Preplanned Studies

Multicenter Antimicrobial Resistance Surveillance of Clinical Isolates from Major Hospitals — China, 2022

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Summary

What is already known about this topic?

Bacterial resistance surveillance is crucial for monitoring and understanding the trends and spread of drug-resistant bacteria.

What is added by this report?

The number of strains collected in 2022 increased compared to 2021. The top five bacteria, including *Escherichia coli*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and Acinetobacter baumannii, remained largely unchanged. The detection rate of methicillin-resistant strains continued to decrease. Among clinical *Enterobacterales* isolates, the resistance rate to carbapenems was generally below 13%, except for *Klebsiella* spp., which had a resistance range of 20.4% to 21.9%. Most clinical *Enterobacterales* isolates were highly susceptible to tigecycline, colistin, and polymyxin B, with resistance rates ranging from 0.1% to 12.6%. The detection rate of meropenem-resistant *P. aeruginosa* and meropenem-resistant *Acinetobacter baumannii* showed a decreasing trend for the fourth consecutive year.

What are the implications for public health practice?

Multidrug-resistant bacteria remain a significant public health challenge in clinical antimicrobial treatment. To effectively address bacterial resistance, it is essential to enhance both bacterial resistance surveillance and the prudent use of antimicrobial agents.

Bacterial resistance surveillance is a critical aspect of understanding the changes in drug-resistant bacteria and controlling their further spread. The surveillance results for non-duplicated clinical isolates collected from 71 hospitals in China by China Antimicrobial Surveillance Network (CHINET) in 2022 will be presented in this study (*1*). Species identification was conducted at each participating hospital and later verified by the central laboratory using matrix-assisted laser desorption ionisation-time of flight mass spectrometry (Bio-Mérieux, Marcy I'Etoile, France). Non-sterile body fluid samples containing coagulase-negative staphylococci and *Streptococcus viridans* were excluded from this study.

Antimicrobial susceptibility testing was performed according to the Clinical and Laboratory Standards Institute (CLSI) (*2*), the European Committee on Antimicrobial Susceptibility Testing (*3*), and US Food and Drug Administration (*4*) 2022 breakpoints. Quality control for the drug susceptibility testing involved the use of standard strains, including *Staphylococcus aureus* ATCC 25923 and ATCC 29213, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, *Streptococcus pneumoniae* ATCC 49619, *Enterococcus faecalis* ATCC 29212, and *Haemophilus influenzae* ATCC 49247.

A total of 339,513 clinical isolates were collected in 2022, with Gram-positive and Gram-negative bacteria accounting for 29.0% and 71.0% of the isolates, respectively. Inpatient and outpatient isolates accounted for 88.5% and 11.5%, respectively. The samples included 38.6% from respiratory secretions (e.g., sputum), 20.7% from urine, 14.4% from blood, 6.6% from wound pus, 6.6% from sterile body fluids (e.g., cerebrospinal fluid), 1.0% from genital secretions, 1.2% from feces, and 10.9% from other sources. *Enterobacterales* accounted for 43.7% of all isolates, with the three most common isolates being *E. coli* (42.8%), *Klebsiella pneumoniae* (32.0%), and *Enterobacter cloacae* (6.4%). Non-fermentable sugar gram-negative bacilli accounted for 23.1% of isolates, with the top three isolates being *Pseudomonas aeruginosa* (34.8%), *Acinetobacter baumannii* (32.5%), and *Stenotrophomonas maltophilia* (11.6%). The most common Gram-positive bacteria were *S. aureus* (32.6%), *E. faecalis* (14.9%), *E. faecium* (12.4%), and *S. pneumoniae* (9.1%). The distribution of the main bacterial strains is shown in Table 1.

The detection rate of methicillin-resistant *S. aureus* (MRSA) was 28.7%, while the detection rate of methicillin-resistant *S. epidermidis* (MRSE) was 82.2%. Among methicillin-resistant strains (MRCNS) in other

TABLE 1. Distribution of bacterial species from major hospitals — China, 2022.

Organism	No. of strains	Percentage (%)
E. coli	63,459	18.7
Klebsiella spp.	54,785	16.1
S. aureus ss. aureus	32,159	9.5
Acinetobacter spp.	29,069	8.6
Enterococcus spp.	29,050	8.6
P. aeruginosa	27,257	8.0
Coagulase-negative Staphylococcus (from blood, CSF and other sterile body fluid)	16,186	4.8
H. influenzae	11,439	3.4
Enterobacter spp.	10,357	3.1
S. maltophilia	9,097	2.7
S. pneumoniae	8,964	2.6
β-hemolytic Streptococcus	7,201	2.1
Moraxella catarrhalis	6,588	1.9
Proteus spp.	5,994	1.8
Serratia spp.	3,821	1.1
*S. viridans (*from blood, CSF and other sterile body fluids)	3,840	1.1
Salmonella spp.	3,621	1.1
Citrobacter spp.	3,100	0.9
Burkholderia spp.	2,812	0.8
Morganella spp.	1,637	0.5
Pseudomonas spp. (except *P. aeruginosa*)	1,118	0.3
Aeromonas spp.	1,111	0.3
Haemophilus spp. (except *H. influenzae*)	621	0.2
Achromobacter xylosoxidans ss. xylosoxidans	498	0.1
Raoultella ornitholytica	466	0.1
Elizabethkingia meningosepticum	437	0.1
Chryseobacterium indologenes	389	0.1
Haemophilus parainfluenzae	339	0.1
Neisseria spp.	310	0.1
Providencia spp.	358	0.1
Helicobacter nemestrinae	291	0.1
Ralstonia spp.	276	0.1
Brucella spp.	200	0.1
Listeria spp.	137	0
Shigella spp.	39	0
Others*	2,487	0.7
Total	339,513	100

* Including *Pantoea* spp., *Comamonas* spp., *Chryseobacterium* spp., *Bordetella* spp., *Brevundimonas* spp., and *Vibrio* spp., et al.

Staphylococcus spp. (excluding *S. pseudintermedius* and *S. schleiferi*), the detection rate was 77.6%. The resistance rates of MRSA, MRSE, and MRCNS to macrolides, aminoglycosides, rifampicin, and quinolones were significantly higher than those of methicillin-susceptible strains (MSSA, MSSE, and MSCNS). However, the resistance rate to trimethoprim-sulfamethoxazole was lower in MRSA (6.4%) compared to MSSA (12.4%). Conversely, the resistance rate was significantly higher in MRSE

(51.8%) compared to MRCNS (29.1%). Moreover, the resistance rate to clindamycin was lower in both MRSE and MRCNS (32.7% and 37.9%) compared to MRSA (53.6%). No strains of *Staphylococcus* spp. exhibited resistance to vancomycin or norvancomycin, and only a few methicillin-resistant coagulase-negative *Staphylococcus spp*. strains were resistant to teicoplanin or linezolid (Table 2).

E. faecalis exhibited significantly lower resistance rates to most tested antimicrobial agents compared to *E. faecium*. However, *E. faecium* showed higher resistance rates to ampicillin (90.8%) and nitrofurantoin (46.6%). *E. faecium* had lower resistance rates to ampicillin (2.4%), nitrofurantoin (1.6%), and fosfomycin (4.5%). Both species were highly susceptible (>99%) to tigecycline, while approximately 34.6% and 39.3% of strains were resistant to high concentrations of gentamicin. Some strains of both *E. faecalis* and *E. faecium* showed resistance to vancomycin, teicoplanin, and linezolid. The prevalence of linezolid-resistant strains was higher in *E. faecalis* (3.5%) compared to *E. faecium* (0.6%), whereas vancomycin-resistant strains were more frequent in *E. faecium* (2.2%) than in *E. faecalis* (0.1%) (Supplementary Table S1, available in https://weekly.chinacdc.cn/).

Among the 7,222 strains of *Streptococcus pneumoniae* isolated from non-meningitis specimens of pediatric patients, the detection rates of penicillin-susceptible *S. pneumoniae* (PSSP), penicillin-intermediate *S. pneumoniae* (PISP), and penicillin-resistant *S. pneumoniae* (PRSP) were 94.4%, 5.2%, and 0.3%, respectively. Similarly, among the 1,419 strains isolated from non-meningitis specimens of adult patients, the detection rates of PSSP, PISP, and PRSP were 95.4%, 3.4%, and 1.2%, respectively. Antimicrobial susceptibility testing revealed high rates of resistance to erythromycin, clindamycin, and trimethoprim-sulfamethoxazole (>54%) in both pediatric and adult strains. Levofloxacin and moxifloxacin resistance rates were lower in pediatric PSSP strains (0.1%–0.3%) compared to adult strains (2.3%–11.8%). No strains showed resistance to vancomycin or linezolid (Supplementary Table S2, available in https://weekly.chinacdc.cn/).

3,474 strains of *Streptococcus viridans* were isolated from sterile body fluid samples such as blood or cerebrospinal fluid. With the exception of S. *viridans*, which displayed a penicillin resistance rate of 6.8%, no penicillin-resistant strains were found in the other groups. The resistance rate to erythromycin and clindamycin exceeded 50% in all groups of *Streptococcus* spp. Except for group B β-*Streptococcus agalactiae* and *S. viridans*, which exhibited resistance

TABLE 2. Resistance and sensitivity rates of *Staphylococcus* spp. to antimicrobial agents from major hospitals — China, 2022 (%).

Antimicrobial agent	MRSA (*n*=9,116)		MSSA (*n*=22,673)		MRSE (*n*=5,353)		MSSE (*n*=1,162)		MRCNS (*n*=6,433)		MSCNS (*n*=1,854)	
	R	S	R	S	R	S	R	S	R	S	R	S
Penicillin G	100.0	0	87.5	12.5	100.0	0	71.8	28.2	100.0	0	66.0	34.0
Oxacillin	100.0	0	0	100.0	100.0	0	0	100.0	100.0	0	0	100.0
Gentamicin	14.6	83.7	5.9	91.1	20.2	69.3	2.8	92.5	22.2	67.2	1.0	97.6
Clindamycin	53.6	45.9	15.9	83.4	32.7	66.2	10.3	88.4	37.9	60.4	10.4	88.8
Erythromycin	73.4	25.8	44.8	53.8	75.1	23.5	64.8	34.8	85.5	13.5	54.3	44.3
Vancomycin	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
Norvancomycin	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
Teicoplanin	0.1	99.9	0	100.0	0.3	99.2	0.2	99.8	0.3	99.4	0.3	99.2
Linezolid	0	100.0	0	100.0	1.1	98.9	0.1	99.9	1.6	98.4	0	100.0
Tigecycline	0.2	99.8	0.1	99.9	0	100.0	0	99.9	0	100.0	0	100.0
Rifampin	3.7	93.9	0.6	98.6	8.5	90.9	1.0	99.0	10.0	89.4	0.5	99.3
Levofloxacin	23.8	75.3	8.3	91.0	53.1	44.5	14.9	83.5	65.8	32.5	4.6	94.6
Trimethoprim-sulfamethoxazole	6.4	93.6	12.4	87.6	51.8	48.1	26.9	72.7	29.1	70.7	6.5	93.5

Abbreviation: R=resistant; S=susceptible; MRSA=methicillin-resistant *Staphylococcus aureus*; MSSA=methicillin-sensitive *Staphylococcus aureus*; MRSE=methicillin-resistant *Staphylococcus epidermidis*; MSSE=methicillin-sensitive *Staphylococcus epidermidis*; MRCNS=methicillin-resistant coagulase-negative *Staphylococci*; MSCNS=methicillin-sensitive coagulase-negative *Staphylococci*.

rates of 43.4% and 12.3%, respectively, all other β-*Streptococcus haemolyticus* spp. displayed high susceptibility to levofloxacin, with resistance rates ranging from 0% to 2.3%. No strains resistant to vancomycin or linezolid were detected. (Supplementary Table S3, available in https://weekly.chinacdc.cn/).

The resistance rates of *E. coli* to ceftriaxone, cefuroxime, piperacillin, trimethoprim-sulfamethoxazole, ciprofloxacin, and levofloxacin were all above 50%. The resistance rates of *Enterobacterales* to the three carbapenems were generally low, except for *Klebsiella* spp. which had resistance rates ranging from 20.4% to 21.9%. Most other *Enterobacterales* had resistance rates of 12.5% or less. *Enterobacterales* showed higher susceptibility to amikacin, with resistance rates ranging from 1.5% to 13.7%. With the exception of *Enterobacterales* and *Citrobacter* spp., which had sensitivity rates of 72.4% and 82.6%, respectively, to ceftazidime-avibactam, other *Enterobacterales* were sensitive to ceftazidime-avibactam with a range of 93.5%–97.4%. Most other *Enterobacterales* were highly susceptible to tigecycline, mucin, and polymyxin B, with resistance rates ranging from 0.1% to 12.6% (Table 3).

The rates of resistance of *Pseudomonas aeruginosa* to imipenem and meropenem were 22.1% and 17.6%, respectively. For polymyxin B, colistin, amikacin, and ceftazidime-avibactam, the resistance rates were 0.5%, 1.7%, 3.5%, and 7.2%, respectively. The resistance rates of *Pseudomonas aeruginosa* to piperacillin-tazobactam, cefoperazone-sulbactam, gentamicin, ciprofloxacin, levofloxacin, ceftazidime, cefepime, and piperacillin ranged from 7% to 20.1%. Similarly, resistance rates to imipenem and meropenem among *Acinetobacter* spp. were 65.8% and 66.6%, with

TABLE 3. Resistance and sensitivity rates of *Enterobacterales* to antimicrobial agents from major hospitals — China, 2022 (%) .

Antimicrobial agent	*E. coli* (*n*=63,459)		*Klebsiella* spp. (*n*=54,785)		*Enterobacter* spp. (*n*=10,357)		*Proteus* spp. (*n*=59,94)		*Serratia* spp. (*n*=3,821)		*Citrobacter* spp. (*n*=3,100)		*Morganella* spp. (*n*=1,637)	
	R	S	R	S	R	S	R	S	R	S	R	S	R	S
Amikacin	1.9	97.7	13.7	86.1	1.6	97.8	2.2	97.2	1.6	98.1	1.5	98.4	1.7	97.8
Gentamicin	34.5	64.6	25.1	73.9	13.4	84.6	19.8	63	8.2	91.1	13.0	85.8	18.3	76.7
Imipenem	1.9	97.9	20.4	78.6	9.7	88.6	11.5	65.6	5.7	91.0	7.5	91.3	23.0	40.8
Meropenem	2.0	97.9	21.9	77.7	9.7	89.5	1.0	98.5	5.1	94.5	7.9	91.7	1.9	97.5
Ertapenem	1.8	98.0	20.4	79.2	12.5	85.2	0.6	98.7	4.8	94.9	7.2	92.6	1.9	97.6
Cefepime	25.5	65.7	29.3	68.3	16.7	76.9	8.0	82.3	8.2	87.2	11.7	84.8	3.6	90.5
Ceftazidime	22.8	69.8	32.4	65.2	34.0	64.3	6.2	92.0	8.4	90.3	28.6	69.6	14.8	80.9
Ceftazidime-avibactam	6.5	93.5	6.2	93.8	27.6	72.4	2.7	97.3	7.1	92.9	17.4	82.6	2.6	97.4
Ceftriaxone	51.3	48.4	39.1	60.6	39.9	58.8	32.4	66.1	19.0	79.9	35.2	64.3	16.0	79.2
Cefoperazone-sulbactam	5.7	87.2	24.9	70.3	17.1	75	0.9	97.4	7.7	88.0	10.7	81.6	3.3	89.6
Cefoxitin	10.2	84.4	28.2	69.8	93.6	5.6	6.5	88.2	26.8	30.3	54.1	40.3	14.2	42.7
Cefuroxime	53.1	44.0	42.8	55.0	47.1	34.8	49.0	50.0	89.2	2.4	37.6	56.6	84.0	5.1
Cefazolin	57.7	42.4	49.2	50.9	93.8	6.1	54.8	45.2	98.3	1.7	66.9	33.1	98.2	1.8
Piperacillin	76.8	19.6	50.4	41.3	40.5	57.2	34.7	58.9	15.7	83.3	48.9	44.3	34.2	61.2
Piperacillin-tazobactam	8	88.5	29.2	65.9	27.5	68.3	1.8	97.3	7.9	89.8	22.1	69.8	7.2	89.1
Ampicillin-sulbactam	35.9	58.6	44.0	53.9	55.5	39.9	30.5	64.2	66.9	29.4	36.2	60.4	54.6	36.6
Ciprofloxacin	61.5	29.6	40.3	53.8	24.0	70.6	45.8	49.9	14.3	81.0	27.0	66.0	41.1	55.0
Levofloxacin	53.8	27.3	30.2	57.7	17.3	71.6	34.7	53.7	11.5	82.5	19.7	67.7	23.6	61.0
Trimethoprim-sulfamethoxazole	52.2	47.7	30.7	69.1	20.9	79.1	56.0	44.0	4.7	95.3	20.6	79.3	37.1	62.8
Tigecycline	0.1	99.4	2.6	92.1	1.9	95.1	12.6	25.0	0.5	94.7	0.6	96.8	9.6	69.3
Colistin	1.3	95.5	2.8	81.5	2.0	88.7	2.1	97.6	9.3	87.9	2.3	97.0	3.2	95.2
Polymyxin B	1.5	86.2	4.8	57.6	9.9	66.0	1.2	97.9	11.6	77.0	2.5	72.2	2.4	96.5

Abbreviation: R=resistant; S=susceptible.

resistance rates of 1.6% to 2.3% for polymyxin B, colistin, and tigecycline. The resistance rates of *Stenotrophomonas maltophilia* to trimethoprim-sulfamethoxazole, minocycline, and levofloxacin were 6.4%, 1%, and 8.7%, respectively. For *Burkholderia cepacia*, the resistance rates were 10.7%, 6.8%, 3.6%, and 4.3% to meropenem, ceftazidime, minocycline, and trimethoprim-sulfamethoxazole (Supplementary Table S4, available in https://weekly.chinacdc.cn/).

Among 11,439 strains of *Haemophilus influenzae*, 76.7% were isolated from children, while 23.2% were from adults. The β-lactamase detection rates in pediatric and adult isolates were 70.3% and 56.2%, respectively. Most of the *H. influenzae* strains showed high susceptibility to ceftriaxone, meropenem, levofloxacin, and chloramphenicol, with susceptibility rates ranging from 96.1% to 99.9%. However, pediatric isolates exhibited higher resistance than adult strains to ampicillin (76.5% *vs*. 63.1%), amoxicillin-clavulanic acid (14.0% *vs*. 4.8%), cefuroxime (53.9% *vs*. 27.4%), and trimethoprim-sulfamethoxazole (74.5% *vs*. 56.3%). Both pediatric and adult isolates showed similar resistance rates to ampicillin-sulbactam (34.5% *vs*. 34.6%) (Supplementary Table S5, available in https://weekly.chinacdc.cn/).

DISCUSSION

Currently, the production of Extended Spectrum Beta-Lactamases (ESBL) and carbapenemases is the most significant mechanism of resistance in Gram-negative bacteria, particularly in *Enterobacterales*. In this study, the prevalence of ceftriaxone or cefotaxime resistance in *E. coli*, *K. pneumoniae*, and *P. mirabilis* was found to be 51%, 40.9%, and 36.6%, respectively. The widespread epidemic spread of ESBL-producing strains presents a major challenge for anti-infective therapy, forcing clinicians to resort to broad-spectrum antimicrobials like carbapenems (*5*–*6*). With the extensive use of carbapenems, the emergence of carbapenem-resistant Gram-negative bacteria under intense antimicrobial pressure has become a significant threat to global public health. Due to the frequent resistance of carbapenem-resistant Gram-negative bacilli to most commonly used antimicrobial agents, the selection of drugs for treating infections caused by these bacilli is limited, leading to high morbidity and mortality among affected patients (*7*).

Carbapenemase production is the predominant resistance mechanism in *Enterobacterales* to carbapenems (*8*). Since various combinations of carbapenemase inhibitors exhibit different levels of inhibitory activity against different carbapenemases, this leads to divergent treatment regimens for infections caused by various drug-resistant bacteria (*9*). To address the significant challenges posed by carbapenem-resistant Gram-negative bacilli, Laboratories should perform susceptibility testing for effective antimicrobials (e.g., ceftazidime-avibactam, tigecycline, and polymyxin), carbapenemase phenotypic or genotypic testing, and combination drug susceptibility testing to support the development of accurate clinical anti-infective treatment regimens (*10*).

The mitigation of bacterial resistance represents a comprehensive endeavor, necessitating the implementation of traditional strategies. These include infection prevention and control, immunization, diminishing exposure to antimicrobial agents, reducing the misuse of these agents, and sustaining the research and development of novel antimicrobials. Crucially, establishing infrastructures to limit the epidemiological proliferation of drug-resistant bacteria is essential. This involves enhancing anti-infective treatment proficiency through education, standardizing antimicrobial susceptibility testing, and integrating various networks. These networks encompass the bacterial and fungal resistance surveillance network, the clinical usage surveillance network, and the hospital infection control network (*11*).

This study has two limitations. First, it was a passive surveillance study, mainly collecting results of routine antimicrobial susceptibility testing from different hospitals for analysis, and the types of antimicrobials tested were limited by the automated systems, which less often included new antimicrobials. Secondly, this study did not investigate the medical history to clarify whether it was the pathogen causing the infection or a colonising strain.

Conflicts of interest: The authors declare no competing interests.

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SUPPLEMENTARY MATERIAL

SUPPLEMENTARY TABLE S1. Resistance and sensitivity rates of *Enterococcus* spp. to antimicrobial agents from major hospitals — China, 2022 (%).

Antimicrobial agent	*E. faecalis* (*n*=12,225)		*E. faecium* (*n*=14,648)	
	R	S	R	S
Ampicillin	2.4	97.6	90.8	9.2
Gentamicin-High	34.6	65.1	39.3	60.7
Vancomycin	0.1	99.9	2.2	97.7
Norvancomycin	0.1	99.9	2.3	97.7
Teicoplanin	0.2	99.7	2.6	97.3
Linezolid	3.5	95.2	0.6	98.9
Tigecycline	0	99.9	0.2	99.6
Levofloxacin	29.7	69.2	83.7	11.5
Nitrofurantoin	1.6	97.1	46.6	25.5
Fosfomycin*	4.5	89.5	–	–

Note: "–" means no data.
Abbreviation: R=resistant; S=susceptible.
* Results only from urinary tract isolates.

SUPPLEMENTARY TABLE S2. Resistance rates of nonmeningitis (*S. pneumoniae*) isolated from children and adults from major hospitals — China, 2022 (%).

Antimicrobial agent	Isolates from children						Isolates from adults					
	PSSP (*n*=6,819)		PISP (*n*=379)		PRSP (*n*=24)		PSSP (*n*=1,354)		PISP (*n*=48)		PRSP (*n*=17)	
	R	S	R	S	R	S	R	S	R	S	R	S
Penicillin G	0	100.0	0	0	100.0	0	0	100.0	0	0	100.0	0
Vancomycin	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
Norvancomycin	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
Linezolid	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
Erythromycin	98.7	1.1	100	0	100	0	93.4	4.1	93.6	4.3	100.0	0
Clindamycin	95.7	3.9	96.8	3.2	95.2	4.8	90.6	7.1	84.1	15.9	91.6	8.3
Trimethoprim-sulfamethoxazole	67.1	21.6	80.1	9.3	87.0	4.3	54.6	29.1	60.4	20.8	70.6	11.8
Levofloxacin	0.3	99.4	0.3	99.7	0	100.0	4.3	94.8	0	97.9	11.8	88.2
Moxifloxacin	0.1	99.8	0.3	99.7	0	100.0	2.3	96.7	0	100.0	7.1	92.9
Chloramphenicol	7.7	92.3	3.2	96.8	9.1	90.9	10.2	89.8	9.7	90.3	0	100.0

Abbreviation: R=resistant; S=susceptible; PSSP=Penicillin susceptible Streptococcus pneumoniae; PISP=Penicillin-intermediate Streptococcus pneumoniae; PRSP=Penicillin resistant Streptococcus pneumoniae.

SUPPLEMENTARY TABLE S3. Resistance rates in (*Streptococcus*) spp. to antimicrobial agents from major hospitals — China, 2022 (%).

Antimicrobial agent	A group (*n*=888)		B group (*n*=6,156)		C group (*n*=489)		F group (*n*=22)		G group (*n*=31)		*S.viridans** (*n*=3,474)	
	R	S	R	S	R	S	R	S	R	S	R	S
Penicillin	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	6.8	72.5
Erythromycin	89.5	9.1	74.9	20.3	71.3	23.4	72.7	22.7	80.6	16.1	60.8	31.5
Clindamycin	87.2	11.2	60.3	37.3	60.9	34.9	81.8	18.2	83.9	16.1	52.5	45.9
Cefotaxime	0	99.0	0	99.9	0	98.7	0	100.0	0	100.0	7.5	88.0
Ceftriaxone	0	99.7	0	99.7	0	98.4	0	100.0	0	100.0	9.8	86.1
Vancomycin	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
Linezolid	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0	0	100.0
Levofloxacin	0.8	98.7	43.4	55.9	2.3	93.6	0	100.0	0	100.0	12.3	85.3

Abbreviation: R=resistant; S=susceptible.
* Isolated from blood, Cerebro-Spinal Fluid, or other sterile body fluids.

SUPPLEMENTARY TABLE S4. Resistance and sensitivity rates of non-fermentative gram-negative bacilli to antimicrobial agents from major hospitals — China, 2022 (%).

Antimicrobial agent	*P. aeruginosa* (*n*=27,257)		*Acinetobacter* spp. (*n*=29,069)		*S.maltophilia* (*n*=9,097)		*B.cepacia* (*n*=2,444)	
	R	S	R	S	R	S	R	S
Amikacin	3.5	95.4	51.1	47.6	NA	NA	NA	NA
Gentamicin	7.0	89.7	61.0	35.4	NA	NA	NA	NA
Imipenem	22.1	75.5	65.8	33.7	NA	NA	NA	NA
Meropenem	17.6	77.9	66.6	32.8	NA	NA	10.7	81.2
Cefepime	9.4	82.3	61.6	33.0	NA	NA	NA	NA
Ceftazidime	14.0	80.9	66.0	32.1	36	57.1	6.8	90.2
Ceftazidime-avibactam	7.2	92.8	81.3	18.7	NA	NA	NA	NA
Cefoperazone-sulbactam	13.8	75.2	52.1	36.5	NA	NA	NA	NA
Aztreonam	20.1	64.4	NA	NA	NA	NA	NA	NA
Piperacillin	16.2	74.8	67.9	26.6	NA	NA	NA	NA
Piperacillin-tazobactam	12.0	78.6	67.6	30.5	NA	NA	NA	NA
Ampicillin-sulbactam	NA	2.0	60.8	33.5	NA	NA	NA	NA
Ciprofloxacin	14.5	78.8	66.2	33.1	NA	NA	NA	NA
Levofloxacin	20.1	72.1	54.3	35	8.7	88.3	19.0	70.3
Trimethoprim-sulfamethoxazole	NA	14.2	49.9	49.8	6.4	93.1	4.3	94.2
Colistin	1.7	98.3	1.6	98.4	NA	NA	NA	NA
Polymixin B	0.5	99.5	2.3	97.7	NA	NA	NA	NA
Tigecycline	NA	NA	2.2	89.5	NA	NA	NA	NA
Minocycline	NA	NA	15.6	61.5	1.0	96.3	3.6	90.0
Chloramphenicol	93.0	4.4	NA	NA	17.3	63.9	11.9	78.4

Abbreviation: R=resistant; S=susceptible; NA=not available.

SUPPLEMENTARY TABLE S5. Resistance and sensitivity rates in strains of *H. iufluenzae* to antimicrobial agents from major hospitals — China, 2022 (%).

Antimicrobial agent	Total (*n*=11,439)		Isolates from children (*n*=8,779)		Isolates from adults (*n*=2,660)	
	R	S	R	S	R	S
Ampicillin	71.3	23.5	76.5	17.6	63.1	33.1
Amoxicillin-clavulanic acid	2.4	95.0	14.0	86.0	4.8	91.7
Ampicillin-sulbactam	33.3	66.7	34.5	65.5	34.6	65.5
Cefuroxime	30.6	56.7	53.9	40.0	27.4	67.8
Ceftriaxone	0.4*	99.6	0.8*	99.2	0.6*	99.4
Meropenem	1.1*	98.9	0.7*	99.3	1.9*	98.1
Chloramphenicol	0.9	98.4	3.1	96.1	0.9	97.1
Levofloxacin	0.5*	99.5	0.1*	99.9	2.3*	97.7
Trimethoprim-sulfamethoxazole	63.1	35.7	74.5	23.9	56.3	42.2

Abbreviation: R=resistant; S=susceptible.
* No susceptible.