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Frequency of Occurrence and Antimicrobial Susceptibility of Bacteria Isolated from Patients Hospitalized with Bacterial Pneumonia in the United States, Western Europe, and Eastern Europe: Results from the SENTRY Program (2016–2019)

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SENTRY ANTIMICROBIAL SURVEILLANCE

Introduction

- The SENTRY Antimicrobial Surveillance Program (SENTRY) monitors the frequency of occurrence and antimicrobial susceptibility of organisms from various infection types worldwide.
- Pneumonia is the second most common infection in hospitalized patients, and it is associated with significant morbidity and mortality.
- The initial antimicrobial management of patients with pneumonia mainly is driven by the understanding of causative pathogens; there are very limited data available on the frequency and antimicrobial susceptibility of organisms causing pneumonia.
- In the SENTRY Program, bacterial isolates are consecutively collected (1 per infection episode) according to the infection type and sent to a central monitoring laboratory (JMI Laboratories, North Liberty, Iowa, USA) where they are tested for susceptibility by reference broth microdilution methods against many antimicrobial agents currently available for clinical use.
- We evaluated the frequency and antimicrobial susceptibility patterns of pathogens collected by the SENTRY Program from patients hospitalized with bacterial pneumonia in 2016–2019.

Materials and Methods

Organism collection

- A total of 28,918 bacterial isolates were collected (1/patient) in 2016–2019 from 121 medical centers located in:
  - United States (US; n=17,770; 82 centers).
  - Western Europe (W-EU; n=7,966; 25 centers from 10 nations).
  - Eastern Europe (E-EU; n=3,182; 14 centers from 11 nations).
- Each participating center was asked to collect consecutive bacterial isolates from lower respiratory tract specimens determined to be significant by local criteria as the reported probable cause of pneumonia.
- Qualified sputum samples and isolates from invasive sampling (transtracheal aspiration, bronchoalveolar lavage, protected brush samples, etc.) were accepted.
- Carbapenem-resistant *Enterobacterales* (CRE) was defined as any isolate displaying MIC values of >2 mg/L for meropenem, imipenem (not applied for *Proteus mirabilis* or indole-positive Proteeae), and/or doripenem.

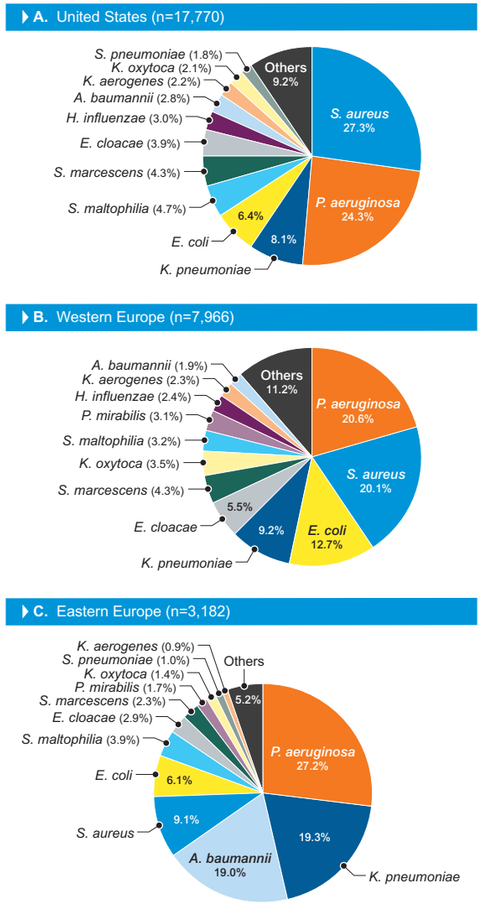
Susceptibility methods

- Organisms were tested for susceptibility by reference broth microdilution methods in a central laboratory.
- MIC panels were prepared at JMI Laboratories and broth microdilution tests were conducted according to the current Clinical and Laboratory Standards Institute (CLSI) documents.
- Susceptibility percentages and quality control results validation were based on the EUCAST (2020) and CLSI (M100; 2020) documents.

Results

- Gram-negative bacilli (GNB) represented 69.1%, 76.3%, and 88.6% of organisms; non-fermentative (NF) GNB represented 34.6%, 26.9%, and 51.8% of organisms in US, W-EU, and E-EU, respectively (Figures 1 and 2).
- High prevalence of NF-GNB was observed: *P. aeruginosa* ranked first in W-EU and E-EU and second in the US, *A. baumannii* ranked third in E-EU, and *S. maltophilia* was among the top 8 in all 3 regions (fifth in the US; Figure 1).
- *P. aeruginosa* susceptibility to piperacillin-tazobactam and meropenem was 76.1% and 74.8% in the US, 75.4% and 76.9% in W-EU, and 57.4% and 48.3% in E-EU, respectively (Table 1 and Figure 3).
- Overall MRSA rates were 43.7% in US, 21.4% in W-EU, and 28.7% in E-EU (Table 1 and Figure 3).
- MRSA rates decreased from 44.8% in 2016 to 40.2% in 2019 ($p<0.05$) in the US and from 29.3% in 2016 to 16.1% in 2019 in W-EU; in E-EU, MRSA rates increased from 32.8% in 2016 to 38.6% in 2019 (Table 2).
- CRE rates decreased continuously in the US from 3.0% in 2016 to 1.7% in 2019 ($p<0.05$; 2.4% overall) and were higher in E-EU (16.6%) than W-EU (2.2%; Table 2 and Figure 4).

Figure 1. Frequency of occurrence of organisms isolated from patients hospitalized with pneumonia stratified by geographic region (2016–2019)



- Among *K. pneumoniae*, susceptibility to ceftriaxone and meropenem was 80.7% and 94.9% in the US, 70.1% and 90.7% in W-EU, and 34.5% and 70.4% in E-EU, respectively (Table 1 and Figure 4).
- Among *E. coli*, susceptibility to ceftriaxone and levofloxacin was 71.4% and 55.0% in the US, 79.2% and 71.2% in W-EU, and 62.6% and 55.9% in E-EU, respectively (Table 1 and Figure 4).
- Only 10.4% of *A. baumannii* isolates from E-EU were MEM-susceptible compared to 45.8% in W-EU and 58.8% in the US (Table 1 and Figure 5).

Table 1. Antimicrobial susceptibility of main organisms isolated from patients hospitalized with pneumonia from United States (USA), Western Europe (W-EU), and Eastern Europe (E-EU)

Organism/ Antimicrobial agent	% Susceptible by geographic region (no. of isolates)[a]		
	USA	W-EU	E-EU
S. aureus	(4,844)	(1,598)	(289)
Oxacillin	56.3	78.6	71.3
Ceftaroline	96.4	97.4	94.8
Clindamycin	80.7	94.4	87.9
Doxycycline	97.8	98.9	98.6
Levofloxacin	61.1	78.9	84.1
TMP-SMX[b]	98.2	99.5	99.3
P. aeruginosa	(4,322)	(1,644)	(864)
Ceftazidime	81.0	79.2	63.2
Ceftazidime-avibactam	96.4	96.5	82.9
Ceftolozane-tazobactam	96.8	93.9	80.8
Piperacillin-tazobactam	76.1	75.4	57.4
Meropenem	74.8	76.9	48.3
Levofloxacin	60.9	68.0	40.7
Tobramycin	91.5	89.4	68.5
K. pneumoniae	(1,432)	(733)	(615)
Ceftriaxone	80.7	70.1	34.5
Ceftazidime-avibactam	100.0	99.2	92.0
Ceftolozane-tazobactam	92.3	87.3	56.7
Piperacillin-tazobactam	87.8	78.8	46.2
Meropenem	94.9	90.7	70.4
Levofloxacin	82.6	71.2	39.2
Gentamicin	89.9	80.9	55.9
E. coli	(1,132)	(1,015)	(195)
Ceftriaxone	71.4	79.2	62.6
Ceftazidime-avibactam	100.0	99.9	99.5
Ceftolozane-tazobactam	95.8	98.8	98.5
Piperacillin-tazobactam	90.5	87.7	90.8
Meropenem	99.4	99.6	99.5
Levofloxacin	55.1	71.2	55.9
Gentamicin	84.7	89.0	79.5
E. cloacae	(1,224)	(436)	(92)
Ceftriaxone	65.6	61.5	56.7
Ceftazidime-avibactam	100.0	99.1	98.9
Ceftolozane-tazobactam	78.2	83.4	83.7
Piperacillin-tazobactam	76.8	76.6	78.3
Meropenem	97.6	99.1	96.7
Levofloxacin	92.5	89.4	82.6
Gentamicin	94.7	92.2	79.3
S. marcescens	(772)	(341)	(74)
Ceftriaxone	83.1	89.4	85.1
Ceftazidime-avibactam	99.7	100.0	100.0
Ceftolozane-tazobactam	97.2	97.3	97.3
Piperacillin-tazobactam	91.6	93.8	97.3
Meropenem	98.2	100.0	100.0
Levofloxacin	89.1	90.0	91.9
Gentamicin	96.9	99.7	90.5
A. baumannii	(493)	(153)	(604)
Ceftazidime	56.2	45.8	6.8
Piperacillin-tazobactam	49.3	39.7	6.0
Meropenem	58.8	45.8	10.4
Levofloxacin	56.2	44.4	6.1
Amikacin	77.7	56.9	15.2
Tobramycin	75.7	56.2	33.4
Colistin	91.3	98.0	82.3
S. maltophilia	(836)	(252)	(125)
Ceftazidime	18.1	14.3	16.0
Minocycline	99.2	100.0	100.0
Levofloxacin	74.5	83.7	84.0
TMP-SMX[b]	94.0	96.4	94.3

[a] Criteria as published by CLSI (2020).
[b] TMP-SMX, trimethoprim-sulfamethoxazole.

Conclusions

- Rank order and antimicrobial susceptibility of bacteria isolated from patients hospitalized with pneumonia varied widely by geographic region.
- *P. aeruginosa* and *S. aureus* combined represented 51.6% and 40.7% of organisms isolated from patients with pneumonia in US and W-EU, respectively, and were the most common pathogens in these regions.
- Multidrug-resistant NF-GNB, such as *P. aeruginosa, A. baumannii,* and *S. maltophilia*, represented an important cause of pneumonia in US and Europe.
- The occurrence of some key resistance phenotypes increased in some regions and decreased in other regions over the 4 years of the investigation.

Figure 2. Frequency of Gram-negative and Gram-positive organisms isolated from patients hospitalized with pneumonia stratified by geographic region (2016–2019)

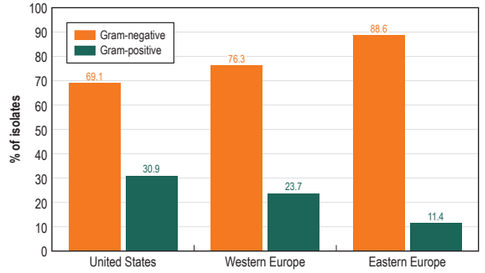


Figure 4. Frequency of meropenem-nonsusceptible *K. pneumoniae* (MEM-NS KPN), ceftriaxone-nonsusceptible *E. coli* (CRO-NS EC), and carbapenem-resistant *Enterobacterales* (CRE) isolated from patients hospitalized with pneumonia stratified by geographic region (2016–2019)

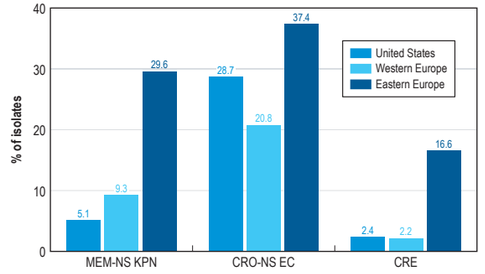


Table 2. Frequency of key resistance phenotypes stratified by year

Resistance phenotype / Region	Year			
	2016	2017	2018	2019
MRSA				
USA	44.8	44.5	42.9	40.1
W-EU	29.2	20.8	19.7	16.1
E-EU	32.8	23.5	17.5	38.6
PIP-TAZ-NS *P. aeruginosa*				
USA	23.8	25.2	24.8	21.1
W-EU	28.8	24.1	22.9	22.2
E-EU	39.6	40.2	44.5	47.2
MEM-NS *A. baumannii*				
USA	45.4	46.3	35.8	29.6
W-EU	65.3	74.2	45.2	29.0
E-EU	93.1	86.3	84.2	93.0
CRE				
USA	3.0	2.5	1.8	1.7
W-EU	4.0	1.8	2.0	1.4
E-EU	10.5	15.8	17.2	23.6

Abbreviations: MRSA, methicillin-resistant *S. aureus*; W-EU, Western Europe; E-EU, Eastern Europe; PIP-TAZ, piperacillin-tazobactam; NS, nonsusceptible; MEM, meropenem; CRE, carbapenem-resistant *Enterobacterales*

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Figure 3. Frequency of methicillin-resistant *S. aureus* (MRSA), piperacillin-tazobactam-nonsusceptible *P. aeruginosa* (PIP-TAZ-NS PSA), and meropenem-nonsusceptible *P. aeruginosa* (MEM-NS PSA) isolated from patients hospitalized with pneumonia stratified by geographic region (2016–2019)

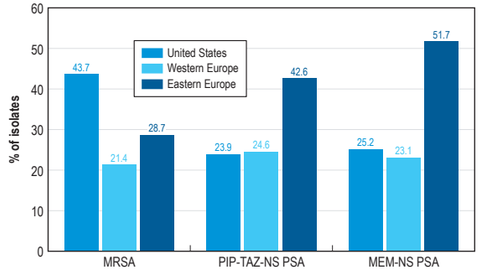
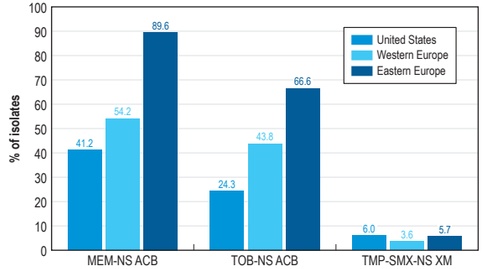


Figure 5. Frequency of meropenem-nonsusceptible *A. baumannii* (MEM-NS ACB), tobramycin-nonsusceptible *A. baumannii* (TOB-NS ACB), and trimethoprim-sulfamethoxazole-nonsusceptible *S. maltophilia* (TKP-SMX-NS XM)



References

Clinical and Laboratory Standards Institute (2020). *M100Ed28E. Performance standards for antimicrobial susceptibility testing: 30th informational supplement.* Wayne, PA: CLSI.

Clinical and Laboratory Standards Institute (2018). *M07Ed11E. Methods for dilution antimicrobial susceptibility tests for bacteria that grow aerobically; approved standard—eleventh edition*. Wayne, PA: CLSI.

Sader HS, Castanheira M, Arends SJR, Goossens H, Flamm RK (2019). Geographical and temporal variation in the frequency and antimicrobial susceptibility of bacteria isolated from patients hospitalized with bacterial pneumonia: results from 20 years of the SENTRY Antimicrobial Surveillance Program (1997–2016). *J Antimicrob Chemother* 74:1595–1606.

Sader HS, Castanheira M, Mendes RE, Flamm RK (2018). Frequency and antimicrobial susceptibility of Gram-negative bacteria isolated from patients with pneumonia hospitalized in ICUs of US medical centres (2015–17). *J Antimicrob Chemother* 73:3053–3059.

Sader HS, Flamm RK, Carvalhaes CG, Castanheira M (2020). Comparison of ceftazidime-avibactam and ceftolozane-tazobactam in vitro activities when tested against gram-negative bacteria isolated from patients hospitalized with pneumonia in United States medical centers (2017–2018). *Diagn Microbiol Infect Dis* 96:114833.