoprim/ sulfametoxazolo	Gentamicina	Tetraciclina	Quinupristin/ dalfopristin
Enterococcus faecalis	259	100.0%			100.0%		100.0%			100.0%	100.0%		R		R
Enterococcus faecium	131	5.3%			100.0%		5.3%			73.8%	73.8%		R		
Staphylococcus aureus	784		23.2%	79.9%	100.0%	100.0%		55.4%	80.5%	100.0%	100.0%	97.3%	( )	89.1%	100.0%
Staphylococcus epidermidis	85			12.9%	100.0%	100.0%		20.2%	32.1%	98.7%	100.0%	51.9%	( )	34.1%	100.0%
Staphylococcus haemolyticus	44			7.0%	100.0%	100.0%		4.5%	7.0%	67.5%	100.0%	23.3%	( )	22.7%	100.0%
Staphylococcus hominis	12			33.3%	100.0%	100.0%		33.3%	66.7%	100.0%	100.0%	50.0%	( )	75.0%	100.0%

Antibiogramma cumulativo *- Percentuale di microrganismi sensibili isolati da materiali non invasivi*

NOTE: considerati solo campioni da tratto urinario

Legenda:

	>= 90% S
	70% - 89% S
	< 70% S
	Intrinsecamente Resistente
	Breakpoints in brackets

Antibiogramma cumulativo – materiali invasivi anno 2023

Bambino Gesù
OSPEDALE PEDIATRICO

1 GRAM – (Materiali Invasivi)	Total	Ampicillina	Amoxicillina/ clavulanato	Piperacillina/ tazobactam	Cefotaxime	Ceftazidime	Cefepime	Meropenem	Imipenem	Amikacina	Gentamicina	Ciprofloxacina	Trimetoprim/ sulfametoxazolo	Colistina	Ceftazidime/ avibactam	Ceftolozane/ tazobactam
Acinetobacter baumannii	6	R	R		R			33.3%	20.0%	( )	( )	20.0%	66.0%			
Enterobacter cloacae	45	R	R	80.9%	66.7%	60.0%	79.1%	93.3%	90.9%	( )	( )	77.8%	82.0%		91.1%	82.2%
Escherichia coli	37			83.8%	75.7%	73.0%	78.4%	100.0%	100.0%	( )	( )	66.7%	58.3%		100.0%	94.6%
Klebsiella pneumoniae	51	R	53.6%	46.9%	40.8%	41.6%	46.5%	80.4%	84.3%	( )	( )	41.2%	38.0%		100.0%	70.0%
Pseudomonas aeruginosa	37	R	R	59.5%	R	67.6%	67.7%	59.5%	63.9%	( )		85.7%	R		86.1%	88.9%
Proteus mirabilis	4		66.7%	100.0%	100.0%	100.0%	100.0%	100.0%	R	( )	( )	75.0%	50.0%	R	100.0%	75.0%
Serratia marcescens	12	R	R		81.8%	100.0%	100.0%	100.0%		( )	( )	83.3%	100.0%	R	100.0%	100.0%
Stenotrophomonas maltophilia	9	R	R	R	R			R	R	R	R		100.0%			

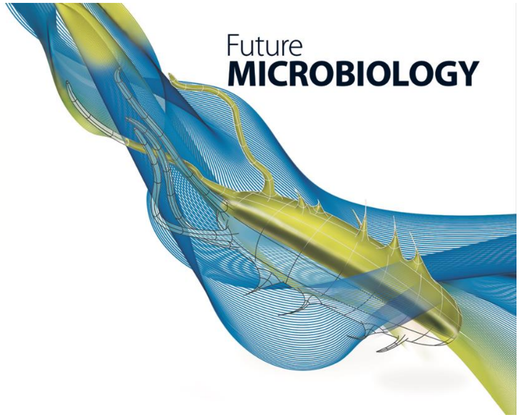
2 GRAM + (Materiali Invasivi)	Total	Ampicillina	Penicillina	Oxacillina	linezolid	Daptomicina	Imipenem	Eritromicina	Levofloxacina	Teicoplanina	Vancomicina	Trimetoprim/ sulfametoxazolo	Gentamicina	Tetraciclina	Quinupristin/ dalfopristin
Enterococcus faecalis	35	100.0%			100.0%		100.0%			100.0%	100.0%		R		R
Enterococcus faecium	23	8.7%			100.0%		8.7%			73.9%	73.9%		R		
Staphylococcus aureus	80		16.3%	75.0%	100.0%	100.0%		56.3%	78.8%	100.0%	100.0%	100.0%	( )	87.5%	100.0%
Staphylococcus epidermidis	298			14.8%	100.0%	100.0%		28.5%	41.4%	95.1%	100.0%	63.3%	( )	34.2%	100.0%
Staphylococcus haemolyticus	73			17.8%	100.0%	100.0%		8.2%	23.3%	97.1%	100.0%	39.7%	( )	26.1%	100.0%
Staphylococcus hominis	142			34.8%	100.0%	100.0%		21.8%	72.3%	100.0%	100.0%	63.8%	( )	54.2%	100.0%

Antibiogramma cumulativo - *Percentuale di microrganismi sensibili isolati da materiali invasivi*

Legenda:
>= 90% S
70% - 89% S
< 70% S
Intrinsecamente Resistente
Breakpoints in brackets

The 24-h clinical microbiology service is essential for patient management

Joseph M Blondeau*,[1,2] & Evgeny A Idelevich[3]



"In summary, optimal patient care requires access to necessary laboratory testing including clinical microbiology. A rethinking of hours of operation is required to shorten time to accurate result reporting."

Blondeau JM, Idelevich EA. Future Microbiol. 2018

Concluding remarks

Emerging antimicrobial resistance **makes empiric therapy unreliable**. Therefore, rapid antimicrobial susceptibility testing will provide early, definitive therapeutic guidance to optimize patient outcome

Genotypic rapid AST methods are fast but can only identify what we know about

Phenotypic rapid AST methods provide a nuanced integrated assessment of resistance that can be used to pick the most active therapy

The combined use of new technologies allows a fast diagnostic approach which shows a positive impact on early targeted therapy

The key elements to be acquired to protect frail patients, are: speed, accuracy of diagnosis, therapeutic appropriateness of new antibiotics, and the need for multidisciplinary task forces

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"good microbiology is clinically relevant microbiology"

Agree with the microbiologist on the most appropriate fast strategy to adopt…

Thank you for your attention

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