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ORIGINAL RESEARCH

Beyond the Cumulative Antibiogram: A Weighted-Incidence Syndromic Combination Antibiogram to Guide Empirical Therapy of Bloodstream Infections in the Emergency Department

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ABSTRACT

Introduction: Traditional cumulative antimicrobial susceptibility test report (cAST) have limitations in supporting empiric antibiotic selection decisions. We evaluated the complementary roles of weighted-incidence syndromic combination antibiogram (WISCA) and the traditional cumulative antimicrobial susceptibility test report (cAST) in guiding empirical therapy for bloodstream infections (BSIs) in the emergency department (ED).

Methods: We performed a retrospective cohort study including all consecutive adult BSI episodes attended in the ED of a tertiary-care hospital in Barcelona, Spain (January 2022–December 2024). A hospital cumulative antimicrobial susceptibility test report (cAST) was generated according to standard methodology for pathogens with ≥30 bloodstream isolates. WISCA coverage was calculated for eight monotherapy and six combination empirical regimens by weighting in vitro susceptibility according to pathogen frequency. Coverage was further stratified by infection acquisition (community-acquired vs. healthcare-associated) and source of infection.

Results: A total of 1716 BSI episodes were analyzed (median age 78 years; 55.2% male); 69.4% were healthcare-associated and the main source was urinary tract infection (42%). The 1913 isolates recovered were predominantly Gram-negative (70.3%); ESBL-producing Enterobacterales accounted for 24.9% of Enterobacterales. The cAST covered 87.3% of isolates after species grouping, whereas WISCA incorporated all pathogens. Highest WISCA coverage among monotherapies

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was observed with imipenem (94.8%), meropenem (91.3%), and piperacillin/tazobactam (89.6%). Ceftriaxone coverage increased from 65.1% to 88.7% when combined with amikacin, whereas carbapenem-based combinations provided only limited additional coverage overall (meropenem plus amikacin, 92.8%; meropenem plus vancomycin, 97.6%). Coverage was consistently lower in healthcare-associated than in community-acquired BSIs, particularly for ceftriaxone, fluoroquinolones, and amoxicillin/clavulanic acid, and was highest in respiratory-source BSIs.
Conclusions: WISCA complements the cAST by providing regimen-level, syndrome- and subgroup-specific coverage estimates, capturing pathogen diversity missed by species-threshold cAST reporting. Integrating WISCA into local antimicrobial-stewardship programs may refine empirical treatment choices for ED bacteremia, especially according to the BSI source and patient-specific characteristics, while supporting judicious use of broad-spectrum agents.

Keywords: Antimicrobial stewardship; Bloodstream infection; Cumulative antimicrobial susceptibility test report; Emergency department; Empirical antimicrobial therapy; Weighted-incidence syndromic combination antibiogram

Key Summary Points

Why carry out this study?

Traditional cumulative antimicrobial susceptibility test reports (cASTs) provide organism-specific susceptibility data but do not directly estimate the coverage of empirical antimicrobial regimens for bloodstream infection syndromes.

We assessed whether the weighted-incidence syndromic combination antibiogram (WISCA) could complement the cAST by estimating regimen-level coverage according to infection acquisition and source.

What was learned from this study?

WISCA incorporated all bloodstream pathogens and identified relevant differences in empirical coverage between community-acquired and healthcare-associated bloodstream infections and across infection sources.

Adding amikacin substantially improved ceftriaxone coverage, whereas carbapenem-based combinations generally yielded smaller incremental gains.

These stratified estimates may help antimicrobial-stewardship programs tailor empirical treatment to clinically distinct patient groups while avoiding unnecessary use of broad-spectrum antibiotics.

INTRODUCTION

Bloodstream infections (BSIs) remain a major cause of morbidity and mortality worldwide [1]. In patients with suspected BSI, empirical antimicrobial therapy should be started before pathogen identification, and susceptibility results become available. Inadequate empirical therapy has been associated with longer hospital stay and increased mortality [2, 3]. Therefore, knowledge of the local epidemiology of pathogens causing BSIs is essential for selecting appropriate empirical antibiotic therapy.

Cumulative antimicrobial susceptibility test (cAST) reports are commonly used to guide empirical prescribing. However, because they summarize susceptibility at the species level, they do not account for pathogen frequency within specific clinical syndromes, provide limited clinical stratification, and may not accurately reflect the microbiological complexity of polymicrobial infections [4–7]. The Clinical and Laboratory Standards Institute (CLSI) and the Spanish Antibiogram Committee (COESANT) provide recommendations for cAST reports [4, 5], but standardized approaches integrating microbiological and clinical data remain limited.

Weighted-incidence syndromic combination antibiograms (WISCAs) were developed to overcome these limitations [7]. WISCA estimates the probability that an empirical antimicrobial regimen will provide adequate coverage for a specific infectious syndrome by integrating pathogen prevalence and antimicrobial susceptibility across the full spectrum of causative organisms. This approach may be more clinically relevant for guiding empirical treatment decisions, particularly when the causative pathogen is unknown. Several studies have evaluated WISCA across different infectious syndromes and patient populations [8–18].

This study aimed to describe how WISCA complements the information provided by a conventional cAST in estimating empirical antimicrobial coverage across commonly used monotherapy and combination regimens in managing BSI in the emergency department (ED).

METHODS

Study Design and Setting

We conducted a retrospective observational cohort study including consecutive episodes of BSI attended in the ED of Hospital de la Santa Creu i Sant Pau, a tertiary-care teaching hospital in Barcelona, Spain, serving approximately 407,000 inhabitants and receiving around 160,000 ED visits annually. The study period was from January 1, 2022 to December 31, 2024. This study followed the reporting recommendations for observational cohort studies in *Clinical Microbiology and Infection* [19].

Participants

We consecutively included adult patients (≥ 18 years) who presented to the ED with community-onset BSI during the study period. BSI was defined as at least one positive blood culture yielding a clinically relevant pathogen. Blood cultures growing common skin commensals in a single set without clinical evidence that the isolate represented a true bloodstream infection were considered contaminants and excluded. Patients could contribute multiple episodes. Distinct episodes were defined as positive blood cultures separated by ≥14 days or a new infectious event considered unrelated to the previous episode.

Eight empirical antimicrobial treatment regimens and six combination regimens were evaluated: amoxicillin/clavulanic acid, ceftriaxone, piperacillin/tazobactam, ertapenem, imipenem, meropenem, ciprofloxacin, and levofloxacin. Combination regimens included ceftriaxone plus metronidazole, ceftriaxone plus gentamicin, ceftriaxone plus amikacin, ceftriaxone plus levofloxacin, meropenem plus vancomycin, and meropenem plus amikacin. These regimens were selected based on their frequent use in the empirical management of suspected BSI in the ED and their relevance in local clinical practice.

For combination regimens, coverage was assumed when at least one agent was active in vitro. For untested antibiotics, interpretation was inferred according to the EUCAST expert rules and expected phenotypes [20].

For polymicrobial BSI, a regimen was considered active only if all causative microorganisms were covered. For combination regimens, each microorganism had to be susceptible to at least one component of the regimen.

The primary outcome was the estimated empirical antimicrobial coverage of each regimen using the WISCA model and the traditional cAST. Secondary analyses assessed the same outcome after stratification by infection acquisition (community-acquired vs. healthcare-associated BSI), source of infection, and residence in a nursing home or long-term care facility, which was selected as a key marker of healthcare-associated exposure and risk of multidrug-resistant organisms outside the acute-care hospital setting.

An exploratory analysis evaluated clinical outcomes according to the WISCA coverage of the empirical regimen received. Regimens were categorized as low (< 70%), moderate (70–90%), or high (> 90%) coverage, overall and stratified by infection acquisition. Outcomes included adequate empirical antimicrobial therapy, vasopressor use, and 7- and 30-day mortality.

Data Collection and Variables

We obtained clinical and demographic variables from electronic health records, and retrieved microbiological data from the microbiology laboratory information system.

Acquisition of infection was classified according to the definitions proposed by Friedman et al. [21, 22]. We assigned the suspected infection source at the time of ED admission, based on the initial clinical diagnosis and microbiological results.

Microbiology

Blood culture studies were performed using the BactAlert VIRTUO system (bioMérieux, France). Microorganism identification was achieved using MALDI-TOF mass spectrometry (Bruker Daltonik GmbH, Bremen, Germany). Antimicrobial susceptibility testing was performed using disc diffusion methodology (I2A, France) and Sensititre broth microdilution panels (Thermo Fisher Scientific, United Kingdom). Results were interpreted according to the European Committee on Antimicrobial Susceptibility Testing (EUCAST) clinical breakpoints applicable at the time of testing [23]. EUCAST phenotypic double-disk synergy tests were used to detect extended-spectrum β-lactamases (ESBLs), cloxacillin inhibition testing to detect AmpC β-lactamases [24], and immunochromatographic assays (NG-Test CARBA 5, NG Biotech, France) to detect carbapenemases (KPC, VIM, IMP, NDM, OXA-48).

cAST and WISCA Construction

The traditional cAST was constructed following to COESANT recommendations including only the first isolate per patient. Susceptibility was expressed as the percentage of isolates categorized as susceptible at standard dosing regimen (S) plus susceptible at increased exposure (I), according to EUCAST definitions. Species-specific susceptibility rates were calculated only for microorganisms with ≥30 isolates. Enterobacterales species with <30 isolates were grouped together. Coagulase-negative staphylococci and viridans group streptococci were also analyzed as grouped categories.

WISCA estimates were calculated by multiplying the probability of each causative microorganism by the probability of susceptibility to each antimicrobial regimen and summing these products across all microorganisms [8]:

$$\mathrm{WISCA} = \Sigma_i[\mathrm{P}(\mathrm{pathogen}_i) \times \mathrm{P}(\mathrm{susceptible}|\mathrm{pathogen}_i)]$$

We estimated each pathogen's probability as its relative frequency among BSI episodes, and calculated susceptibility probabilities from observed in vitro susceptibility profiles.

Sample Size

This study included all consecutive eligible BSI episodes from a previously established cohort of patients presenting to the emergency department (ED) during the study period (Batista CSP et al., manuscript submitted for publication). Because the analysis was based on a predefined cohort, no formal sample size calculation was performed.

Statistical Methods

Continuous variables were summarized as mean with standard deviation or median with interquartile range (IQR) as appropriate, and categorical variables as frequencies and percentages. Analyses were conducted using a complete-case approach. WISCA estimates were calculated overall and within predefined subgroups. Uncertainty was assessed using non-parametric bootstrap resampling with 1000 replicates, generating 95% highest density interval (HDI). Categorical outcomes across WISCA coverage groups were compared using the chi-squared or Fisher's exact test, as appropriate.

All analyses were performed using the AMR package (version 3.0.1.9002) in R statistical software (R Foundation for Statistical Computing, Vienna, Austria; version 4.4.3). The study was approved by the Ethics Committee of Hospital de la Santa Creu i Sant Pau (IIBSP-WIS-2022-144; April 17, 2024) and conducted in accordance with the Declaration of Helsinki and European data protection regulations. The ethics committee waived the informed consent requirement because of the study's retrospective observational design.

RESULTS

Study Population and Microbiology

During the study period, 1716 episodes of BSIs were included. Baseline characteristics and infection features are shown in Table 1. The median age was 78 years (IQR 67–86), 947 patients were male (55.2%) and 419 (24.4%) resided in nursing homes or long-term care facilities. Overall, 271 (15.8%) required vasopressors, and 219 (12.8%) died within 30 days.

Most episodes were healthcare-associated (1191, 69.4%). The most frequent source was urinary tract infection (721, 42%), followed by abdominal infection (347, 20.2%), and bacteremia of unknown source (295, 17.2%). Polymicrobial BSIs occurred in 144 episodes (8.4%).

Overall, 1913 microorganisms were isolated from blood cultures. Of these, 1344 (70.3%) were Gram-negative bacteria, 557 (29.1%) were Gram-positive bacteria, and 12 (0.6%) were yeasts. The most frequent species were *Escherichia coli* (804/1913, 42%), *Klebsiella pneumoniae* (193/1913, 10.1%), *Staphylococcus aureus* (133/1913, 7%), *Streptococcus pneumoniae* (98/1913, 5.1%), and *Pseudomonas aeruginosa* (83/1913, 4.3%). Supplementary Material shows the etiological distribution; full counts are provided in Supplementary Table S1 and Supplementary Figure S1. Polymicrobial BSIs accounted for 330 microorganisms.

Among Enterobacterales, 294/1181 (24.9%) were ESBL producers, 38/1181 (3.2%) AmpC producers, and 7/1181 (0.6%) were carbapenemase producers. Among *P. aeruginosa* isolates, 7/83 (8.4%) were extensively drug-resistant according to Magiorakos et al. [25]. Methicillin resistance was observed in 37/133 (27.8%) *S. aureus* isolates. One vancomycin-resistant enterococcal isolate was identified.

Cumulative Antimicrobial Susceptibility Test

The cAST is shown in Table 2. Seven species accounted for 75.4% of all microorganisms. After grouping Enterobacterales species with fewer than 30 isolates, coagulase-negative staphylococci, and viridans group streptococci, the cAST represented 87.3% of all microorganisms. The remaining isolates corresponded to more than 75 different species, each with fewer than 30 isolates.

In the cAST, carbapenems exhibited the highest activity against Enterobacterales, with susceptibility rates ranging from 93% to 100%, followed by amikacin (97.1–99.1%). Against *P. aeruginosa*, all antipseudomonal agents demonstrated susceptibility rates exceeding 85%. Among Gram-positive organisms, *S. pneumoniae* showed high susceptibility to β-lactams (96.9–100%), with complete susceptibility to fluoroquinolones and vancomycin. *Enterococcus faecalis* remained fully susceptible to amoxicillin/clavulanic acid, piperacillin/tazobactam, and imipenem, whereas fluoroquinolone susceptibility was around 70%. Vancomycin resistance was rare, with only one resistant *E. faecalis* isolate detected.

Overall WISCA Estimates

The WISCA analysis is shown in Table 3. Among monotherapy regimens, the highest estimated coverage was observed with imipenem (94.8%), meropenem (91.3%), piperacillin/tazobactam (89.6%) and ertapenem (85.8%). Combination regimens increased empirical coverage. Ceftriaxone alone provided 65.1% coverage, increasing to 88.7% with amikacin and 81.8% with gentamicin. The addition of levofloxacin resulted in 76.7% coverage, whereas metronidazole provided minimal improvement (67.5%). In

Table 1 Baseline characteristics, infection features, and mortality in 1716 patients with bloodstream infection

	Total *n* = 1716) *N* (%)
Demographic characteristics	
Age, median (IQR), years	78 (67–86)
Sex	
Female	769 (44.8)
Male	947 (55.2)
Comorbidities	
Cancer	530 (30.9)
Diabetes mellitus	501 (29.2)
Renal failure	375 (21.9)
Congestive heart failure	311 (18.1)
Cognitive impairment	302 (17.6)
Chronic respiratory disease	235 (13.7)
Liver disease	96 (5.6)
Immunological status	
Immunosuppressive therapy	281 (16.4)
Neutropenia	152 (8.9)
Transplant recipient	39 (2.3)
Risk Factors for MDR Organism Infection	
Age ≥70 years	1213 (70.7)
Hospitalization (previous year)	798 (46.5)
Residence in nursing home/long-term care facility	419 (24.4)
Antimicrobial use (previous 90 days)	396 (23.1)
Previous isolation of MDR organisms	238 (13.9)
Infection characteristics	
Origin	
Healthcare-associated	1191 (69.4)
Community-acquired	525 (30.6)
Source of infection	
Urinary	721 (42)
Abdominal	347 (20.2)
Respiratory	117 (6.8)
Cutaneous	95 (5.5)
Cardiovascular	58 (3.4)
Catheter-related	37 (2.2)
Articular	26 (1.5)
Neurological	15 (0.9)
Gynecological	5 (0.3)
Unknown source	295 (17.2)
Polymicrobial	144 (8.4)
MDR microorganism	370 (21.6)
ESBL	285 (16.6)
MRSA	37 (2.2)
Severity/clinical management	
Hospital admission	1388 (80.9)
Vasopressor use	271 (15.8)
ICU admission	99 (5.8)
Mortality	
Death at 7 days	138 (8)
Death at 30 days	219 (12.8)

ICU intensive care unit; Pathogens were considered multidrug-resistant (MDR) when identified as ESBL-producing Enterobacterales, carbapenemase-producing Enterobacterales (CPE), AmpC β-lactamase-producing Enterobacterales (including plasmid-mediated and chromosomally derepressed isolates), methicillin-resistant *Staphylococcus aureus* (MRSA), or vancomycin-resistant *Enterococcus* spp. (VRE). For *Pseudomonas aeruginosa*, MDR and extensively drug-resistant (XDR) phenotypes were defined according to the international consensus criteria proposed by Magiorakos et al.

contrast, carbapenem-based regimens showed limited additional benefit. Meropenem in combination with amikacin (92.8%) or vancomycin

(97.6%) provided only modest increases in coverage.

Stratified WISCA Analyses

Empirical coverage was consistently higher in community-acquired than in healthcare-associated BSI. The largest differences were observed for ceftriaxone (81.4% vs. 58.2%), ciprofloxacin (79.8% vs. 59.1%), amoxicillin/clavulanic acid (78.4% vs. 59.4%) and piperacillin/tazobactam (95.8% vs. 87%). This pattern was particularly evident in urinary-source bacteremia, where ceftriaxone coverage decreased from 82.5% in community-acquired episodes to 50.9% in healthcare-associated episodes.

In urinary-source bacteremia, the highest monotherapy coverage was observed with imipenem (97.3%), meropenem (95.2%), piperacillin/tazobactam (90.6%) and ertapenem (90.3%). Meropenem plus vancomycin and meropenem plus amikacin achieved 98.4% and 96.3% coverage, respectively. In respiratory-source bacteremia, coverage was high with meropenem (97.5%), imipenem (96.7%), piperacillin/tazobactam (95%), and fluoroquinolones (95–95.8%), whereas amoxicillin/clavulanic acid and ceftriaxone reached 87.5%. For abdominal-source bacteremia, ceftriaxone plus metronidazole achieved 78.3% coverage overall and 85.3% in community-acquired episodes.

Meropenem coverage was lower in catheter-related (66.7%) and cardiovascular-source bacteremia (72.4%), but increased to 95.6% and 100%, respectively, when combined with vancomycin.

Residence in nursing homes or long-term care facilities was associated with lower ceftriaxone coverage (48.9% vs. 70.4%), whereas carbapenem-based regimens including meropenem plus vancomycin maintained high coverage across subgroups.

Coverage was generally lower in polymicrobial than in monomicrobial BSI, particularly for ertapenem (79.1% vs. 87.2%), meropenem (85.8% vs. 92.4%), and meropenem plus amikacin (86.7% vs. 94.1%). Meropenem plus vancomycin maintained high coverage in both groups (97% vs. 97.8%) (Table 3).

Exploratory Clinical Outcome Analysis

Higher WISCA coverage was associated with a greater proportion of adequate empirical antimicrobial therapy, increasing from 72.4% with <70% coverage to 87.9% with 70–90% coverage and 94.4% with >90% coverage ($p < 0.001$). However, patients receiving higher-coverage regimens more frequently required vasopressors (8.8%, 21.6%, and 26.2%, respectively; $p < 0.001$) and showed higher crude 7- and 30-day mortality. Similar patterns were observed after stratification by infection acquisition and regimen (Tables 4 and 5, Supplementary Figure S1).

DISCUSSION

This study shows that WISCA provides clinically relevant information beyond that available from conventional cAST by integrating pathogen frequency with susceptibility to generate syndrome-specific estimates of empirical antimicrobial coverage.

The WISCA approach was first described by Hebert et al. for abdominal-biliary and urinary tract infections [7]. Their study showed that WISCA reports the probability that a regimen covers an infectious syndrome, rather than the susceptibility of a single organism to a single drug. This distinction is relevant for empirical prescribing, when the causative pathogen is unknown.

WISCA may assist antimicrobial stewardship teams in developing local empirical treatment recommendations for patients with suspected severe BSI, when early appropriate antimicrobial therapy is essential, considering the source of infection, the mode of acquisition, and other risk factors for multidrug-resistant (MDR) organisms, such as residence in long-term care facilities. However, its use should not replace antimicrobial stewardship principles or restrictive empirical prescribing strategies. In clinically stable patients, unnecessary

Table 2 Traditional cumulative antibiogram (cAST) for bloodstream infections diagnosed in the emergency department: percentage of susceptible isolates

	n	AMC	CRO	TZP	ETP	IPM	MEM	CIP	LVX	GEN	AMK	VAN	CRO + GEN	CRO + AMK	CRO + LVX	MEM + AMK	MEM + VAN
E. coli	804	60.1%	71.6%	94.2%	99.9%	100.0%	100.0%	60.2%	60.2%	82.7%	97.1%	-	87.9%	97.9%	75.5%	100.0%	100.0%
K. pneumoniae	193	63.2%	68.4%	82.4%	93.3%	99.0%	99.0%	67.9%	67.9%	81.3%	97.4%	-	83.4%	98.4%	75.6%	99.5%	99.0%
P. mirabilis	69	76.8%	63.8%	98.6%	100.0%	100.0%	100.0%	36.2%	36.2%	63.8%	98.6%	-	82.6%	98.6%	63.8%	100.0%	100.0%
Other Enterobacterales	115	41.7%	84.3%	92.2%	93.0%	100.0%	100.0%	89.6%	89.6%	90.4%	99.1%	-	95.7%	99.1%	94.8%	100.0%	100.0%
P. aeruginosa	83	-	-	88.0%	-	85.5%	94.0%	88.0%	88.0%	-	100.0%	-	-	100.0%	88.0%	100.0%	85.5%
S. aureus	133	72.2%	72.2%	72.2%	72.2%	72.2%	72.2%	71.4%	71.4%	89.5%	89.5%	100.0%	93.2%	93.2%	76.7%	93.2%	100.0%
CoNS	39	51.3%	51.3%	51.3%	51.3%	51.3%	51.3%	51.3%	51.3%	59.0%	59.0%	100.0%	69.2%	69.2%	59.0%	69.2%	100.0%
E. faecalis	62	100.0%	-	100.0%	-	100.0%	-	69.4%	69.4%	-	-	98.4%	-	-	69.4%	-	98.4%
S. pneumoniae	98	96.9%	100.0%	96.9%	100.0%	100.0%	100.0%	100.0%	100.0%	-	-	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Viridans group streptococci	73	100.0%	97.3%	100.0%	100.0%	100.0%	100.0%	79.5%	79.5%	-	-	100.0%	97.3%	97.3%	98.6%	100.0%	100.0%

AMC, amoxicillin/clavulanic acid; CRO, ceftriaxone; TZP, piperacillin/tazobactam; ETP, ertapenem; IPM, imipenem; MEM, meropenem; CIP, ciprofloxacin; LVX, levofloxacin; GEN, gentamicin; AMK, amikacin; VAN, vancomycin;

Percent Susceptible including susceptible at standard dosing regimen (S) or susceptible at increased exposure (I), according to EUCAST definitions.

Legend:

>85%
50% - 85%
<50%

Table 3 Weighted-incidence syndromic combination antibiograms (WISCA) for bloodstream infections in the emergency department

	n	AMC	CRO	TZP	ETP	IPM	MEM	CIP	LVX	CRO + GEN	CRO + AMK	CRO + MTR	CRO + LVX	MEM + VAN	MEM + AMK
All isolates	1913	65.1% [62.9 - 67.1]	65.1% [62.9 - 67.2]	89.6% [88.2 - 91.1]	85.8% [84.3 - 87.3]	94.8% [93.8 - 95.7]	91.3% [90.0 - 92.5]	65.3% [63.0-67.3]	66.4% [64.3 - 68.5]	81.8% [79.9 - 83.5]	88.7% [87.2 - 90.1]	67.5% [65.5 - 69.6]	76.7% [74.8 - 78.6]	97.6% [96.9 - 98.3]	92.8% [91.7 - 94.0]
By origin															
Community - acquired	570	78.4% [74.9 - 81.4]	81.4% [78.2 - 84.4]	95.8% [94.0 - 97.4]	93.2% [91.1 - 95.1]	98.2% [97.0 - 99.1]	94.9% [92.8 - 96.7]	79.8% [76.5-83.0]	81.9% [78.8 - 85.1]	89.6% [87.2 - 91.9]	92.3% [90.0 - 94.4]	83.5% [80.7 - 86.5]	90.5% [88.1 - 92.8]	98.2% [97.0 - 99.3]	94.7% [92.8 - 96.5]
Healthcare - associated	1343	59.4% [56.8 - 62.1]	58.2% [55.5 - 61.0]	87.0% [85.3 - 88.8]	82.7% [80.6 - 84.9]	93.3% [92.0 - 94.6]	89.7% [88.2 - 91.4]	59.1% [56.6-61.7]	59.9% [57.3 - 62.4]	78.4% [76.1 - 80.5]	87.2% [85.3 - 89.0]	60.7% [58.1 - 63.4]	70.8% [68.4 - 73.2]	97.4% [96.4 - 98.2]	92.0% [90.5 - 93.5]
By focus															
Abdominal	442	68.1% [63.3 - 72.2]	71.9% [67.9 - 76.0]	91.9% [88.9 - 94.3]	88.9% [85.5 - 91.6]	96.8% [95.0 - 98.2]	92.5% [90.0 - 94.8]	69.7% [65.4-73.8]	69.9% [65.8 - 74.2]	81.0% [77.4 - 84.6]	84.4% [80.8 - 87.8]	78.3% [74.4 - 81.9]	82.6% [79.0 - 86.0]	97.3% [95.7 - 98.6]	92.1% [89.6 - 94.6]
Cardiovascular	58	91.4% [84.5 - 98.3]	69.0% [56.9 - 81.0]	93.1% [86.2 - 98.3]	72.4% [60.3 - 82.8]	93.1% [86.2 - 98.3]	72.4% [60.3 - 82.8]	82.8% [72.4-91.4]	82.8% [72.4 - 91.4]	74.1% [62.1 - 86.2]	74.1% [62.1 - 86.2]	69.0% [56.9 - 81.0]	89.7% [81.0 - 96.6]	100.0% [100.0 - 100.0]	77.6% [67.2 - 87.9]
Catheter - related	45	42.2% [28.9 - 57.8]	42.2% [28.8 - 55.6]	60.0% [46.7 - 73.4]	46.7% [31.1 - 62.2]	66.7% [53.3 - 80.0]	66.7% [53.3 - 80.0]	51.1% [37.8-64.4]	51.1% [37.8 - 64.4]	73.3% [60.0 - 84.4]	73.3% [60.0 - 84.4]	42.2% [28.8 - 55.6]	57.8% [42.2 - 71.1]	95.6% [88.9 - 100.0]	75.6% [62.2 - 86.7]
Cutaneous	107	70.1% [60.7 - 78.5]	65.4% [56.1 - 73.8]	84.1% [76.6 - 90.7]	74.8% [66.4 - 83.2]	86.9% [79.4 - 93.5]	85.0% [77.6 - 91.6]	71.0% [61.7-80.4]	71.0% [61.7 - 80.4]	86.0% [79.4 - 92.5]	86.9% [80.4 - 93.5]	69.2% [60.7 - 77.6]	81.3% [73.8 - 88.8]	95.3% [90.7 - 99.1]	90.7% [85.0 - 95.3]
Unknown source	329	69.3% [63.8 - 74.2]	62.3% [57.1 - 67.5]	89.4% [86.0 - 92.7]	81.5% [77.2 - 85.7]	93.6% [90.9 - 96.0]	87.8% [84.5 - 91.5]	64.4% [59.6-69.6]	69.6% [64.7 - 74.8]	80.9% [76.6 - 85.1]	85.7% [81.8 - 89.7]	65.0% [59.9 - 70.2]	80.5% [76.0 - 85.1]	97.0% [94.8 - 98.8]	88.8% [85.4 - 92.1]
Respiratory	120	87.5% [80.8 - 93.3]	87.5% [80.8 - 93.3]	95.0% [90.8 - 98.3]	89.2% [83.3 - 94.2]	96.7% [93.3 - 99.2]	97.5% [94.2 - 100.0]	95.0% [90.8-98.3]	95.8% [91.7 - 99.2]	96.7% [93.3 - 99.2]	99.2% [97.5 - 100.0]	87.5% [80.8 - 93.3]	95.8% [91.7 - 99.2]	97.5% [94.2 - 100.0]	99.2% [97.5 - 100.0]
Urinary	766	55.9% [52.5 - 59.3]	59.4% [56.0 - 62.9]	90.6% [88.5 - 92.4]	90.3% [88.4 - 92.3]	97.3% [96.1 - 98.3]	95.2% [93.6 - 96.6]	56.9% [53.3-60.6]	57.2% [53.5 - 60.7]	80.5% [77.7 - 83.3]	93.2% [91.4 - 94.9]	59.5% [56.1 - 63.1]	68.0% [64.7 - 71.3]	98.4% [97.5 - 99.2]	96.3% [94.9 - 97.5]
By healthcare - associated and focus															
Abdominal	279	65.9% [60.6 - 71.3]	67.4% [61.6 - 73.1]	89.2% [85.7 - 92.5]	86.0% [81.7 - 90.0]	95.7% [93.2 - 97.8]	91.4% [88.2 - 94.3]	69.5% [64.2-74.9]	69.9% [64.5 - 74.9]	78.9% [73.5 - 83.9]	83.5% [78.9 - 87.5]	74.2% [69.2 - 79.6]	81.4% [76.7 - 86.0]	97.5% [95.3 - 99.3]	91.4% [87.8 - 94.3]
Cardiovascular	35	88.6% [77.1 - 97.1]	65.7% [51.4 - 80.0]	91.4% [82.9 - 100.0]	71.4% [57.1 - 85.7]	91.4% [82.9 - 100.0]	71.4% [57.1 - 85.7]	74.3% [60.0-88.6]	74.3% [60.0 - 88.6]	71.4% [57.1 - 85.7]	71.4% [57.1 - 85.7]	65.7% [51.4 - 80.0]	85.7% [74.3 - 97.1]	100.0% [100.0 - 100.0]	77.1% [62.9 - 88.6]
Catheter – related	45	42.2% [28.9 - 57.8]	42.2% [28.8 - 55.6]	60.0% [46.7 - 73.4]	46.7% [31.1 - 62.2]	66.7% [53.3 - 80.0]	66.7% [53.3 - 80.0]	51.1% [37.8-64.4]	51.1% [37.8 - 64.4]	73.3% [60.0 - 84.4]	73.3% [60.0 - 84.4]	42.2% [28.8 - 55.6]	57.8% [42.2 - 71.1]	95.6% [88.9 - 100.0]	75.6% [62.2 - 86.7]
Cutaneous	71	63.4% [52.1 - 73.2]	60.6% [47.9 - 71.8]	81.7% [73.2 - 90.1]	70.4% [59.2 - 80.3]	84.5% [76.1 - 91.5]	83.1% [74.6 - 91.5]	64.8% [53.5-76.1]	64.8% [53.5 - 76.1]	85.9% [77.5 - 94.4]	87.3% [78.9 - 94.4]	64.8% [53.5 - 74.6]	77.5% [67.6 - 87.3]	97.2% [93.0 - 100.0]	91.5% [84.5 - 97.2]
Unknown source	257	64.6% [58.8 - 70.4]	59.5% [53.3 - 65.8]	88.3% [84.0 - 92.2]	79.4% [73.9 - 84.0]	93.0% [89.5 - 96.1]	86.4% [82.1 - 90.3]	61.5% [55.6-67.7]	64.2% [58.4 - 70.0]	77.4% [72.4 - 82.5]	84.0% [79.4 - 88.3]	62.6% [56.8 - 68.9]	75.9% [70.8 - 81.3]	96.5% [94.2 - 98.5]	87.9% [83.7 - 91.8]
Respiratory	68	77.9% [67.6 - 86.8]	77.9% [67.6 - 86.8]	91.2% [83.8 - 97.1]	80.9% [70.6 - 89.7]	94.1% [88.2 - 98.5]	95.6% [89.7 - 100.0]	91.2% [83.8-97.1]	92.6% [86.8 - 98.5]	94.1% [88.2 - 98.5]	98.5% [95.6 - 100.0]	77.9% [67.6 - 86.8]	92.6% [86.8 - 98.5]	95.6% [89.7 - 100.0]	98.5% [95.6 - 100.0]

Table 3 continued

	n	AMC	CRO	TZP	ETP	IPM	MEM	CIP	LVX	CRO + GEN	CRO + AMK	CRO + MTR	CRO + LVX	MEM + VAN	MEM + AMK
Urinary	560	50.2% [45.9 - 54.3]	50.9% [46.8 - 55.0]	88.4% [85.5 - 90.9]	88.4% [85.7 - 91.1]	96.4% [94.6 - 97.9]	94.3% [92.3 - 96.1]	47.9% [44.1-51.8]	48.0% [44.1 - 52.0]	76.6% [73.0 - 80.0]	91.4% [89.1 - 93.7]	51.1% [47.0 - 55.2]	60.0% [56.2 - 63.8]	98.0% [97.0 - 99.1]	95.7% [94.1 - 97.3]
By community - acquired and focus															
Abdominal	163	71.8% [65.0 - 78.5]	79.8% [73.0 - 85.9]	96.3% [93.3 - 98.8]	93.9% [89.6 - 96.9]	98.8% [96.3 - 100.0]	94.5% [90.8 - 97.5]	69.9% [62.6-77.3]	69.9% [62.6 - 77.3]	84.7% [79.1 - 90.2]	85.9% [80.4 - 90.8]	85.3% [79.8 - 90.8]	84.7% [78.5 - 90.2]	96.9% [94.5 - 99.4]	93.3% [89.6 - 96.9]
Cutaneous	36	83.3% [69.4 - 94.4]	75.0% [61.1 - 86.2]	88.9% [77.8 - 97.2]	83.3% [69.4 - 94.4]	91.7% [83.3 - 100.0]	88.9% [77.8 - 97.2]	83.3% [72.2-94.4]	83.3% [72.2 - 94.4]	86.1% [75.0 - 94.4]	86.1% [75.0 - 94.4]	77.8% [63.9 - 88.9]	88.9% [77.8 - 97.2]	91.7% [83.3 - 100.0]	88.9% [77.8 - 97.2]
Unknown source	72	86.1% [77.8 - 93.1]	72.2% [62.5 - 81.9]	93.1% [87.5 - 98.6]	88.9% [81.9 - 95.8]	95.8% [90.3 - 100.0]	93.1% [86.1 - 98.6]	75.0% [63.9-84.7]	88.9% [81.9 - 95.8]	93.1% [87.5 - 98.6]	91.7% [84.7 - 97.2]	73.6% [63.9 - 83.3]	97.2% [93.1 - 100.0]	98.6% [95.8 - 100.0]	91.7% [84.7 - 97.2]
Respiratory	52	100.0% [100.0 - 100.0]	100.0% [100.0 - 100.0]	100.0% [100.0 - 100.0]	100.0% [100.0 - 100.0]	100.0% [100.0 - 100.0]	100.0% [100.0 - 100.0]	100.0% [100.0- 100.0]	100.0% [100.0 - 100.0]	100.0% [100.0 - 100.0]	100.0% [100.0 - 100.0]	100.0% [100.0 - 100.0]	100.0% [100.0 - 100.0]	100.0% [100.0 - 100.0]	100.0% [100.0 - 100.0]
Urinary	206	71.4% [65.5 - 77.7]	82.5% [77.2 - 87.4]	96.6% [93.7 - 99.0]	95.6% [93.2 - 98.1]	99.5% [98.5 - 100.0]	97.6% [95.1 - 99.5]	81.6% [76.2-86.9]	82.0% [76.2 - 86.9]	91.3% [87.4 - 94.7]	98.1% [96.1 - 99.5]	82.5% [77.2 - 87.4]	89.8% [85.9 - 93.7]	99.5% [98.5 - 100.0]	98.1% [96.1 - 99.5]
Residence in nursing home / long - term care facility															
Yes	472	49.2% [44.7 - 53.2]	48.9% [44.5 - 53.2]	84.7% [81.4 - 88.1]	83.9% [80.7 - 87.1]	92.4% [89.8 - 94.7]	89.4% [86.7 - 92.2]	43.6% [39.2-47.9]	44.3% [40.0 - 48.5]	76.1% [72.2 - 79.9]	89.4% [86.7 - 92.2]	50.2% [45.6 - 54.7]	58.5% [54.0 - 62.9]	97.7% [96.0 - 98.9]	93.2% [90.9 - 95.6]
No	1441	70.3% [67.9 - 72.4]	70.4% [68.1 - 72.7]	91.3% [89.7 - 92.7]	86.4% [84.6 - 88.1]	95.5% [94.4 - 96.5]	91.8% [90.4 - 93.1]	72.4% [70.1-74.7]	73.7% [71.6 - 75.9]	83.6% [81.8 - 85.6]	88.5% [86.8 - 90.2]	73.1% [70.7 - 75.4]	82.7% [80.8 - 84.5]	97.6% [96.8 - 98.4]	92.6% [91.3 - 94.1]
Polymicrobial bloodstream infections															
Yes	330	61.5% [56.1-66.7]	60.6% [55.2-65.5]	88.2% [84.2-91.2]	79.1% [74.5-83.3]	94.2% [91.5-96.4]	85.8% [81.8-89.1]	66.4% [61.2-71.2]	67.0% [61.8-71.8]	77.6% [72.7-81.8]	83.3% [78.8-87.0]	63.6% [58.5-68.5]	75.5% [70.6-80.0]	97.0% [94.8-98.5]	86.7% [82.7-90.0]
No	1583	65.8% [63.5-68.2]	66.1% [63.6-68.4]	90.0% [88.5-91.4]	87.2% [85.5-88.8]	94.8% [93.8-95.9]	92.4% [91.1-93.6]	65.1% [62.8-67.5]	66.3% [64.1-68.7]	82.6% [80.7-84.4]	89.8% [88.4-91.3]	68.3% [65.9-70.6]	76.9% [74.7-79.0]	97.8% [97.1-98.5]	94.1% [92.8-95.1]

AMC, amoxicillin/clavulanic acid; CRO, ceftriaxone; TZP, piperacillin/tazobactam; ETP, ertapenem; IPM, imipenem; MEM, meropenem; CIP, ciprofloxacin; LVX, levofloxacin; GEN, gentamicin; AMK, amikacin; MTR, metronidazole; VAN, vancomycin;

95% highest density interval (HDI) are reported in parentheses

Legend:

>85%
50% - 85%
<50%

Table 4 Clinical outcomes according to WISCA coverage of the empirical regimen, overall and stratified by infection acquisition

Variable	<70%	70–90%	>90%	*p* value
Overall				
Adequate empirical antimicrobial therapy	518 (72.4%)	204 (87.9%)	284 (94.4%)	<0.001
Death at 7 days	61 (8.5%)	29 (12.5%)	63 (20.9%)	<0.001
Death at 30 days	34 (4.8%)	21 (9.1%)	42 (14.0%)	<0.001
Vasopressor use	63 (8.8%)	50 (21.6%)	79 (26.2%)	<0.001
Community-acquired				
Adequate empirical antimicrobial therapy	–	256 (82.6%)	79 (97.5%)	0.001
Death at 7 days	–	32 (10.3%)	26 (32.1%)	< 0.001
Death at 30 days	–	9 (2.9%)	8 (9.9%)	0.012
Vasopressor use	–	18 (5.8%)	11 (13.6%)	0.032
Healthcare-associated				
Adequate empirical antimicrobial therapy	276 (65.7%)	337 (89.2%)	58 (98.3%)	< 0.001
Death at 7 days	35 (8.3%)	83 (22.0%)	16 (27.1%)	< 0.001
Death at 30 days	26 (6.2%)	49 (13.0%)	5 (8.5%)	0.004
Vasopressor use	44 (10.5%)	69 (18.3%)	11 (18.6%)	0.005

broad-spectrum antibiotic therapy should continue to be avoided.

The traditional cAST remains useful for surveillance and provides organism-level data while excluding species below reporting thresholds. This also highlights a limitation of cAST in BSI, where pathogen diversity may limit species-level reporting for less common pathogens. A similar limitation has been described in low-volume or high-diversity settings [15]. In nursing homes, only one of 59 facilities could generate a CLSI-standard urinary antibiogram, whereas WISCA-based models increased this proportion to 36–85% [15]. In our study, WISCA included all causative pathogens, including infrequent species excluded from the cAST.

This advantage may be particularly relevant in polymicrobial BSI, where empirical coverage must simultaneously account for all causative microorganisms. Unlike organism-specific cAST, WISCA can evaluate whether a single regimen or combination provides complete episode-level coverage.

Our findings are consistent with studies in other infectious syndromes. In ICU ventilator-associated pneumonia and catheter-related bloodstream infection, Randhawa et al. found that no monotherapy exceeded 85% coverage, whereas several dual regimens exceeded 90% [13]. In our ED BSI cohort, carbapenems and piperacillin/tazobactam had the highest monotherapy coverage, while combinations mainly increased coverage when vancomycin or amikacin was added.

In a pediatric febrile neutropenia WISCA study, Liberati et al. found that piperacillin/tazobactam plus amikacin increased from 78 to 89% coverage when a glycopeptide was added [12]. Similarly, in our cohort, the benefit of meropenem plus vancomycin was concentrated in catheter-related, osteoarticular,, and cardiovascular-source bacteremia, particularly healthcare-associated cases, and was limited in urinary and

Table 5 WISCA coverage and clinical outcomes according to the empirical antimicrobial regimen received, overall and stratified by infection acquisition

Origin	Empirical regimen used	n	WISCA	AEAT	Vasopressor use	Death at 7 days	Death at 30 days
Overall	CRO	345	65.1	249 (72.2%)	22 (6.4%)	5 (1.4%)	17 (4.9%)
	MEM	230	91.3	214 (93.0%)	58 (25.2%)	36 (15.7%)	50 (21.7%)
	CRO + MTR	166	67.5	126 (75.9%)	22 (13.3%)	11 (6.6%)	19 (11.4%)
	AMC	165	65.1	116 (70.3%)	13 (7.9%)	16 (9.7%)	23 (13.9%)
	TZP	126	89.6	105 (83.3%)	35 (27.8%)	12 (9.5%)	19 (15.1%)
	ETP	52	85.8	52 (100.0%)	2 (3.8%)	4 (7.7%)	5 (9.6%)
	MEM + VAN	44	97.6	44 (100.0%)	14 (31.8%)	3 (6.8%)	6 (13.6%)
	CRO + LVX	32	76.7	27 (84.4%)	6 (18.8%)	4 (12.5%)	4 (12.5%)
	IPM	27	94.8	26 (96.3%)	7 (25.9%)	3 (11.1%)	7 (25.9%)
	CRO + GEN	22	81.8	20 (90.9%)	7 (31.8%)	1 (4.5%)	1 (4.5%)
	CIP	20	65.3	12 (60.0%)	4 (20.0%)	1 (5.0%)	1 (5.0%)
	LVX	19	66.4	15 (78.9%)	2 (10.5%)	1 (5.3%)	1 (5.3%)
Community—acquired	CRO	152	81.4	130 (85.5%)	9 (5.9%)	3 (2.0%)	9 (5.9%)
	CRO + MTR	68	83.5	55 (80.9%)	10 (14.7%)	0 (0.0%)	1 (1.5%)
	AMC	57	78.4	44 (77.2%)	6 (10.5%)	4 (7.0%)	6 (10.5%)
	MEM	31	94.9	30 (96.8%)	11 (35.5%)	4 (12.9%)	6 (19.4%)
	TZP	25	95.8	24 (96.0%)	7 (28.0%)	0 (0.0%)	0 (0.0%)
	CRO + GEN	15	89.6	14 (93.3%)	4 (26.7%)	1 (6.7%)	1 (6.7%)
	CIP	11	79.8	6 (54.5%)	2 (18.2%)	1 (9.1%)	1 (9.1%)
	CRO + LVX	9	90.5	9 (100.0%)	3 (33.3%)	3 (33.3%)	3 (33.3%)
	LVX	7	81.9	7 (100.0%)	1 (14.3%)	0 (0.0%)	0 (0.0%)
	IPM	6	98.2	6 (100.0%)	2 (33.3%)	1 (16.7%)	2 (33.3%)
	MEM + VAN	6	98.2	6 (100.0%)	3 (50.0%)	0 (0.0%)	0 (0.0%)
	ETP	4	93.2	4 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Healthcare—associated	MEM	199	89.7	184 (92.5%)	47 (23.6%)	32 (16.1%)	44 (22.1%)
	CRO	193	58.2	119 (61.7%)	13 (6.7%)	2 (1.0%)	8 (4.1%)
	AMC	108	59.4	72 (66.7%)	7 (6.5%)	12 (11.1%)	17 (15.7%)
	TZP	101	87	81 (80.2%)	28 (27.7%)	12 (11.9%)	19 (18.8%)
	CRO + MTR	98	60.7	71 (72.4%)	12 (12.2%)	11 (11.2%)	18 (18.4%)

Table 5 continued

Origin	Empirical regimen used	n	WISCA	AEAT	Vasopressor use	Death at 7 days	Death at 30 days
	ETP	48	82.7	48 (100.0%)	2 (4.2%)	4 (8.3%)	5 (10.4%)
	MEM + VAN	38	97.4	38 (100.0%)	11 (28.9%)	3 (7.9%)	6 (15.8%)
	CRO + LVX	23	70.8	18 (78.3%)	3 (13.0%)	1 (4.3%)	1 (4.3%)
	IPM	21	93.3	20 (95.2%)	5 (23.8%)	2 (9.5%)	5 (23.8%)
	LVX	12	59.9	8 (66.7%)	1 (8.3%)	1 (8.3%)	1 (8.3%)
	CIP	9	59.1	6 (66.7%)	2 (22.2%)	0 (0.0%)	0 (0.0%)
	CRO + GEN	7	78.4	6 (85.7%)	3 (42.9%)	0 (0.0%)	0 (0.0%)

AMC, amoxicillin/clavulanic acid; CRO, ceftriaxone; TZP, piperacillin/tazobactam; ETP, ertapenem; IPM, imipenem; MEM, meropenem; CIP, ciprofloxacin; LVX, levofloxacin; GEN, gentamicin; AMK, amikacin; MTR, metronidazole; VAN, vancomycin; AEAT, adequate empirical antimicrobial therapy; WISCA, weighted-incidence syndromic combination antibiogram

abdominal sources. Vancomycin use should therefore reflect the likelihood of glycopeptide-requiring pathogens, not numerical coverage alone.

Quinolones showed lower overall coverage, except in respiratory-source BSI. Ceftriaxone plus levofloxacin did not improve coverage over levofloxacin alone, although it exceeded ceftriaxone monotherapy. This likely reflects that these were mainly community-onset BSI, rather than atypical or nosocomial pneumonias. This suggests that the value of dual therapy depends on expected respiratory microbiology rather than on combination therapy itself.

Lower empirical coverage in healthcare-associated bloodstream infections, likely reflecting differences in pathogen epidemiology, supports the use of acquisition-specific WISCA estimates, which are more directly applicable to empirical treatment decisions than conventional cumulative antibiograms.

These results should be interpreted from a stewardship perspective. Because no validated cAST or WISCA cutoff exists, coverage targets should depend on severity, with approximately 80% potentially acceptable for non-severe infections and ≥90% favored for severe infections or critically ill patients [4, 7, 11, 13, 26]. Higher coverage does not necessarily imply a preferable regimen.

In practice, WISCA may be incorporated into periodic antimicrobial stewardship review of local empirical treatment guidelines alongside syndrome-specific cAST data. This requires linkage of microbiological susceptibility data with clinical information on infection source and acquisition. Ideally, these data are reviewed jointly by microbiology and the multidisciplinary stewardship team and interpreted together with disease severity, patient characteristics, antimicrobial toxicity and ecological impact. WISCA should be recalculated during scheduled guideline reviews and when relevant changes in local epidemiology occur, rather than used as a stand-alone tool to select the regimen with the highest numerical coverage.

In the exploratory outcome analysis, higher WISCA coverage was associated with a greater probability of adequate empirical therapy but not with lower crude mortality. Higher-coverage regimens were also more frequently administered to patients requiring vasopressors, suggesting substantial confounding by indication, as broader empirical therapy was preferentially selected for patients with greater clinical

severity. These findings should therefore not be interpreted as evidence of a causal relationship between WISCA coverage and mortality.

Whether WISCA-guided prescribing improves clinical outcomes remains uncertain, as evidence from interventional studies has been inconclusive [18]. WISCA should therefore be regarded as a decision-support tool that complements clinical judgment and antimicrobial stewardship. In this study, uncertainty was addressed using bootstrap resampling. Future work should assess Bayesian or hierarchical WISCA approaches and whether patient-level predictors improve empirical treatment selection.

This study has limitations. It was conducted in a single center and reflects local pathogen distribution and antimicrobial susceptibility. The clinical outcome analysis was exploratory and subject to confounding by indication, and did not account for antibiotic dosing, source control, drug exposure or toxicity. Some untested antibiotic-pathogen combinations required rule-based assumptions. Finally, WISCA estimates should not be interpreted as treatment recommendations without clinical validation.

CONCLUSIONS

WISCA complemented the traditional cAST by providing empirical coverage estimates that incorporated pathogen frequency, susceptibility, and clinical subgroups. In ED bacteremia, this approach identified differences between syndromes and patient groups that were not captured by the overall cAST. WISCA may help inform local empirical treatment guidelines when used together with clinical judgement and antimicrobial stewardship review.

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Data Availability. The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest. Celso Soares Pereira Batista, Laura Escolà-Vergé, Ferran Navarro and Alba Rivera declare that they have no conflicts of interest.

Ethical Approval. The study was approved by the Ethics Committee of Hospital de la Santa Creu i Sant Pau (IIBSP-WIS-2022-144; April 17, 2024). and conducted in accordance with the Declaration of Helsinki and European data protection regulations. The requirement for informed consent was waived by the ethics committee due to the retrospective observational design of the study.

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