细菌耐药监测
Bacterial Resistance Surveillance

中国细菌耐药监测研究(CARST)
2023－2024 年革兰氏阴性菌监测报告

Antimicrobial susceptibility of gram－negative organisms: Results from China antimicrobial resistance surveillance trial (CARST) program, 2023－2024

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摘要:目的 监测我国主要城市三级甲等医院感染患者分离革兰氏阴性菌耐药状况,掌握耐药流行趋势,为抗生素合理使用提供科学数据。**方法** 定点收集全国18 家医院临床分离细菌,由中心实验室统一用琼脂/肉汤二倍稀释法测定抗菌药物最低抑菌浓度(MIC)值。**结果** 对 2023 年 7 月至 2024 年 6 月间来自全国 18 座城市 18 家医院的 4 681 株临床分离致病菌进行了 MIC 测定。结果显示,大肠埃希菌和肺炎克雷伯菌中超广谱 β－内酰胺酶(ESBLs)表型检出率分别为 50.7% 和 20.7%,表型检出率继续下降,碳青霉烯类耐药肺炎克雷伯菌(CRKP)比例则较前次监测上升 10 个百分点,达 35.4%。对肠杆菌目细菌抗菌作用较好的药物包括:碳青霉烯类、β－内酰胺合剂、阿米卡星等,细菌敏感率在 78% 以上。此外,替加环素、依拉环素和黏菌素对各自有效菌属/种保持很好抗菌活性,细菌敏感/中介(黏菌素)率 >90%。铜绿假单胞菌和鲍曼不动杆菌对亚胺培南的耐药率分别为 32.7% 和 70.7%,多重耐药菌(MDR)检出率分别为 43.3% 和 78.3%,泛耐药菌(XDR)检出率分别为 17.0% 和 71.0%。不同病房、不同年龄以及不同标本来源菌株耐药率比较提示,来源重症监护病房(ICU)肺炎克雷伯菌、铜绿假单胞菌和鲍曼不动杆菌耐药率均显著高于来源非 ICU 菌株。儿童分离铜绿假单胞菌对测试药物耐药率均显著低于成人与老年人,但儿童分离肺炎克雷伯菌中 ESBLs 表型检出率为 57.1%,显著高于成人(16.3%)和老年人(19.8%),此外流感嗜血杆菌,来自儿童的菌株对头孢菌素类、阿奇霉素和四环素类耐药率均高于成人和老年人。不同标本来源比较显示,尿标本分离鲍曼不动杆菌对测试药物耐药率显著低于其他来源;其他主要菌种不同标本间在统计学上差异均无统计学意义,痰标本中的铜绿假单胞菌及来源引流液的大肠埃希菌耐药率较其他来源略高。**结论** 大肠埃希菌、肺炎克雷伯菌中 ESBLs 表型检出率持续下降,CRKP、氨苄西林耐药流感嗜血杆菌检出率呈上升趋势,需持续关注。

关键词:细菌耐药监测;革兰氏阴性菌;最低抑菌浓度;敏感率;耐药率;最低抑菌浓度分布
DOI:10.13699/j.cnki.1001－6821.2025.18.002
中图分类号:R972 **文献标志码:**A
文章编号:1001－6821(2025)18－2567－21

Abstract: Objective To investigate the gram－negative bacteria resistance in nationwide tietiary hospitals, understand the trend of antimicrobial resistance and provide scientific data for the rational use of antibiotis. **Method** All the clinical isolates were collected from 18 hospitals and the minimal inhibitory concentrations (MICs) were tested using agar/broth dilution method recommended by Clinical and Laboratory Standards Institute (CLSI) in central laboratory. **Results** A total of 4 681 pathogenic isolates from 18 tertiary hospitals in 18 cities

nationwide over the period from July 2023 to June 2024 were studied. Based on the MIC results, *Escherichia coli* and *Klebsiella pneumoniae* showed extended spectrum β - lactamase (ESBLs) phenotype rates of 50.7% and 20.7%, respectively, ESBLs phenotype rate keeps going down. The ratio of carbapenems resistance *Klebsiella pneumoniae* (CRKP) was 35.4%, increased by 10 percentage points compared with the previous monitoring. Carbapenems, β - lactam combination agents and amikacin displayed desirable antibacterial activity against *Enterobacterales*, susceptibal rates were above 78%. In addition, tigacycline, eravacycline, colistin maintained good antibacterial activity against their respective effective bacteria/species, and the bacterial sensitivity rates by more than 90%. Resistance rates of *Pseudomonas aeruginosa* and *Acinetobacter baumannnii* to imipennnem were 32.7% and 70.7% and multidrug - resistant (MDR) detection rates were 43.3% and 78.3%, Extensively drug - resistant (MDR) were 17.0% and 71.0%, respectively. Comparison of drug resistance rates from different wards, ages and specimen sources indicated that the proportion of resistance in *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Acinetobacter baumannii* isolated from intensive care unit (ICU) were significantly higher than non - ICU. Resistance rates of *Pseudomonas aeruginosa* isolated from children were significantly lower than that in adults and the elderly. However, the detection rate of ESBLs phenotypes in *Klebsiella pneumoniae* in children was 57.1%, significantly higher than that in adults (16.3%) and the elderly (19.8%). In addition, the strains of *Haemophilus influenzae* from children had a higher resistance rates to cephalosporins, macrolides, and clindamycin than those in adults and the elderly. Comparisons of different specimen sources showed that the resistance rates of *Acinetobacter baumannii* isolated from urine specimens were significantly lower than that from other sources. No statistical differences were observed among other major bacterial species in different specimens, while the resistance rates of *Pseudomonas aeruginosa* in sputum specimens and *Escherichia coli* in source drainage fluids were slightly higher than those from other sources. **Conclusion** The detection rates of ESBLs phenotypes in *Escherichia coli* and *Klebsiella pneumoniae* have continued to decline, while the detection rates of CRKP and ampicillin - resistant *Haemophilus influenzae* have shown an upward trend, which requires continuous attention.

Key words: antimicrobial resistance surveillance; gram - negative bacteria; minimum inhibitory concentration; susceptibility; resistance; minimal inhibitory concentration distribution

近十年,革兰氏阴性菌耐药已成为全球关注的公共卫生问题,其中碳青霉烯类耐药的鲍曼不动杆菌、肠杆菌以及第三代头孢菌素耐药肠杆菌被世界卫生组织(World Health Organizatioin, WHO)列为新型抗菌药物研发重点针对病原体中极为重要的3类耐药菌[1]。虽然近年陆续有针对耐药菌的新抗菌药物上市,但新药研发仍滞后于耐药发展,因此合理使用抗菌药物,延缓耐药发生、发展尤为重要。细菌耐药监测结果是抗菌药物合理应用的基础,由于其意义重大,WHO及很多国家、组织、公司都建立有自己相应的细菌耐药监测网络,如:WHO的全球抗菌药物耐药监测系统(Global Antimicrobial Resistance Surveillance System,GLASS),辉瑞公司支持的抗菌药物测试领导和监测(the Antimicrobial Testing Leadership and Surveillance,ATLAS)项目等,这些细菌耐药监测网为促进抗菌药物合理使用发挥了积极作用。北京大学临床药理研究所自1998年起开展全国性耐药监测工作,现将2023至2024年度监测结果汇报如下。

材料与方法

1 材料

药品 阿莫西林、哌拉西林、头孢唑林、头孢西丁、头孢呋辛、头孢噻肟、头孢曲松、头孢哌酮、头孢吡肟、氨曲南、美罗培南、舒巴坦、他唑巴坦、克拉维酸、庆大霉素、阿米卡星、四环素、米诺环素、左氧氟沙星、红霉素、阿奇霉素、克林霉素和呋喃妥因,均购自中国食品药品研究院(或中国药品生物制品检定所);氨苄西林、利福平、氯霉素,均由意大利INALCO公司生产;头孢硫脒,由广州白云山医药集团股份有限公司白云山制药总厂生产;头孢他啶、阿维巴坦,均由齐鲁制药有限公司生产;亚胺培南,由美国Asta Tech公司生产;厄他培南,由杭州默沙东公司生产;依拉环素,由云顶新耀医药科技有限公司生产;环丙沙星,由上虞京新药业有限公司生产;莫西沙星,由杭州洋洋康生物技术有限公司生产;奈诺沙星,由浙江医药股份

有限公司新昌制药厂生产;吉米沙星,由韩国 LG 化学公司生产;磺胺甲噁唑,由美国 Sigma - Aldrich 公司生产;甲氧苄啶,由山东淄博新达制药厂生产;磷霉素氨丁三醇,由西藏仟源药业有限公司生产;替卡西林,由英国葛兰素史克公司生产;替加环素、黏菌素药敏板,均由温州市康泰生物科技有限公司生产。其中复方制剂氨苄西林/舒巴坦、头孢哌酮/舒巴坦配比均为2∶1,甲氧苄啶/磺胺甲噁唑(trimethoprim/sulfamethoxazole, SXT)为1∶19,哌拉西林/他唑巴坦中他唑巴坦浓度恒定为4 mg·L^{-1},头孢他啶/阿维巴坦中阿维巴坦浓度恒定为4 mg·L^{-1},替卡西林/克拉维酸中克拉维酸浓度恒定为2 mg·L^{-1},阿莫西林/克拉维酸中克拉维酸浓度恒定为4 mg·L^{-1}。

标准菌株 大肠埃希菌 ATCC25922,大肠埃希菌 ATCC35218,铜绿假单胞菌 ATCC27853,流感嗜血杆菌 ATCC49247,流感嗜血杆菌 ATCC49766。

临床收集菌株 菌株收集时间为 2023 年 7 月 1 日至 2024 年 6 月 30 日。同一患者分离的相同菌株取第一株。

2 培养基与孵育条件

琼脂二倍稀释法 卡他莫拉菌在血培养基[在 MH 琼脂(Mueller - Hinton agar, MHA)培养基中加入 5% 脱纤维羊血制成]35 ℃空气环境孵育 20 ~ 24 h;嗜血杆菌在嗜血杆菌检测培养基(*Haemophilus* test medium, HTM),35 ℃ 5% CO_2环境(CO_2培养箱)孵育 16 ~ 18 h;其他革兰氏阴性菌在 MHA 培养基,35 ℃空气环境孵育 16 ~ 20 h(不动杆菌属、洋葱伯克霍尔德菌复合群和嗜麦芽窄食单胞菌孵育 20 ~ 24 h)。

微量肉汤二倍稀释法 头孢他啶/阿维巴坦、替加环素、依拉环素、黏菌素测定培养液为阳离子调节 HM 肉汤(cation - adjusted Mueller - Hinton broth, CAMHB),嗜血杆菌使用 MH 苛氧(Mueller - Hinton fastidious, MH - F)肉汤。

3 最低抑菌浓度(minimal inhibitory concentration, MIC)及产酶测定

琼脂二倍稀释法 被试菌悬液用多点接种仪接种,每点接种量为 1.0×10^4 CFU。

微量肉汤二倍稀释法 菌液终浓度为 5.0×10^5 CFU·mL^{-1},反应体积 100 μL。头孢他啶/阿维巴坦、替加环素、依拉环素、黏菌素采用微量肉汤稀释法,其他药物采用琼脂稀释法。每株细菌在试验前经平板转活分纯,以新鲜菌体用于试验。每次实验均用标准菌株作为敏感实验质控菌;用不含抗菌药物的平皿或菌液做为试验菌株生长对照。超广谱 β - 内酰胺酶(extended - spectrum β - lactamases, ESBLs)表型判定参照美国临床和实验室标准化协会(Clinical and Laboratory Standards Institute, CLSI)[2]推荐方法,以头孢噻肟、头孢噻肟加4 mg·L^{-1}克拉维酸判定。以硝噻吩按说明书操作检测嗜血杆菌是否产酶。

4 结果处理

用 SPSS 20.0 统计软件处理 MIC 测定结果,计算 MIC_{50}和 MIC_{90}。根据 CLSI 2025[2]颁布的抗菌药物折点,计算细菌敏感率、耐药率。没有判定标准的药物,参考欧洲抗微生物药物敏感性试验委员会(European Committee on Antimicrobial Susceptibility Testing, EUCAST)2025[3]或相似药物标准或不予以计算。替加环素根据美国食品及药物管理局(US Food and Drug Administration, FDA)[4]颁布标准计算,依拉环素根据中国国家药敏专委会(Expert Committee of the National Health Commission on Antimicrobial Susceptibility Testing and Standard Research, ChinaCAST)[5]颁布标准计算,详见表后注解。

结 果

1 菌株收集情况

共 4 681 株细菌进行了 MIC 分析。前 5 位标本来源依次为痰标本 1 567 份(33.5%),血标本 1 351 份(28.9%),分泌物 611 份(13.1%),引流液 525 份(11.2%),尿标本 513 份(11.0%)。每家医院提供菌株数量在 165 ~ 375 株之间,患者男女比例为1.74∶1.00,年龄范围 14 min ~ 104 岁,中位年龄 61 岁。

2 抗菌药物对肠杆菌目细菌的 MIC 结果

大肠埃希菌和肺炎克雷伯菌中 ESBLs 表型检出率分别为 50.7% 和 20.7%。对于全部 2 579 株肠杆菌目细菌,敏感率高于 75% 的药物依次为头孢他啶/阿维巴坦(95.5%)、美罗培南(87.7%)、厄他培南(86.0%)、阿米卡星(84.1%)、亚胺培南(80.4%)、头孢哌酮/舒巴坦(80.2%)和哌拉西林/他唑巴坦(78.2%)。此外,替加环素和依拉环素测定 2 217 株细菌,所测菌株对替加环素敏感率为 99.4%;依拉环素对所测肠杆菌目细菌 MIC_{50}值在 0.12 ~ 0.5 mg·L^{-1},MIC_{90}值在 0.12 ~ 1 mg·L^{-1},与替加环素相似,大肠埃希菌和肺炎克雷伯菌对其敏感率分别为 99.4% 和 93.2%,其他菌种/属因没有折点未计算敏感率;黏菌素测定 1 583 株细菌,所测菌株对其耐药率为 7.1%。

大肠埃希菌对碳青霉烯类、β - 内酰胺合剂、阿米

卡星、替加环素、依拉环素、呋喃妥因、磷霉素氨丁三醇、黏菌素等仍保持较好敏感性,细菌耐药率均<10%,对头孢菌素耐药率约在20% ~ 60%,对四环素、喹诺酮类药物和SXT耐药率>55%,见表1。肺炎克雷伯菌对哌拉西林、四环素、喹诺酮类药物和SXT耐药率均低于大肠埃希菌10个百分以上,但对碳青霉烯类药物耐药率在33.6% ~35.9%,远高于大肠埃希菌(2.1% ~3.8%)。碳青霉烯类不敏感ESBLs阴性大肠埃希菌对替加环素、依拉环素100%敏感,对阿米卡星敏感率82.6%,对黏菌素耐药率8.7%,对其他药物耐药率基本>60%,见表2。碳青霉烯类不敏感ESBLs阴性肺炎克雷伯菌对头孢他啶/阿维巴坦、替加环素敏感>90%,对依拉环素敏感率82.3%,对黏菌素耐药率21.1%,对其他药物耐药率基本>70%,见表3。其他克雷伯菌属中约87%为产酸克雷伯菌,耐药率多低于肺炎克雷伯菌20个百分点以上。产气克雷伯菌对多数β-内酰胺类药物耐药率高于其他克雷伯菌,见表1。大肠埃希菌和肺炎克雷伯菌MIC分布见表4和表5。

肠杆菌属中约94%为阴沟肠杆菌,其对阿米卡星、替加环素耐药率<5%,对碳青霉烯类、头孢他啶/阿维巴坦、头孢哌酮/舒巴坦、庆大霉素和米诺环素耐药率在12.1% ~19.5%。枸橼酸杆菌属中最主要菌种为弗劳地枸橼酸杆菌,占42.8%。其对头孢吡肟耐药率7.5%,明显低于第二、三代头孢菌素和氨曲南(约25% ~40%),对碳青霉烯类耐药率约为5%,其他测试药物耐药率基本<25%。沙雷菌属中94.5%为黏质沙雷菌,除对四环素高耐,对其他被测药物耐药率均低于17%,但碳青霉烯类耐药率为7.9%,略高于枸橼酸杆菌属,见表6。变形杆菌属中奇异变形杆菌中ESBLs检出率为36.6%(53株/145株),所测药物中,β-内酰胺合剂、氨曲南、美罗培南和厄他培南耐药率均低于10%。摩根菌属对β-内酰胺合剂、头孢吡肟、美罗培南、厄他培南以及阿米卡星耐药率均低于5%。普罗威登菌属细菌对氨曲南以外的其他药物耐药率基本>30%,碳青霉烯类耐药率在32.7% ~38.2%。根据CLSI,来自肠道的沙门菌,常规只报告氨苄西林、氟喹诺酮和SXT;非肠道沙门菌还可报告第三代头孢菌素和氯霉素。本次监测55.4%沙门菌株来自肠道。所有菌株对上述药物的耐药率多在10% ~30%,测定的其他药物体外结果供参考,见表7。

3 抗菌药物对非发酵革兰氏阴性菌的MIC结果

铜绿假单胞菌对亚胺培南耐药率为32.7%,其他药物耐药率均低于30%。亚胺培南敏感铜绿假单胞菌对测试药物耐药率<14%;亚胺培南不敏感铜绿假单胞菌对黏菌素耐药率为7.1%,其他药物耐药率多>30%,见表8。铜绿假单胞菌MIC分布见表9。

鲍曼不动杆菌对多数被测药物耐药率>70%,对碳青霉烯类的耐药率在70.7% ~74.9%。依拉环素和黏菌素对鲍曼不动杆菌保持较好抗菌作用,不敏感/耐药率分别为3.2%和3.4%。亚胺培南敏感鲍曼不动杆菌对被测药物耐药率除哌拉西林、哌拉西林/他唑巴坦和头孢吡肟外均<10%,而亚胺培南耐药菌除对依拉环素和黏菌素耐药率<5%,其他药物耐药率基本>90%,见表10。鲍曼不动杆菌MIC分布见表11。

嗜麦芽窄食单胞菌对米诺环素、左氧氟沙星和SXT敏感率>80%。替加环素和依拉环素对嗜麦芽窄食单胞菌MIC值均≤2 mg·L^{-1},与米诺环素相似,见表12;对洋葱伯克霍尔德菌复合群MIC值≤8 mg·L^{-1},与SXT相似,在测试药物中最低,见表13。

4 抗菌药物对嗜血杆菌与卡他莫拉菌的MIC结果

流感嗜血杆菌β-内酰胺酶阳性率为68.7%,对氨苄西林耐药率为87.8%;产酶菌对氨苄西林100%耐药,对氨苄西林/舒巴坦耐药率为93.6%。哌拉西林/他唑巴坦、第三代头孢菌素、美罗培南、四环素类、喹诺酮类和氯霉素对流感嗜血杆菌有很好抗菌作用,细菌敏感>90%。副流感嗜血杆菌β-内酰胺酶阳性率为35.3%,对氨苄西林耐药率为63.8%;产酶菌对氨苄西林100%耐药,对氨苄西林/舒巴坦耐药率为80.5%。副流感嗜血杆菌对美罗培南、四环素类、喹诺酮类耐药/不敏感率显著高于流感嗜血杆菌,其他药物则多相似或低于流感嗜血杆菌,见表14。

所测药物,除大环内酯类、克林霉素对卡他莫拉菌MIC_{90}值较高,细菌耐药/不敏感率达25%以上,其他药物均表现出较好的抗菌活性,见表15。

5 不同来源主要菌种耐药率比较

重症监护病房(intensive care unit, ICU)菌株耐药率整体高于非ICU,结果见表16和表17。来源ICU肺炎克雷伯菌耐药率多高于非ICU菌株15~25个百分点,在统计学上差异有统计学意义($P<0.01$),ICU菌株碳青霉烯类耐药率49.5% ~51.5%;鲍曼不动杆菌,来源于ICU菌株耐药率高于非ICU菌株约15~20个百分点,在统计学上差异有统计学意义($P<0.05$);来源于ICU铜绿假单胞菌耐药率高于非ICU菌株约10~15个百分点,在统计学上差异有统计学意义($P<0.05$);大肠埃希菌2种来源间,在统计学上差异无统计学意义($P>0.05$)。

来自儿童的铜绿假单胞菌对测试药物耐药率<10%，低于成人和老年人约10～30个百分点，在统计学上差异有统计学意义（$P<0.01$），成人与老年人之间在统计学上差异无统计学意义；来自儿童的鲍曼不动杆菌耐药率约60%，多低于成人10～20个百分点，在统计学上差异无统计学意义（$P>0.05$）；来自儿童的肺炎克雷伯菌中ESBLs表型检出率为57.1%，显著高于成人（16.3%）和老年人（19.8%），对青霉素和头孢菌素类药物耐药率高于成人和老年人约10～20个百分点，但碳青霉烯类耐药率仅9.5%，明显低于成人和老年人，此外对氨基糖苷类、四环素类（除四环素）和喹诺酮类药物耐药率也明显低于成人和老年人；来自儿童的流感嗜血杆菌对头孢菌素类、阿奇霉素、四环素类耐药率高于成人和老年人，但在统计学上差异无统计学意义（$P>0.05$），见表18～表21。

尿标本来源的鲍曼不动杆菌对测试药物耐药率显著低于痰和血标本来源菌株（$P<0.05$），非常显著低于引流液和分泌物来源菌株（$P<0.01$），其他各来源间在统计学上差异无统计学意义；其他主要菌种不同标本间，在统计学上差异无统计学意义，痰标本中的铜绿假单胞菌和来源引流液的大肠埃希菌耐药率较其他来源略高，见表22～表25。

表1 抗菌药物对大肠埃希菌和克雷伯菌属的抗菌作用（$mg \cdot L^{-1}$）及细菌敏感（S）和耐药（R）率（%）

Table 1 Antibacterail activity ($mg \cdot L^{-1}$) and susceptibilility (S), resistance (R) rates (%) of antimicrobial agents against *Escherichia coli* and *Klebsiella spp.*

Antibiotic	*Escherichia coli* ($n=712$)				*Klebsiella pneumoniae* ($n=590$)				*Klebsiella aerogenes* ($n=144$)				Other *Klebsiella spp.* ($n=137$)			
	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R
Piperacillin	256	>256	17.7	78.7	256	>256	32.7	58.5	4	>256	62.5	30.6	16	>256	44.5	38.7
P/T	2	8	92.1	6.3	8	>256	55.6	40.2	4	128	66.7	26.4	2	>256	79.6	18.2
Cefazolin	>256	>256	26.3	62.6	>256	>256	39.3	54.2	128	>256	4.9	92.4	8	>256	26.3	53.3
Cefoxitin	8	32	75.7	14.2	8	>256	54.9	41.0	>256	>256	3.5	95.8	2	256	83.9	12.4
Cefuroxime	>256	>256	37.2	56.9	>256	>256	43.6	54.1	8	>256	54.2	37.5	4	>256	71.5	26.3
Cefotaxime	32	>256	43.7	55.8	16	>256	48.0	51.0	0.12	64	67.4	28.5	0.03	64	77.4	20.4
Ceftriaxone	32	>256	44.1	55.5	4	>256	48.8	50.5	0.12	256	68.1	28.5	0.06	128	78.1	20.4
Ceftazidime	2	64	62.9	30.1	4	>256	51.0	46.8	0.5	128	73.6	26.4	0.12	16	83.9	11.7
CZA	0.12	0.5	97.3	2.7	0.5	4	96.9	3.1	0.25	1	95.1	4.9	0.25	0.5	95.6	4.4
Cefoperazone	32	>256	47.5	49.0	32	>256	49.2	49.8	0.25	256	78.5	13.9	2	>256	75.9	22.6
CSL	4	32	85.5	8.3	4	>256	57.8	38.8	0.25	32	89.6	7.6	2	128	83.2	13.9
Cefepime	1	64	58.8	21.3	0.5	>256	52.4	43.1	0.06	8	86.8	9.7	0.03	8	86.1	9.5
Aztreonam	4	128	55.5	35.7	1	>256	51.7	47.3	0.12	32	75.0	22.9	0.25	32	83.9	16.1
Imipenem	0.12	0.12	96.8	3.1	0.25	64	66.3	33.6	0.25	1	93.1	6.3	0.12	0.25	93.4	6.6
Meropenem	0.016	0.03	97.5	2.1	0.03	128	65.8	33.7	0.03	0.06	93.8	6.3	0.016	0.06	92.7	7.3
Ertapenem	0.008	0.12	95.1	3.8	0.03	>256	64.1	35.4	0.06	0.25	92.4	7.6	0.016	0.12	92.0	7.3
Gentamicin	2	128	62.2	36.2	1	>256	64.7	34.2	1	2	93.1	5.6	1	128	86.1	10.9
Amikacin	4	8	87.6	4.2	2	>256	70.7	26.9	2	4	95.8	2.8	2	4	96.4	1.5
Tetracycline	64	256	33.6	65.3	8	>256	43.4	49.2	2	128	78.5	18.8	1	128	73.0	24.8
Minocycline	2	16	74.6	15.9	4	64	56.3	31.5	2	16	82.6	15.3	2	8	86.9	7.3
Tigecycline	0.12	0.25	99.7	0.0	0.25	1	98.5	0.3	0.12	0.5	99.3	0.7	0.12	0.25	100.0	0.0
Eravacycline	0.12	0.12	99.4	0.6[a]	0.25	1	93.2	6.8[a]	0.12	0.5	–	–	0.12	0.25	–	–
Ciprofloxacin	8	64	33.6	60.7	0.5	256	45.9	48.6	0.03	2	77.8	16.0	0.03	16	72.3	21.9
Levofloxacin	8	32	32.7	61.0	1	128	47.1	44.2	0.06	4	78.5	13.2	0.06	16	75.9	17.5
Nemonoxacin	8	32	41.4	58.6	2	256	54.9	45.1	64	256	–	–	–	–	–	–
Nitrofurantoin	16	32	91.1[c]	3.7[c]	128	256	8.8[c]	82.4[c]	4	32	–	–	16	128	–	–
FOS	0.25	4	93.3[c]	5.2[c]	8	256			0.12	1	–	–	4	8	–	–
SXT	64	>64	44.9	55.1	0.5	>64	58.3	41.7	0.5	1	91.7	8.3	0.12	>64	78.1	21.9
Colistin	0.5	0.5	–	1.7	0.5	4	–	13.9	2	128	–	4.9	0.5	2	–	8.8

P/T: Piperacillin/tazobactam; CZA: Ceftazidime/avibactam; CSL: Cefoperazone/sulbactam; FOS: Fosfomycin trometamol; SXT: Trimethoprim – sulfamethoxazole; The breakpoint of cefoperazone was used for cefoperazone/sulbactam (S: ≤16 $mg \cdot L^{-1}$; R: ≥64 $mg \cdot L^{-1}$); Interpretive criteria of USA – FDA breakpoint was applied for tigecycline (S: ≤2 $mg \cdot L^{-1}$; R: ≥8 $mg \cdot L^{-1}$); Interpretive criteria of ChinaCAST was used for Eravacycline (*Escherichia coli* S: ≤0.5 $mg \cdot L^{-1}$, *Klebsiella pneumoniae* S: ≤1 $mg \cdot L^{-1}$); Interpretive criteria of Nemonoxacin Malate and Sodium Chloride Injection introduction was used for Nemonoxacin (S: ≤2 $mg \cdot L^{-1}$; R: ≥4 $mg \cdot L^{-1}$); a: Non – susceptibility; c: The rates of susceptibility and resistance of urinary tract isolates contain 135 *Escherichia coli* strains and 34 *Klebsiella pneumoniae* strains; –: No breakpoint.

表2 抗菌药物对超广谱β-内酰胺酶(ESBLs)阴性、阳性大肠埃希菌的抗菌作用(mg·L^{-1})及细菌敏感(S)和耐药(R)率(%)

Table 2 Antibacterail activity (mg·L^{-1}) and susceptibilility (S) and resistance (R) rates (%) of antimicrobial agents against extended spectrum β-lactamase (ESBLs)+ and ESBLs- of *Escherichia coli*

Antibiotic	Carbapenems sensitive ESBLs-(n=328)				Carbapenems non-sensitive ESBLs-(n=23)				ESBLs+(n=361)			
	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R
Piperacillin	32	256	38.4	53.7	>256	>256	0.0	100.0	>256	>256	0.0	100.0
P/T	2	4	98.8	0.6	>256	>256	13.0	87.0	4	8	91.1	6.4
Cefazolin	2	16	57.0	18.9	>256	>256	0.0	100.0	>256	>256	0.0	100.0
Cefoxitin	4	32	84.8	10.1	>256	>256	0.0	100.0	8	32	72.3	12.5
Cefuroxime	8	16	80.8	6.4	>256	>256	0.0	100.0	>256	>256	0.0	100.0
Cefotaxime	0.06	0.5	94.8	4.0	>256	>256	0.0	100.0	128	>256	0.0	100.0
Ceftriaxone	0.06	0.25	95.4	3.7	>256	>256	0.0	100.0	256	>256	0.3	99.7
Ceftazidime	0.25	0.5	95.7	2.7	>256	>256	0.0	100.0	16	128	37.1	50.4
CZA	0.12	0.5	100.0	0.0	256	>256	17.4	82.6	0.12	0.5	100.0	0.0
Cefoperazone	0.5	4	99.1	0.3	>256	>256	0.0	100.0	256	>256	3.6	90.0
CSL	0.25	2	99.4	0.0	256	>256	4.3	95.7	8	64	78.1	10.2
Cefepime	0.03	0.12	100.0	0.0	128	>256	0.0	91.3	8	128	25.2	36.3
Aztreonam	0.06	0.25	97.9	1.8	32	>256	21.7	65.2	32	256	19.1	64.5
Imipenem	0.06	0.12	100.0	0.0	8	32	8.7	87.0	0.12	0.12	99.4	0.6
Meropenem	0.016	0.03	100.0	0.0	4	64	21.7	65.2	0.016	0.03	100.0	0.0
Ertapenem	0.008	0.016	100.0	0.0	16	128	4.3	87.0	0.016	0.25	96.4	1.9
Gentamicin	1	128	75.3	23.5	32	256	21.7	78.3	2	256	52.9	45.2
Amikacin	4	8	89.9	2.4	2	16	82.6	13.0	4	8	85.9	5.3
Tetracycline	64	256	45.1	54.6	128	256	4.3	87.0	128	256	24.9	73.7
Minocycline	2	8	82.9	9.8	8	64	43.5	43.5	4	32	69.0	19.7
Tigecycline	0.12	0.12	99.7	0.0	0.12	0.25	100.0	0.0	0.12	0.25	99.7	0.0
Eravacycline	0.06	0.12	99.7	0.3[a]	0.12	0.12	100.0	-	0.12	0.12	99.2	0.8[a]
Ciprofloxacin	0.25	32	53.4	40.5	32	128	0.0	87.0	16	128	17.7	77.3
Levofloxacin	1	16	49.4	41.5	16	64	8.7	82.6	8	32	19.1	77.3
Nemonoxacin	1	16	61.6	38.4	32	128	17.4	82.6	16	64	24.7	75.3
Nitrofurantoin	16	32	94.4[c]	2.8[c]	16	128	-	-	16	32	89.7[c]	1.7[c]
FOS	0.25	1	100.0[c]	0.0[c]	1	>256	-	-	0.25	64	89.7[c]	6.9[c]
SXT	0.25	>64	61.0	39.0	>64	>64	17.4	82.6	>64	>64	32.1	67.9
Colistin	0.5	0.5	-	1.2	0.5	1	-	8.7	0.5	0.5	-	1.7

Same as table 1; c: The rates of susceptibility and resistance of urinary tract isolates contain 71 carbapenems sensitive ESBLs- strains and 58 ESBLs+ strains.

表3 抗菌药物对超广谱β-内酰胺酶(ESBLs)阴性、阳性肺炎克雷伯菌的抗菌作用(mg·L^{-1})及细菌敏感(S)和耐药(R)率(%)

Table 3 Antibacterail activity (mg·L^{-1}) and susceptibilility (S) and resistance (R) rates (%) of antimicrobial agents against extended spectrum β-lactamase (ESBLs)+ and ESBLs- of *Klebsiella pneumoniae*

Antibiotic	Carbapenems sensitive ESBLs-(n=293)				Carbapenems non-sensitive ESBLs-(n=175)				ESBLs+(n=122)			
	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R
Piperacillin	8	64	65.9	16.7	>256	>256	0.0	100.0	>256	>256	0.0	99.2
P/T	4	8	93.9	3.4	>256	>256	0.0	100.0	16	>256	43.4	42.6
Cefazolin	2	4	78.8	8.9	>256	>256	0.0	100.0	>256	>256	0.8	97.5
Cefoxitin	4	16	88.4	7.8	256	>256	0.0	98.3	8	256	53.3	38.5
Cefuroxime	4	16	87.7	8.5	>256	>256	0.0	98.9	>256	>256	0.0	99.2
Cefotaxime	0.06	0.25	96.2	2.7	>256	>256	0.6	98.9	256	>256	0.0	98.4
Ceftriaxone	0.06	0.25	96.9	1.7	>256	>256	1.1	98.9	>256	>256	1.6	98.4
Ceftazidime	0.25	0.5	96.2	3.1	>256	>256	1.7	98.3	64	>256	13.1	77.9
CZA	0.12	0.5	100.0	0.0	2	8	91.4	8.6	0.5	2	97.5	2.5
Cefoperazone	0.25	2	98.3	0.7	>256	>256	0.0	100.0	>256	>256	1.6	95.9
CSL	0.25	1	99.3	0.3	>256	>256	0.0	98.3	32	256	41.0	45.9
Cefepime	0.03	0.12	100.0	0.0	256	>256	1.1	97.1	32	256	11.5	68.9
Aztreonam	0.06	0.25	98.6	1.0	>256	>256	3.4	96.0	128	>256	8.2	88.5

续表 3 (Table 3 continued)

Antibiotic	Carbapenems sensitive ESBLs − (n = 293)				Carbapenems non − sensitive ESBLs − (n = 175)				ESBLs + (n = 122)			
	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R
Imipenem	0.12	0.25	100.0	0.0	64	128	0.6	98.9	0.25	32	79.5	20.5
Meropenem	0.016	0.06	100.0	0.0	128	256	1.1	98.3	0.03	32	76.2	22.1
Ertapenem	0.008	0.03	100.0	0.0	>256	>256	0.0	99.4	0.12	256	69.7	28.7
Gentamicin	0.5	1	96.9	2.4	>256	>256	20.0	78.3	1	>256	51.6	47.5
Amikacin	2	4	98.0	0.3	>256	>256	22.3	74.3	4	>256	74.6	23.0
Tetracycline	2	128	79.2	16.0	256	>256	6.9	77.7	256	>256	9.8	87.7
Minocycline	2	8	86.3	6.8	16	256	21.7	65.1	8	128	33.6	42.6
Tigecycline	0.25	0.5	100.0	0.0	1	2	96.6	1.1	0.25	1	97.5	0.0
Eravacycline	0.12	0.5	99.3	0.7 [a]	0.5	2	82.3	17.7 [a]	0.25	1	94.3	5.7 [a]
Ciprofloxacin	0.03	0.5	84.3	8.5	128	>256	1.7	97.7	16	256	17.2	74.6
Levofloxacin	0.06	1	83.6	6.1	64	256	2.9	97.1	4	128	23.0	59.8
Nemonoxacin	0.25	2	92.8	7.2	128	>256	2.3	97.7	8	256	39.3	60.7
Nitrofurantoin	64	256	–	–	256	>256	–	–	128	256	–	–
FOS	8	16	–	–	64	>256	–	–	8	>256	–	–
SXT	0.12	16	88.7	11.3	>64	>64	28.0	72.0	>64	>64	28.7	71.3
Colistin	0.5	2	–	8.5	0.5	32	–	21.1	0.5	8	–	16.4

Same as table 1.

表 4 抗菌药物对 721 株大肠埃希菌的 MIC 分布(株)

Table 4 Minimal inhibitory concentrations (MICs) distribution of antimicrobial agents against 721 *Escherichia coli* (strains No.)

Antibiotic	MIC(mg · L^{-1})																		
	0.002	0.004	0.008	0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Piperacillin	0	0	0	0	0	0	0	1	2	14	42	49	18	26	53	67	74	97	269
P/T	0	0	0	0	0	1	2	1	7	74	299	204	68	11	9	4	6	7	19
Cefazolin	0	0	0	0	0	0	0	0	0	60	127	79	25	6	3	6	11	37	358
Cefoxitin	0	0	0	0	0	0	0	0	2	7	60	259	211	72	38	15	17	6	25
Cefuroxime	0	0	0	0	0	0	0	1	1	4	18	126	115	42	16	4	0	11	374
Cefotaxime	0	0	2	2	39	147	77	26	10	8	4	10	7	19	37	65	72	72	115
Ceftriaxone	0	0	4	6	102	132	49	16	2	3	3	1	5	14	24	54	89	99	109
Ceftazidime	0	0	0	1	2	24	119	125	42	36	41	58	50	70	48	30	17	21	28
CZA	0	0	0	0	2	131	302	192	51	11	2	2	0	1	1	2	2	2	11
Cefoperazone	0	0	0	0	3	20	49	67	75	47	23	22	19	13	25	57	69	88	135
CSL	0	0	1	5	6	26	61	68	71	49	65	73	98	86	44	27	12	11	9
Cefepime	0	0	4	44	146	93	33	10	9	28	52	56	85	46	28	22	27	8	21
Aztreonam	0	0	2	2	31	157	96	22	7	7	22	49	63	54	48	72	27	19	34
Imipenem	0	0	0	1	14	336	311	23	3	1	1	9	4	4	5	0	0	0	0
Meropenem	0	13	191	363	96	16	6	4	1	4	3	4	3	1	3	4	0	0	0
Ertapenem	0	132	240	138	75	47	18	14	13	8	6	3	3	7	0	4	3	0	1
Gentamicin	0	0	0	0	0	0	0	4	48	271	120	11	6	13	27	62	93	31	26
Amikacin	0	0	0	0	0	0	0	0	1	36	300	287	58	20	3	0	0	0	7
Tetracycline	0	0	0	0	0	0	0	0	2	50	159	28	8	4	15	113	179	127	27
Minocycline	0	0	0	0	0	0	2	7	44	140	193	145	68	52	33	13	10	3	2
Tigecycline	0	0	0	0	12	177	440	72	6	3	0	2	0	0	0	0	0	0	0
Eravacycline	0	0	0	0	16	337	319	34	2	2	1	1	0	0	0	0	0	0	0
Ciprofloxacin	1	3	19	41	7	13	57	98	41	14	10	23	33	119	110	68	33	15	7
Levofloxacin	0	0	0	12	35	23	17	73	73	45	26	51	145	122	57	26	5	2	0
Nemonoxacin	0	0	0	0	8	38	24	29	92	80	24	27	105	124	92	35	18	11	5
Nitrofurantoin	0	0	0	0	0	0	0	0	1	0	4	42	257	291	75	31	8	3	0
FOS	0	0	0	0	0	2	81	330	135	51	31	15	8	7	4	4	16	9	19
SXT	0	0	3	20	108	83	34	30	17	20	5	8	3	0	3	29	349	0	0
Colistin	0	0	0	0	0	0	2	84	575	36	3	6	3	0	0	0	0	0	3

Same as table 1.

表5 抗菌药物对590株肺炎克雷伯菌的MIC分布(株)

Table 5 MIC distribution of antimicrobial agents against 590 *Klebsiella pneumoniae* (strains No.)

Antibiotic	MIC(mg·L^{-1})																		
	0.002	0.004	0.008	0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Piperacillin	0	0	0	0	0	0	0	0	0	1	3	56	133	52	19	18	5	9	294
P/T	0	0	0	0	0	0	0	0	2	3	91	190	42	25	12	1	2	9	213
Cefazolin	0	0	0	0	0	0	0	0	2	94	136	38	4	5	1	2	0	5	303
Cefoxitin	0	0	0	0	0	0	0	1	1	10	127	136	49	24	13	14	21	98	96
Cefuroxime	0	0	0	0	0	0	0	0	2	6	101	119	29	14	8	4	4	3	300
Cefotaxime	0	0	1	12	82	134	29	10	7	8	6	4	1	7	13	18	24	35	199
Ceftriaxone	0	0	1	15	69	136	34	21	9	3	4	4	1	0	3	15	15	35	225
Ceftazidime	0	0	0	0	1	9	113	106	41	12	5	14	13	24	21	25	35	26	145
CZA	0	0	0	1	3	31	138	121	75	42	88	57	16	1	3	0	1	0	13
Cefoperazone	0	0	0	0	1	3	44	116	70	31	15	6	1	3	6	6	12	30	246
CSL	0	0	0	0	0	2	68	115	65	24	14	7	25	21	20	21	15	55	138
Cefepime	0	0	1	21	152	66	42	11	3	6	7	9	18	20	21	19	54	76	64
Aztreonam	0	0	0	8	95	105	50	21	10	6	6	4	6	11	22	14	15	25	192
Imipenem	0	0	0	0	1	64	214	73	34	5	1	3	10	15	25	103	39	3	0
Meropenem	0	0	22	198	102	57	1	2	2	4	3	8	8	3	13	35	82	44	6
Ertapenem	0	17	135	112	47	20	20	21	6	3	1	5	7	13	5	3	11	45	119
Gentamicin	0	0	0	0	0	0	1	22	190	159	10	6	4	5	1	18	18	11	145
Amikacin	0	0	0	0	0	0	0	1	6	99	211	100	14	3	1	1	1	0	153
Tetracycline	0	0	0	0	0	0	0	0	6	67	145	38	44	14	7	17	52	72	128
Minocycline	0	0	0	0	0	0	0	0	0	60	162	110	72	49	53	38	14	13	19
Tigecycline	0	0	0	0	0	1	119	212	109	98	42	7	2	0	0	0	0	0	0
Eravacycline	0	0	0	0	0	15	222	144	80	89	34	4	2	0	0	0	0	0	0
Ciprofloxacin	0	0	3	67	135	32	10	24	32	15	14	11	11	12	15	41	53	77	38
Levofloxacin	0	0	0	1	56	140	39	13	29	51	15	7	14	18	36	55	73	36	7
Nemonoxacin	0	0	0	4	2	12	121	89	15	30	51	18	11	21	25	45	54	72	20
Nitrofurantoin	0	0	0	0	0	0	0	0	0	0	0	1	6	19	56	112	160	178	58
FOS	0	0	0	0	0	0	0	2	5	6	44	136	133	51	69	47	36	14	47
SXT	0	0	0	1	3	36	149	83	40	23	9	7	2	1	1	0	235	0	0
Colistin	0	0	0	0	0	0	0	52	348	78	30	23	13	13	13	8	4	2	6

Same as table 1.

表6 抗菌药物对肠杆菌属、枸橼酸菌属和沙雷菌属的抗菌作用(mg·L^{-1})及细菌敏感(S)和耐药(R)率(%)

Table 6 Antibacterail activity(mg·L^{-1}) and susceptibilility (S), resistance (R) rates (%) of antimicrobial agents against *Enterobacter spp.*, *Citrobacter spp.* and *Serratia spp.*

Antibiotic	*Enterobacter spp.* (*n*=190)				*Citrobacter spp.* (*n*=159)				*Serratia spp.* (*n*=164)			
	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R
Piperacillin	8	>256	54.2	41.6	8	>256	54.1	39.0	4	128	82.3	14.0
P/T	4	>256	66.3	25.8	4	128	73.6	19.5	2	16	89.0	8.5
Cefuroxime	32	>256	29.5	54.2	8	>256	52.2	40.3	–	–	–	–
Cefotaxime	0.5	>256	55.3	44.7	0.25	128	67.3	30.2	0.5	32	79.9	15.9
Ceftriaxone	0.5	>256	55.3	44.2	0.25	256	67.9	29.6	0.5	64	81.7	16.5
Ceftazidime	1	>256	58.4	39.5	0.5	256	70.4	28.3	0.5	4	91.5	5.5
CZA	0.5	>256	85.8	14.2	0.25	1	94.3	5.7	0.12	0.5	98.2	1.8
Cefoperazone	1	>256	60.5	32.1	1	256	74.8	21.4	2	64	87.8	11.0
CSL	1	>256	78.4	16.3	0.5	32	83.6	8.8	2	16	90.2	8.5
Cefepime	0.06	64	72.1	21.6	0.03	4	86.8	7.5	0.12	8	88.4	8.5
Aztreonam	0.12	128	61.6	36.8	0.12	64	74.2	24.5	0.25	32	87.2	11.6
Imipenem	0.25	8	85.8	12.6	0.25	1	93.7	4.4	0.5	1	90.9	7.9
Meropenem	0.03	8	86.3	12.1	0.016	0.12	94.3	4.4	0.03	0.12	92.1	7.9
Ertapenem	0.03	16	81.1	18.4	0.008	0.25	93.7	5.7	0.06	0.12	91.5	7.9
Gentamicin	1	128	80.5	19.5	1	16	88.1	11.3	1	2	91.5	6.7

续表 6 (Table 6 continued)

Antibiotic	*Enterobacter spp.* (n = 190)				*Citrobacter spp.* (n = 159)				*Serratia spp.* (n = 164)			
	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R
Amikacin	2	4	93.2	4.7	2	4	93.7	3.1	2	8	79.9	5.5
Tetracycline	4	256	67.9	29.5	1	256	75.5	22.6	64	256	1.8	95.1
Minocycline	4	32	74.2	16.3	2	16	81.1	10.1	4	8	67.1	3.7
Tigecycline	0.25	1	99.5	0.0	0.12	0.5	100.0	0.0	0.5	1	100.0	0.0
Eravacycline	0.25	1	–	–	0.12	0.25	–	–	0.5	1	–	–
Ciprofloxacin	0.03	16	67.9	25.8	0.06	8	76.1	21.4	0.12	1	83.5	11.0
Levofloxacin	0.06	16	71.6	21.1	0.25	8	80.5	15.7	0.25	1	87.8	9.1
Nitrofurantoin	128	256	–	–	32	64	60.9[c]	10.9[c]	256	>256	–	–
FOS	8	64	–	–	0.25	2	–	–	8	16	–	–
SXT	0.12	>64	74.7	25.3	0.06	>64	76.7	23.3	0.5	0.5	96.3	3.7

Same as table 1; c: The rates of susceptibility and resistance of urinary tract isolates contain 46 *Citrobacter spp.* strains.

表 7 抗菌药物对变形菌属、摩根菌属、沙门菌属和普罗威登菌属的抗菌作用(mg·L^{-1})及细菌敏感(S)和耐药(R)率(%)

Table 7 Antibacterail activity (mg·L^{-1}) and susceptibilility (S), resistance (R) rates (%) of antimicrobial agents *Proteus spp.*, *Morganella*, *Salmonella spp.* and *Providencia spp.*

Antibiotic	*Proteus spp.* (n = 171)				*Morganella* (n = 136)				*Salmonella spp.* (n = 121)				*Providencia spp.* (n = 55)			
	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R
Piperacillin	8	128	55.6	38.6	2	128	69.9	25.7	256	>256	–	–	8	256	54.5	45.5
P/T	0.5	2	96.5	1.8	0.25	2	96.3	2.9	4	16	–	–	2	128	65.5	29.1
Cefoxitin	4	32	85.4	10.5	16	32	42.6	12.5	–	–	–	–	8	128	52.7	36.4
Cefuroxime	256	>256	43.3	56.7	64	>256	0.7	91.2	–	–	–	–	8	>256	50.9	43.6
Cefotaxime	0.12	128	55.6	42.1	0.06	16	71.3	27.2	0.12	>256	68.6	31.4	0.25	128	52.7	43.6
Ceftriaxone	0.12	256	61.4	38.6	0.016	4	82.4	12.5	0.12	>256	68.6	30.6	0.06	128	56.4	40.0
Ceftazidime	0.12	32	85.4	12.3	0.12	32	78.7	16.9	0.25	64	–	–	1	>256	54.5	41.8
CZA	0.06	0.12	97.7	2.3	0.06	0.12	99.3	0.7	0.25	0.5	–	–	0.25	>256	61.8	38.2
Cefoperazone	2	64	62.6	25.1	2	32	80.1	8.8	8	>256	–	–	4	>256	61.8	36.4
CSL	2	4	97.1	2.9	1	8	98.5	1.5	4	16	–	–	4	256	65.5	27.3
Cefepime	0.12	16	78.4	11.1	0.03	0.25	97.8	0.7	0.06	32	–	–	0.06	32	63.6	23.6
Aztreonam	0.016	2	91.2	8.8	0.016	4	91.9	7.4	0.12	64	–	–	0.016	8	85.5	9.1
Imipenem	1	4	53.2	15.2	2	4	23.5	23.5	0.12	0.12	98.3	1.7	1	64	50.9	38.2
Meropenem	0.06	0.12	94.7	4.1	0.06	0.12	98.5	1.5	0.016	0.03	98.3	1.7	0.06	64	67.3	32.7
Ertapenem	0.008	0.03	94.7	5.3	0.016	0.06	97.8	1.5	0.008	0.03	98.3	1.7	0.03	8	65.5	34.5
Gentamicin	4	32	49.1	39.2	1	128	66.9	22.1	1	32	–	–	4	64	36.4	47.3
Amikacin	4	32	75.4	18.1	2	8	88.2	2.9	2	4	–	–	4	64	61.8	30.9
Tetracycline	–	–	–	–	–	–	–	–	32	128	44.6	53.7	–	–	–	–
Minocycline	–	–	–	–	–	–	–	–	4	64	52.1	32.2	–	–	–	–
Tigecycline	–	–	–	–	–	–	–	–	0.25	0.5	100.0	0.0	–	–	–	–
Eravacycline	–	–	–	–	–	–	–	–	0.12	0.5	–	–	–	–	–	–
Ciprofloxacin	1	64	40.4	56.1	0.5	16	45.6	47.1	0.12	1	25.6	17.4	4	32	32.7	61.8
Levofloxacin	1	32	44.4	45.6	1	8	48.5	36.8	0.5	2	26.4	14.9	8	32	29.1	63.6
FOS	4	256	–	–	>256	>256	–	–	0.12	2	–	–	32	>256	–	–
SXT	>64	>64	43.3	56.7	1	>64	54.4	45.6	0.25	>64	71.1	28.9	0.5	>64	56.4	43.6

Same as table 1.

表8 抗菌药物对铜绿假单胞菌(PA)抗菌作用(mg·L^{-1})及细菌敏感(S)和耐药(R)率(%)

Table 8 Antibacterail activity(mg·L^{-1}) and susceptibilility (S), resistance (R) rates (%) of antimicrobial agents *Pseudomonas aeruginoas* (PA)

Antibiotic	PA(n=624)				Imipenem-susceptibility PA(n=400)		Imipenem-non-susceptibility PA(n=197)	
	MIC_{50}	MIC_{90}	S	R	S	R	S	R
Piperacillin	8	256	66.7	29.3	83.3	14.0	37.1	56.7
P/T	8	256	68.6	23.6	84.5	9.8	40.2	48.2
Ceftazidime	4	128	73.6	22.4	89.3	8.0	45.5	48.2
CZA	2	16	88.6	11.4	98.5	1.5	71.0	29.0
Cefoperazone	8	256	-	-	-	-	-	-
CSL	8	128	-	-	-	-	-	-
Cefepime	4	32	75.6	15.2	90.5	5.0	49.1	33.5
Aztreonam	8	64	61.3	24.7	77.5	11.8	32.1	47.8
Imipenem	2	32	64.1	32.7	100.0	0.0	0.0	91.1
Meropenem	0.5	16	67.6	23.4	96.8	1.0	15.6	63.4
Gentamicin	2	32	-	-	-	-	-	-
Amikacin	4	16	92.9	4.5	98.8	0.3	82.6	12.1
Ciprofloxacin	0.25	4	73.2	19.9	87.8	8.5	47.3	40.2
Levofloxacin	1	16	64.4	24.5	81.8	10.8	33.5	49.1
FOS	64	128	-	-	-	-	-	-
Colistin	1	2	-	9.0	-	10.0	-	7.1

P/T: Piperacillin/tazobactam; CZA: Ceftazidime/avibactam; CSL: Cefoperazone/sulbactam; FOS: Fosfomycin trometamol; -: No breakpoint.

表9 抗菌药物对624株铜绿假单胞菌的MIC分布(株)

Table 9 MIC distribution of antimicrobial agents against 624 *Pseudomonas aeruginosa* (strains No.)

Antibiotic	MIC(mg·L^{-1})																
	0.008	0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Piperacillin	0	0	0	0	0	0	3	5	35	187	112	74	25	52	35	44	52
P/T	0	0	1	1	0	4	4	3	44	213	92	66	49	25	37	46	39
Ceftazidime	0	0	0	0	0	2	3	82	194	129	49	25	45	31	29	12	23
CZA	0	0	0	0	0	3	6	99	267	125	53	31	10	6	4	4	16
Cefoperazone	0	0	0	0	0	0	5	3	30	158	131	82	50	33	33	46	53
CSL	0	0	0	0	0	1	5	5	49	190	117	78	38	49	41	28	23
Cefepime	0	0	0	0	0	4	21	109	158	112	68	57	39	19	19	4	14
Aztreonam	0	0	0	0	1	5	3	8	57	195	113	88	57	50	19	12	16
Imipenem	0	0	0	0	0	7	36	182	175	20	34	105	35	5	5	8	12
Meropenem	0	3	6	19	78	114	114	56	32	56	46	41	20	14	6	11	8
Gentamicin	0	0	0	0	3	5	8	108	231	148	34	23	8	3	9	5	39
Amikacin	0	0	0	1	1	3	6	29	168	219	110	43	16	7	7	2	12
Ciprofloxacin	0	0	5	25	169	152	106	43	36	28	12	17	15	11	2	3	0
Levofloxacin	0	0	0	3	2	22	220	155	69	44	30	33	24	14	7	1	0
FOS	0	0	0	0	0	1	0	2	7	13	12	15	139	328	63	10	34
Colistin	0	0	0	0	0	4	33	317	214	43	10	0	0	1	0	0	2

Same as table 8.

表 10 抗菌药物对鲍曼不动杆菌(AB)的抗菌作用(mg·L^{-1})及细菌敏感(S)和耐药(R)率(%)

Table 10 Antibacterail activity(mg·L^{-1}) and susceptibilility (S), resistance (R) rates (%) of antimicrobial agents against *Acinetobacter baumannii* (AB)

Antibiotic	AB(n=617)				Imipenem-susceptibility AB(n=153)		Imipenem-non-susceptibility AB(n=464)	
	MIC_{50}	MIC_{90}	S	R	S	R	S	R
Piperacillin	>256	>256	16.0	78.8	64.1	16.3	0.2	99.4
P/T	>256	>256	21.1	77.6	82.4	14.4	0.9	98.5
Ampicillin/sulbactam	64	128	24.0	70.8	89.5	1.3	2.4	93.8
Cefotaxime	>256	>256	14.3	73.9	56.2	5.2	0.4	96.6
Ceftriaxone	>256	>256	7.9	73.9	32.0	6.5	0.0	96.1
Ceftazidime	256	>256	26.4	71.5	94.8	3.3	3.9	94.0
CZA	16	128	–	–	–	–	–	–
Cefoperazone	>256	>256	–	–	–	–	–	–
CSL	64	128	–	–	–	–	–	–
Sulbactam	32	128	–	–	–	–	–	–
Cefepime	128	>256	21.7	75.2	84.3	13.7	1.1	95.5
Imipenem	32	128	24.8	70.7	100.0	0.0	0.0	94.0
Meropenem	32	64	24.8	74.9	99.3	0.0	0.2	99.6
Gentamicin	>256	>256	26.7	70.7	94.1	3.3	4.5	92.9
Amikacin	>256	>256	36.5	62.4	98.7	0.7	15.9	82.8
Tetracycline	>256	>256	–	–	–	–	–	–
Minocycline	8	32	28.7	65.8	96.7	2.6	6.3	86.6
Tigecycline	1	2	–	–	–	–	–	–
Eravacycline	0.25	0.5	96.8	3.2 [a]	99.3	0.7 [a]	95.9	4.1 [a]
Ciprofloxacin	64	256	24.1	75.7	96.1	3.3	0.4	99.6
Levofloxacin	16	64	24.5	71.6	97.4	2.6	0.4	94.4
SXT	32	>64	43.3	56.7	92.2	7.8	27.2	72.8
Colistin	1	1	–	3.4	–	2.6	–	3.7

P/T: Piperacillin/tazobactam; CZA: Ceftazidime/avibactam; CSL: Cefoperazone/sulbactam; SXT: Trimethoprim-sulfamethoxazole; Interpretive criteria of ChinaCAST was used for Eravacycline(S: ≤1 mg·L^{-1}); a: Non-susceptibility; –: No breakpoint.

表 11 抗菌药物对 617 株鲍曼不动杆菌的 MIC 分布(株)

Table 11 MIC distribution of antimicrobial agents against 617 *Acinetobacter baumannii* (strains No.)

Antibiotic	MIC(mg·L^{-1})																	
	0.004	0.008	0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Piperacillin	0	0	0	0	0	0	0	0	0	0	7	32	60	21	11	8	22	456
P/T	74	8	5	2	4	9	7	4	1	8	4	3	1	1	7	21	39	419
Ampicillin/sulbactam	0	0	0	0	0	0	0	1	31	68	29	19	32	67	198	118	33	21
Cefotaxime	0	0	0	0	0	0	0	0	0	5	29	54	61	12	11	14	48	383
Ceftriaxone	0	0	0	0	0	0	0	0	0	1	18	30	80	32	13	13	22	408
Ceftazidime	0	0	0	0	0	0	0	0	12	45	81	25	13	6	37	88	81	229
CZA	0	0	0	0	0	0	0	0	8	73	89	89	187	14	45	61	18	33
Cefoperazone	0	0	0	0	0	0	0	0	0	0	0	2	21	43	58	17	9	467
CSL	0	0	0	0	0	0	0	7	38	65	22	13	30	77	209	124	15	17
Sulbactam	0	0	0	0	0	0	9	38	69	16	17	41	104	170	89	42	16	6
Cefepime	0	0	0	0	0	0	0	11	36	69	11	7	19	29	79	100	140	116
Imipenem	0	0	0	0	0	36	99	13	2	3	28	14	48	164	146	56	5	3
Meropenem	0	0	0	0	0	15	77	39	17	5	2	22	76	148	186	23	6	1
Gentamicin	0	0	0	0	0	0	1	15	54	67	28	16	4	8	6	22	9	387
Amikacin	0	0	0	0	0	0	0	1	4	47	78	74	21	7	3	1	4	377
Tetracycline	0	0	0	0	0	0	0	4	8	29	56	52	20	20	16	9	10	393
Minocycline	0	0	0	6	37	51	53	13	17	34	33	118	157	77	16	5	0	0
Tigecycline	0	0	0	0	16	76	48	143	244	68	18	3	1	0	0	0	0	0

续表 11(Table 11 continued)

Antibiotic	MIC(mg·L^{-1})																	
	0.004	0.008	0.016	0.03	0.06	0.12	0.25	0.5	1	2	4	8	16	32	64	128	256	>256
Eravacycline	0	0	9	94	51	20	187	195	41	19	1	0	0	0	0	0	0	0
Ciprofloxacin	0	0	0	0	13	76	45	12	3	1	0	3	4	29	149	125	100	57
Levofloxacin	0	0	0	0	24	99	21	3	2	2	24	95	148	112	53	24	9	1
SXT	0	0	0	0	7	17	59	53	71	60	19	7	3	16	87	218	0	0
Colistin	0	0	0	0	0	0	7	251	300	38	3	2	1	0	2	2	3	8

Same as table 10.

表 12 抗菌药物对 180 株嗜麦芽窄食单胞菌抗菌作用(mg·L^{-1})及细菌敏感(S)和耐药(R)率(%)

Table 12 Antibacterail activity(mg·L^{-1}) and susceptibilility (S), resistance (R) rates (%) of antimicrobial agents against 180 *Stenotrophomonas maltophilia*

Antibiotic	MIC_{50}	MIC_{90}	S	R
Ticarcillin/cavulanic acid	32	128	40.0	15.0
Ceftazidime	32	256	–	–
Ceftazidime/avibactam	16	128	–	–
Minocycline	0.25	1	91.7	2.2
Tigecycline	0.5	1	–	–
Eravacycline	0.5	1	–	–
Levofloxacin	1	2	90.6	7.2
SXT	1	4	83.3	16.7
Chloramphenicol	16	32	42.8	33.3

–: No breakpoint.

表 13 抗菌药物对 111 株洋葱伯克霍尔德菌复合群抗菌作用(mg·L^{-1})及细菌敏感(S)和耐药(R)率(%)

Table 13 Antibacterail activity(mg·L^{-1}) and susceptibilility (S), resistance (R) rates (%) of antimicrobial agents against 111 *Burkholderia cepacia* complex

Antibiotic	MIC_{50}	MIC_{90}
Ticarcillin/cavulanic acid	>256	>256
Ceftazidime	4	8
Ceftazidime/avibactam	2	4
Imipenem	16	16
Meropenem	4	4
Minocycline	8	16
Tigecycline	1	2
Eravacycline	0.5	1
Levofloxacin	4	64
SXT	0.5	2
Chloramphenicol	16	32

表 14 抗菌药物对嗜血杆菌的抗菌作用(mg·L^{-1})及细菌敏感(S)和耐药(R)率(%)

Table 14 Antibacterail activity(mg·L^{-1}) and susceptibilility (S), resistance (R) rates (%) of antimicrobial agents *Haemophilus spp.*

Antibiotic	*Haemophilus influenzae*(n=319)				*Haemophilus parainfluenzae*(n=116)			
	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R
Ampicillin	128	>256	8.8	87.8	8	>256	22.4	63.8
Ampicillin/sulbactam	8	32	21.6	78.4	4	8	43.1	56.9
Piperacillin	32	128	–	–	1	64	–	–
P/T	0.12	0.5	100.0	0.0	0.25	1	93.1	6.9
Cefazolin	256	>256	–	–	16	>256	–	–
Cefathiamidine	256	>256	12.5	87.5	64	>256	–	–
Cefuroxime	64	256	20.7	73.4	8	64	48.3	40.5
Cefotaxime	0.5	2	96.9	3.1[a]	0.12	2	94.8	5.2[a]
Ceftriaxone	0.12	0.5	100.0	–	0.06	0.5	100.0	–
Ceftazidime	0.5	2	94.0	6.0[a]	0.25	2	98.3	1.7[a]
Cefepime	1	4	87.1	12.9[a]	0.25	4	80.2	19.8[a]
Aztreonam	2	16	59.6	40.4[a]	0.5	4	81.9	18.1[a]
Imipenem	8	32	44.2	55.8[a]	2	32	66.4	33.6[a]
Meropenem	0.25	0.5	92.8	7.2[a]	0.25	1	74.1	25.9[a]
Ertapenem	0.5	2	71.5	28.5[a]	0.25	2	67.2	32.8[a]
Azithromycin	4	128	52.7	47.3[a]	2	64	61.2	38.8[a]
Tetracycline	0.5	1	92.5	6.6	1	4	87.1	6.9
Minocycline	0.5	1	94.7	5.3	1	2	66.4	33.6
Tigecycline	0.12	0.25	90.3	9.7[a]	0.5	1	21.6	78.4[a]
Eravacycline	0.06	0.12	–	–	0.12	0.25	–	–
Ciprofloxacin	0.008	0.5	98.1	1.9[a]	2	16	39.7	60.3[a]

续表 14 (Table 14 continued)

Antibiotic	*Haemophilus influenzae* (n = 319)				*Haemophilus parainfluenzae* (n = 116)			
	MIC_{50}	MIC_{90}	S	R	MIC_{50}	MIC_{90}	S	R
Levofloxacin	0.016	0.5	98.7	1.3[a]	2	8	62.9	37.1[a]
Moxifloxacin	0.03	0.5	97.5	2.5[a]	4	32	34.5	65.5[a]
Nemonoxacin	0.016	0.25	97.5	2.5	2	16	31.9	68.1
Gemifloxacin	0.008	0.25	86.2	13.8[a]	4	32	24.1	75.9[a]
SXT	8	64	40.4	56.4	2	64	36.2	40.5
Chloramphenicol	0.5	2	92.8	6.6	1	4	82.8	6.9

P/T: Piperacillin/tazobactam; SXT: Trimethoprim – sulfamethoxazole; Interpretive criteria of cefathiamidine susceptibility test plate manual was used for cefathiamidine (S: ≤16mg · L^{-1}; R: ≥32 mg · L^{-1}); The breakpoints of EUCAST were used for minocycline (S: ≤1 mg · L^{-1}; R: ≥2 mg · L^{-1}); Interpretive criteria of USA – FDA breakpoint was applied for tigecycline (S: ≤0.25 mg · L^{-1}); Interpretive criteria of Nemonoxacin Malate and Sodium Chloride Injection introduction was used for Nemonoxacin (S: ≤0.5 mg · L^{-1}; R: ≥1 mg · L^{-1}); a: Non – susceptibility; –: No breakpoint.

表 15 抗菌药物对 135 株卡他莫拉菌的抗菌作用(mg · L^{-1})及细菌敏感(S)和耐药(R)率(%)

Table 15 Antibacterail activity (mg · L^{-1}) and susceptibilility (S), resistance (R) rates (%) of antimicrobial agents against 135 *Moraxella catarrhalis*

Antibiotic	MIC_{50}	MIC_{90}	S	R
Amoxicillin	2	8	–	–
Amoxicillin/cavulanic acid	≤0.002	0.06	100.0	0.0
Piperacillin	0.25	1	–	–
P/T	0.004	0.016	–	–
Cefazolin	4	8	–	–
Cefathiamidine	2	2	100.0	0.0
Cefuroxime	1	4	99.3	0.0
Cefotaxime	0.5	1	100.0	–
Ceftriaxone	0.5	1	100.0	–
Ceftazidime	0.06	0.25	100.0	–
Cefepime	1	2	100.0	0.0
Imipenem	0.03	0.06	100.0	0.0
Meropenem	0.004	0.004	100.0	0.0
Ertapenem	0.008	0.016	100.0	0.0
Erythromycin	0.12	256	71.1	28.9 [a]
Azithromycin	0.12	256	71.1	28.9[a]
Clindamycin	2	>256	36.3	37.0
Tetracycline	0.25	0.5	97.8	2.2
Minocycline	0.12	0.12	100.0	0.0
Tigecycline	0.06	0.12	–	–
Eravacycline	0.016	0.03	–	–
Ciprofloxacin	0.03	0.06	100.0	–
Levofloxacin	0.03	0.06	100.0	–
Moxifloxacin	0.06	0.12	94.8	5.2
Nemonoxacin	0.03	0.06	–	–
Gemifloxacin	0.016	0.03	–	–
SXT	0.12	0.5	90.4	3.7
Rifampicin	0.03	0.06	100.0	0.0
Chloramphenicol	0.5	0.5	100.0	0.0

P/T: Piperacillin/tazobactam; SXT: Trimethoprim – sulfamethoxazole; Interpretive criteria of cefathiamidine susceptibility test plate manual was used for cefathiamidine (S: ≤16mg · L^{-1}; R: ≥32 mg · L^{-1}); The breakpoint of cefepime (S: ≤4 mg · L^{-1}; R: ≥8 mg · L^{-1}); Imipenem, meropenem (S: ≤2 mg · L^{-1}; R: ≥4 mg · L^{-1}); Ertapenem (S: ≤0.5 mg · L^{-1}; R: ≥1 mg · L^{-1}); Minocycline (S: ≤1 mg · L^{-1}; R: ≥2 mg · L^{-1}); Moxifloxacin (S: ≤0.25 mg · L^{-1}; R: ≥0.5 mg · L^{-1}) were based on EUCAST; a: Non – susceptibility; –: No breakpoint.

表16 重症监护病房(ICU)与非ICU分离大肠埃希菌、肺炎克雷伯菌对抗菌药物敏感(S)和耐药(R)率比较(%)

Table 16 Comparison of susceptibilility (S) and resistance (R) rates (%) of *Escherichia coli* and *Klebsiella pneumoniae* isolated from intensive care unit(ICU) and non-ICU

Antibiotic	*Escherichia coli*				*Klebsiella pneumoniae*			
	ICU(n=95)		Non-ICU(n=614)		ICU(n=202)		Non-ICU(n=388)	
	S	R	S	R	S	R	S	R
Piperacillin	13.7	83.2	18.4	77.9	26.2	70.8	36.1	52.1
P/T	86.3	10.5	93.0	5.7	39.1	56.4	64.2	31.7
Cefazolin	24.2	63.2	26.7	62.5	29.7	67.3	44.3	47.4
Cefoxitin	72.6	15.8	76.1	14.0	41.1	54.5	62.1	34.0
Cefuroxime	33.7	58.9	37.8	56.5	31.2	66.8	50.0	47.4
Cefotaxime	43.2	56.8	43.8	55.5	33.2	65.8	55.7	43.3
Ceftriaxone	43.2	56.8	44.3	55.2	34.2	65.3	56.4	42.8
Ceftazidime	61.1	33.7	63.4	29.6	34.7	63.4	59.5	38.1
CZA	96.8	3.2	97.4	2.6	95.5	4.5	97.7	2.3
Cefoperazone	44.2	53.7	48.0	48.4	34.2	64.4	57.0	42.3
CSL	82.1	8.4	86.0	8.3	42.1	54.5	66.0	30.7
Cefepime	54.7	23.2	59.3	21.2	38.1	55.4	59.8	36.6
Aztreonam	53.7	41.1	55.7	35.0	37.1	62.4	59.3	39.4
Imipenem	94.7	5.3	97.1	2.8	50.0	49.5	74.7	25.3
Meropenem	96.8	3.2	97.6	2.0	49.0	51.0	74.5	24.7
Ertapenem	92.6	6.3	95.4	3.4	48.0	51.5	72.4	27.1
Gentamicin	54.7	42.1	63.2	35.5	54.0	45.5	70.4	28.4
Amikacin	86.3	5.3	87.8	4.1	58.9	39.6	76.8	20.4
Tetracycline	30.5	67.4	34.2	64.8	33.7	58.4	48.5	44.3
Minocycline	75.8	12.6	74.3	16.4	46.5	42.1	61.3	26.0
Tigecycline	100.0	0.0	99.7	0.0	98.5	1.0	98.5	0.0
Eravacycline	100.0	–	99.3	0.7[a]	91.6	8.4[a]	94.1	5.9[a]
Ciprofloxacin	30.5	56.8	33.7	61.6	35.6	59.9	51.3	42.8
Levofloxacin	28.4	61.1	33.1	61.2	37.6	55.4	52.1	38.4
Nemonoxacin	43.2	56.8	40.9	59.1	44.6	55.4	60.3	39.7
Nitrofurantoin	–	–	90.8[c]	3.8[c]	–	–	9.7[c]	80.6[c]
FOS	–	–	93.1[c]	5.4[c]	–	–	–	–
SXT	46.3	53.7	44.8	55.2	50.5	49.5	62.4	37.6
Colistin	–	1.1	–	1.8	–	15.3	–	13.1

Same as table 1; c: The rates of susceptibility and resistance of urinary tract isolates contain 130 *Escherichia coli* strains and 31 *Klebsiella pneumoniae* strains isolated from non-ICU.

表17 ICU与非ICU分离铜绿假单胞菌和鲍曼不动杆菌对抗菌药物敏感(S)和耐药(R)率比较(%)

Table 17 Comparison of susceptibilility (S) and resistance (R) rates (%) of *Pseudomonas aeruginosa* and *Acinetobacter baumannii* isolated from ICU and non-ICU

Antibiotic	*Pseudomonas aeruginosa*				*Acinetobacter baumannii*			
	ICU(n=179)		Non-ICU(n=444)		ICU(n=310)		Non-ICU(n=307)	
	S	R	S	R	S	R	S	R
Piperacillin	60.3	37.4	69.1	26.1	10.6	85.8	21.5	71.7
P/T	60.3	34.1	71.8	19.4	13.5	84.8	28.7	70.4
SAM	–	–	–	–	16.5	80.0	31.6	61.6
Cefotaxime	–	–	–	–	7.4	83.2	21.2	64.5
Ceftriaxone	–	–	–	–	4.2	82.6	11.7	65.1
Ceftazidime	64.8	31.3	77.0	18.9	16.8	81.0	36.2	61.9
CZA	82.7	17.3	91.0	9.0	–	–	–	–
Cefepime	65.4	21.8	79.7	12.6	13.9	84.2	29.6	66.1
Aztreonam	53.6	31.8	64.2	21.8	–	–	–	–
Imipenem	54.2	42.5	68.0	28.8	15.2	78.4	34.5	62.9

续表 17 (Table 17 continued)

Antibiotic	*Pseudomonas aeruginosa*				*Acinetobacter baumannii*			
	ICU (n = 179)		Non – ICU (n = 444)		ICU (n = 310)		Non – ICU (n = 307)	
	S	R	S	R	S	R	S	R
Meropenem	58.7	30.2	71.2	20.7	15.2	84.5	34.5	65.1
Gentamicin	–	–	–	–	18.4	79.7	35.2	61.6
Amikacin	90.5	7.8	93.9	3.2	27.1	71.6	45.9	53.1
Minocycline	–	–	–	–	20.0	73.9	37.5	57.7
Eravacycline	–	–	–	–	96.5	3.5[a]	97.1	2.9[a]
Ciprofloxacin	71.5	21.2	73.9	19.4	14.8	85.2	33.6	66.1
Levofloxacin	59.8	25.7	66.2	24.1	15.2	80.0	33.9	63.2
SXT	–	–	–	–	37.1	62.9	49.5	50.5
FOS	–	–	73.8[c]	11.9[c]	–	–	–	–
Colistin	–	10.1	–	8.6	–	2.6	–	4.2

Same as table 8 and 10; c: The rates of susceptibility and resistance of urinary tract isolates contain 42 strains isolated from non – ICU.

表 18 不同年龄患者分离大肠埃希菌和肺炎克雷伯菌对抗菌药物耐药率比较(%)

Table 18 Comparison of susceptibilility and resistance rates (%) of *Escherichia coli* and *Klebsiella pneumoniae* isolated from different age groups

Antibiotic	*Escherichia coli*						*Klebsiella pneumoniae*					
	≤14 years (n = 58)		15 – 64 years (n = 332)		≥65 years (n = 322)		≤14 years (n = 42)		15 – 64 years (n = 295)		≥65 years (n = 253)	
	S	R	S	R	S	R	S	R	S	R	S	R
Piperacillin	13.8	75.9	14.5	82.2	21.7	75.5	23.8	73.8	35.6	56.3	30.8	58.5
P/T	93.1	6.9	92.8	4.8	91.3	7.8	57.1	19.0	55.6	41.7	55.3	41.9
Cefazolin	43.1	55.2	21.1	66.3	28.6	60.2	28.6	69.0	41.7	52.2	38.3	54.2
Cefoxitin	77.6	19.0	74.1	15.7	77.0	11.8	78.6	16.7	53.2	43.7	53.0	41.9
Cefuroxime	41.4	50.0	33.7	59.6	40.1	55.3	31.0	66.7	45.8	51.9	43.1	54.5
Cefotaxime	48.3	48.3	41.3	58.4	45.3	54.3	33.3	66.7	49.2	49.5	49.0	50.2
Ceftriaxone	50.0	50.0	41.6	58.1	45.7	53.7	33.3	66.7	50.2	49.2	49.8	49.4
Ceftazidime	65.5	22.4	59.6	32.2	65.8	29.2	35.7	64.3	52.2	45.1	52.2	45.8
CZA	94.8	5.2	97.6	2.4	97.5	2.5	95.2	4.8	96.6	3.4	97.6	2.4
Cefoperazone	56.9	41.4	44.3	51.2	49.1	48.1	33.3	64.3	50.5	48.1	50.2	49.4
CSL	93.1	5.2	83.4	8.4	86.3	8.7	64.3	21.4	56.9	39.7	57.7	40.7
Cefepime	69.0	12.1	54.2	22.6	61.8	21.7	38.1	52.4	54.2	42.7	52.6	41.9
Aztreonam	63.8	24.1	51.2	40.7	58.4	32.6	35.7	64.3	52.9	46.1	53.0	45.8
Imipenem	94.8	3.4	96.7	3.3	97.2	2.8	90.5	9.5	64.4	35.6	64.4	35.2
Meropenem	94.8	3.4	97.6	2.1	97.8	1.9	90.5	9.5	63.4	35.9	64.4	35.2
Ertapenem	94.8	3.4	95.8	3.6	94.4	4.0	90.5	9.5	62.0	38.0	62.1	36.8
Gentamicin	62.1	37.9	60.8	37.0	63.7	35.1	81.0	19.0	63.1	35.6	64.0	35.2
Amikacin	100.0	0.0	87.7	5.1	85.4	4.0	90.5	7.1	68.1	30.2	70.4	26.5
Tetracycline	36.2	63.8	31.6	67.5	35.1	63.4	38.1	61.9	43.4	47.5	44.3	49.0
Minocycline	69.0	19.0	72.0	18.4	78.3	12.7	66.7	11.9	53.9	34.2	57.3	31.6
Tigecycline	100.0	0.0	99.4	0.0	100.0	0.0	100.0	0.0	97.6	0.3	99.2	0.4
Eravacycline	100.0	–	98.8	1.2[a]	100.0	–	92.9	7.1[a]	75.3	24.7[a]	79.1	20.9[a]
Ciprofloxacin	51.7	44.8	32.5	62.3	31.4	61.8	40.5	45.2	48.5	47.1	43.9	51.0
Levofloxacin	53.4	43.1	32.2	63.0	29.5	62.1	50.0	26.2	48.5	44.7	45.1	46.6
Nemonoxacin	56.9	43.1	39.2	60.8	41.0	59.0	61.9	38.1	55.9	44.1	52.6	47.4
Nitrofurantoin	–	–	87.7[c]	3.1[c]	93.9[c]	4.5[c]	–	–	–	–	–	–
FOS	–	–	95.4[c]	4.6[c]	90.9[c]	6.1[c]	–	–	–	–	–	–
SXT	44.8	55.2	41.9	58.1	48.1	51.9	64.3	35.7	59.3	40.7	56.1	43.9
Colistin	–	0.0	–	0.9	–	2.8	–	9.5	–	14.9	–	13.4

Same as table 1; c: The rates of susceptibility and resistance of urinary tract isolates contain 65 and 66 *Escherichia coli* strains isolated from adult (15 – 64 years) and the elderly (≥65 years), respectively.

表19 不同年龄患者分离铜绿假单胞菌对抗菌药物耐药率比较(%)

Table 19 Comparison of susceptibilility and resistance rates (%) of *Pseudomonas aeruginosa* isolated from different age groups

Antibiotic	≤14 years(n=49)		15-64 years(n=268)		≥65 years(n=307)	
	S	R	S	R	S	R
Piperacillin	93.9	4.1	63.1	31.7	65.5	31.3
P/T	93.9	2.0	64.6	26.1	68.1	24.8
Ceftazidime	95.9	2.0	73.5	21.6	70.0	26.4
CZA	100.0	0.0	89.9	10.1	85.7	14.3
Cefepime	98.0	2.0	74.6	14.2	73.0	18.2
Aztreonam	93.9	4.1	62.3	22.4	55.0	30.0
Imipenem	87.8	8.2	64.9	32.1	59.6	37.1
Meropenem	95.9	4.1	67.5	23.1	63.2	26.7
Amikacin	100.0	0.0	92.5	3.7	92.2	5.9
Ciprofloxacin	95.9	2.0	73.5	17.9	69.4	24.4
Levofloxacin	98.0	2.0	65.7	23.5	58.0	29.0
Colistin	–	6.1	–	9.3	–	9.1

Same as table 8.

表20 不同年龄患者分离鲍曼不动杆菌对抗菌药物耐药率比较(%)

Table 20 Comparison of susceptibilility and resistance rates (%) of *Acinetobacter baumannii* isolated from different age groups

Antibiotic	≤14 years(n=53)		15-64 years(n=272)		≥65 years(n=292)	
	S	R	S	R	S	R
Piperacillin	32.1	64.2	12.1	83.1	16.8	77.4
P/T	35.8	64.2	16.5	81.6	22.6	76.4
Ampicillin/sulbactam	32.1	62.3	19.9	76.1	26.4	67.5
Cefotaxime	17.0	62.3	12.5	79.0	15.4	71.2
Ceftriaxone	3.8	62.3	9.2	78.7	7.5	71.6
Ceftazidime	37.7	62.3	21.7	76.8	28.8	68.2
Cefepime	26.4	73.6	18.4	80.1	24.0	70.9
Imipenem	37.7	18.9	20.6	78.7	26.4	72.6
Meropenem	37.7	62.3	20.6	79.4	26.4	72.9
Gentamicin	35.8	64.2	22.8	74.6	28.8	68.2
Amikacin	41.5	58.5	33.5	65.8	38.4	59.9
Minocycline	39.6	56.6	25.4	70.6	29.8	63.0
Eravacycline	98.1	1.9[a]	97.1	2.9[a]	96.2	3.8[a]
Ciprofloxacin	34.0	66.0	19.9	79.8	26.4	73.6
Levofloxacin	34.0	47.2	20.6	76.5	26.4	71.6
SXT	41.5	58.5	40.1	59.9	46.6	53.4
Colistin	–	0.0	–	3.3	–	4.1

Same as table 10.

表21 不同年龄患者分离流感嗜血杆菌对抗菌药物耐药率比较(%)

Table 21 Comparison of susceptibilility and resistance rates (%) of *Haemophilus influezae* isolated from different age groups

Antibiotic	≤14 years(n=93)		15-64 years(n=109)		≥65 years(n=117)	
	S	R	S	R	S	R
Ampicillin	2.2	96.8	9.2	87.2	13.7	81.2
Ampicillin/sulbactam	14.0	86.0	19.3	80.7	29.9	70.1
P/T	100.0	0.0	100.0	0.0	100.0	0.0
Cefathiamidine	6.5	93.5	12.8	87.2	17.1	82.9
Cefuroxime	16.1	80.6	14.7	77.1	29.9	64.1
Cefotaxime	95.7	4.3[a]	96.3	3.7[a]	98.3	1.7[a]
Ceftriaxone	100.0	–	100.0	–	100.0	–
Ceftazidime	89.2	10.8[a]	93.6	6.4[a]	98.3	1.7[a]

续表 21 (Table 21 continued)

Antibiotic	≤14 years (n = 93)		15 – 64 years (n = 109)		≥65 years (n = 117)	
	S	R	S	R	S	R
Cefepime	84.9	15.1[a]	84.4	15.6[a]	91.5	8.5[a]
Aztreonam	49.5	50.5[a]	58.7	41.3[a]	68.4	31.6[a]
Imipenem	50.5	49.5[a]	39.4	60.6[a]	43.6	56.4[a]
Meropenem	92.5	7.5[a]	94.5	5.5[a]	91.5	8.5[a]
Ertapenem	73.1	26.9[a]	68.8	31.2[a]	72.6	27.4[a]
Azithromycin	39.8	60.2[a]	56.0	44.0[a]	59.8	40.2[a]
Tetracycline	90.3	8.6	93.6	6.4	93.2	5.1
Minocycline	91.4	8.6	97.2	2.8	94.9	5.1
Tigecycline	81.7	18.3[a]	93.6	6.4[a]	94.0	6.0[a]
Ciprofloxacin	100.0	–	96.3	3.7[a]	98.3	1.7[a]
Levofloxacin	100.0	–	98.2	1.8[a]	98.3	1.7[a]
Moxifloxacin	98.9	1.1[a]	95.4	4.6[a]	98.3	1.7[a]
Nemonoxacin	98.9	1.1	95.4	4.6	98.3	1.7
Gemifloxacin	90.3	9.7[a]	80.7	19.3[a]	88.0	12.0[a]
SXT	32.3	64.5	45.0	51.4	42.7	54.7
Chloramphenicol	91.4	7.5	93.6	6.4	93.2	6.0

Same as table 14.

表 22 不同标本来源大肠埃希菌对抗菌药物耐药率比较(%)

Table 22 Comparison of susceptibilility and resistance rates (%) of *Escherichia coli* isolated from different spcimens

Antibiotic	Blood (n = 390)		Urine (n = 135)		Drainage fluid (n = 88)		Secretion (n = 87)	
	S	R	S	R	S	R	S	R
Piperacillin	16.7	79.7	20.0	75.6	19.3	80.7	16.1	77.0
P/T	94.4	4.6	89.6	8.9	87.5	9.1	89.7	8.0
Cefazolin	24.9	64.6	26.7	57.0	22.7	64.8	34.5	59.8
Cefoxitin	74.9	11.0	79.3	16.3	71.6	21.6	79.3	17.2
Cefuroxime	35.9	58.2	41.5	51.9	35.2	60.2	39.1	55.2
Cefotaxime	42.3	57.4	49.6	49.6	39.8	59.1	44.8	54.0
Ceftriaxone	42.3	57.4	50.4	48.9	40.9	58.0	46.0	54.0
Ceftazidime	63.6	29.7	63.0	30.4	56.8	35.2	66.7	25.3
CZA	97.9	2.1	95.6	4.4	96.6	3.4	97.7	2.3
Cefoperazone	45.6	50.5	53.3	42.2	44.3	52.3	49.4	49.4
CSL	86.2	7.7	83.7	8.1	79.5	14.8	90.8	5.7
Cefepime	57.7	22.6	64.4	23.7	50.0	22.7	64.4	12.6
Aztreonam	54.9	36.4	60.0	35.6	46.6	43.2	58.6	25.3
Imipenem	97.7	2.1	95.6	4.4	96.6	3.4	94.3	5.7
Meropenem	98.5	1.5	96.3	3.0	96.6	3.4	95.4	2.3
Ertapenem	96.7	2.1	92.6	5.9	92.0	6.8	94.3	5.7
Gentamicin	63.8	35.4	54.8	43.0	59.1	37.5	66.7	32.2
Amikacin	89.7	2.3	88.1	6.7	76.1	11.4	90.8	2.3
Tetracycline	31.5	67.4	33.3	65.2	36.4	61.4	37.9	62.1
Minocycline	76.9	14.4	74.8	17.0	67.0	20.5	71.3	17.2
Tigecycline	99.7	0.0	100.0	0.0	98.9	0.0	100.0	0.0
Eravacycline	99.5	0.5[a]	99.3	0.7[a]	98.9	1.1[a]	100.0	–
Ciprofloxacin	33.1	60.0	24.4	71.9	34.1	62.5	48.3	44.8
Levofloxacin	33.3	60.0	20.7	72.6	31.8	62.5	47.1	47.1
Nemonoxacin	41.8	58.2	31.9	68.1	39.8	60.2	56.3	43.7
Nitrofurantoin	–	–	91.1	3.7	–	–	–	–
FOS	–	–	93.3	5.2	–	–	–	–
SXT	46.9	53.1	41.5	58.5	43.2	56.8	43.7	56.3
Colistin	–	1.3	–	3.7	–	1.1	–	1.1

Same as table 1.

表23 不同标本来源肺炎克雷伯菌对抗菌药物耐药率比较(%)

Table 23 Comparison of susceptibilility and resistance rates (%) of *Klebsiella pneumonia* isolated from different spcimens

Antibiotic	Blood(n=308)		Sputum(n=105)		Drainage fluid(n=71)		Secretion(n=67)		Urine(n=34)	
	S	R	S	R	S	R	S	R	S	R
Piperacillin	33.1	55.5	31.4	62.9	32.4	60.6	40.3	56.7	20.6	67.6
P/T	57.5	38.6	54.3	36.2	53.5	43.7	56.7	43.3	50.0	50.0
Cefazolin	41.6	51.3	37.1	58.1	36.6	53.5	43.3	53.7	26.5	67.6
Cefoxitin	57.8	39.0	59.0	33.3	49.3	49.3	49.3	46.3	44.1	50.0
Cefuroxime	46.8	50.3	38.1	60.0	42.3	56.3	44.8	52.2	35.3	64.7
Cefotaxime	51.0	47.7	41.0	58.1	52.1	46.5	49.3	50.7	35.3	64.7
Ceftriaxone	51.9	48.1	41.9	58.1	53.5	46.5	49.3	49.3	35.3	55.9
Ceftazidime	54.9	41.9	42.9	55.2	52.1	47.9	55.2	43.3	35.3	64.7
CZA	97.4	2.6	95.2	4.8	97.2	2.8	100.0	0.0	97.1	2.9
Cefoperazone	51.9	47.4	41.9	57.1	53.5	46.5	49.3	47.8	41.2	55.9
CSL	59.1	37.0	57.1	37.1	57.7	42.3	55.2	43.3	58.8	41.2
Cefepime	55.8	39.3	42.9	49.5	53.5	43.7	56.7	43.3	44.1	52.9
Aztreonam	54.5	44.5	44.8	55.2	53.5	46.5	55.2	43.3	41.2	52.9
Imipenem	68.2	31.8	66.7	32.4	64.8	35.2	59.7	40.3	67.6	32.4
Meropenem	67.9	31.5	66.7	33.3	63.4	35.2	59.7	40.3	67.6	32.4
Ertapenem	65.9	33.4	65.7	34.3	62.0	38.0	58.2	40.3	64.7	35.3
Gentamicin	66.9	31.8	71.4	28.6	59.2	39.4	61.2	38.8	47.1	50.0
Amikacin	73.1	24.7	76.2	21.0	63.4	32.4	68.7	31.3	58.8	38.2
Tetracycline	47.1	45.5	41.0	53.3	42.3	53.5	40.3	47.8	29.4	61.8
Minocycline	58.1	29.5	61.0	29.5	47.9	38.0	61.2	29.9	38.2	38.2
Tigecycline	97.7	0.6	100.0	0.0	98.6	0.0	98.5	0.0	100.0	0.0
Eravacycline	93.5	6.5[a]	95.2	4.8[a]	87.3	12.7[a]	95.5	4.5[a]	97.1	2.9[a]
Ciprofloxacin	48.7	47.1	42.9	49.5	47.9	46.5	46.3	49.3	29.4	61.8
Levofloxacin	49.4	43.5	46.7	39.0	45.1	45.1	49.3	46.3	29.4	58.8
Nemonoxacin	56.2	43.8	57.1	42.9	54.9	45.1	53.7	46.3	41.2	58.8
Nitrofurantoin	–	–	–	–	–	–	–	–	8.8	82.4
SXT	59.4	40.6	60.0	40.0	69.0	31.0	49.3	50.7	41.2	58.8
Colistin	–	14.9	–	5.7	–	14.1	–	19.4	–	11.8

Same as table 1.

表24 不同标本来源铜绿假单胞菌对抗菌药物耐药率比较(%)

Table 24 Comparison of susceptibilility and resistance rates (%) of *Pseudomonas aeruginosa* isolated from different spcimens

Antibiotic	Sputum(n=241)		Blood(n=133)		Secretion(n=116)		Drainage fluid(n=82)		Urine(n=47)	
	S	R	S	R	S	R	S	R	S	R
Piperacillin	64.7	32.4	67.7	29.3	67.2	25.0	69.5	28.0	66.0	27.7
P/T	66.4	27.0	69.2	21.1	67.2	22.4	74.4	22.0	72.3	19.1
Ceftazidime	70.1	25.3	73.7	22.6	75.9	20.7	78.0	19.5	76.6	17.0
CZA	88.0	12.0	85.7	14.3	90.5	9.5	90.2	9.8	91.5	8.5
Cefepime	70.5	18.3	77.4	14.3	75.0	14.7	80.5	13.4	89.4	6.4
Aztreonam	55.6	29.5	68.4	18.0	61.2	25.0	65.9	24.4	63.8	17.0
Imipenem	59.8	36.9	63.2	33.8	72.4	25.9	64.6	34.1	66.0	23.4
Meropenem	62.7	27.8	69.2	24.1	71.6	17.2	68.3	24.4	76.6	12.8
Amikacin	92.5	4.6	92.5	4.5	93.1	4.3	92.7	4.9	95.7	4.3
Ciprofloxacin	66.4	22.8	81.2	15.0	70.7	22.4	82.9	13.4	72.3	25.5
Levofloxacin	58.9	29.9	68.4	18.8	62.9	26.7	75.6	15.9	61.7	25.5
Colistin	–	7.5	–	12.0	–	7.8	–	9.8	–	8.5

Same as table 8.

表 25 不同标本来源鲍曼不动杆菌对抗菌药物耐药率比较(%)

Table 25 Comparison of susceptibilility and resistance rates (%) of *Acinetobacter baumannii* isolated from different spcimens

Antibiotic	Sputum(n=288)		Blood(n=140)		Drainage fluid(n=74)		Secretion(n=61)		Urine(n=35)	
	S	R	S	R	S	R	S	R	S	R
Piperacillin	20.5	76.0	12.9	80.0	10.8	82.4	4.9	91.8	28.6	60.0
P/T	24.0	74.3	18.6	80.0	17.6	82.4	9.8	90.2	40.0	57.1
Ampicillin/sulbactam	26.4	66.7	22.9	74.3	21.6	78.4	13.1	83.6	40.0	48.6
Cefotaxime	16.0	70.8	13.6	75.0	10.8	81.1	6.6	83.6	31.4	54.3
Ceftriaxone	8.3	70.5	6.4	77.1	8.1	77.0	6.6	85.2	17.1	54.3
Ceftazidime	29.5	67.4	24.3	75.0	20.3	78.4	16.4	82.0	48.6	48.6
Cefepime	24.7	70.8	19.3	80.0	17.6	82.4	9.8	86.9	42.9	48.6
Imipenem	26.0	64.2	24.3	75.7	20.3	79.7	16.4	83.6	45.7	54.3
Meropenem	26.4	73.3	24.3	75.7	20.3	79.7	16.4	83.6	42.9	54.3
Gentamicin	27.4	70.5	27.1	69.3	23.0	74.3	19.7	77.0	45.7	54.3
Amikacin	37.8	60.8	38.6	60.7	29.7	70.3	31.1	67.2	48.6	48.6
Minocycline	29.9	63.2	30.0	67.9	20.3	71.6	24.6	72.1	45.7	45.7
Eravacycline	95.5	4.5[a]	98.6	1.4[a]	97.3	2.7[a]	98.4	1.6[a]	94.3	5.7[a]
Ciprofloxacin	25.7	74.3	23.6	75.7	20.3	79.7	14.8	85.2	45.7	54.3
Levofloxacin	25.7	68.1	24.3	72.1	20.3	79.7	14.8	83.6	45.7	54.3
SXT	39.9	60.1	53.6	46.4	45.9	54.1	32.8	67.2	45.7	54.3
Colistin	–	4.2	–	2.9	–	1.4	–	4.9	–	2.9

Same as table 10.

讨　论

肠杆菌目细菌中,大肠埃希菌 ESBLs 表型检出率为 50.7%,较上一届监测[6]下降 4.3 个百分点,在前次小幅回升后仍持续下降趋势,较 2007 至 2008 年[7]下降了 26.7%,与 2023 年我国的全国细菌耐药监测网(China Antimicrobial Resistance Surveillance System, CARSS)[8]报道大肠埃希菌对第三代头孢菌素耐药率全国平均值及 CHINET[9]监测结果基本一致。欧盟的欧洲抗菌药物耐药监测网(European Antimicrobial Resistance Surveillance Network, EARS-Net)[10] 2023 年监测数据显示第三代头孢菌素耐药大肠埃希菌比例平均为 16.2%,最高可达 37.3%;SENTRY 抗菌药物监测项目(SENTRY Antimicrobial Surveillance Program, SENTRY)[11]全球数据平均为 30.4%,亚洲、西太平洋和拉美地区相较北美和欧洲略高,我国检出率仍居较高位置;大肠埃希菌对碳青霉烯类耐药在 2.1% ~3.8%,较前次减少 1 ~2 个百分点,尚属较低水平,与全国[8-9]及 ATLAS[12]全球数据基本一致;其他监测药物耐药率稳定。肺炎克雷伯菌 ESBLs 表型检出率为 20.7%,持续 18 年下降;碳青霉烯类耐药肺炎克雷伯菌(carbapenem-resistant *Klebsiella pneumoniae*, CRKP)检出率为 35.4%,较前次增加 10 个百分点,明显高于 CARSS[8]和 CHINET[9]结果。分析各家医院数据,18 家医院中有 9 家 CRKP 检出率 >30%,9 家医院多位于上海、北京、湖南、浙江等 CRKP 高发地区,推测高检出率由于高发地区医院占比较高导致,不排除个别医院存在 CRKP 同克隆爆发流行。EARS-NET[10] CRKP 从 0 ~69.7%,平均 13.3%,呈上升趋势。SENTRY[11]和 ATLAS[12]中,CRKP 全球平均检出率约在 10% ~20%。受 CRKP 检出率升高影响,其他监测药物耐药率多较前次增加 5 ~10 个百分点。普罗威登菌属虽然临床分离率不高,但碳青霉烯类耐药菌比例仅次于肺炎克雷伯菌,且多因产金属酶导致,合并其对四环素类、黏菌素和多黏菌素 B 天然耐药,使得测试药物敏感率均 <90%。其他肠杆菌目细菌耐药情况未见明显增加。

非发酵菌中,铜绿假单胞菌对亚胺培南耐药率较上届监测[6]增加 6.4 个百分比,美罗培南变化不大。多重耐药(multidrug-resistant, MDR)菌[13]占 43.3%,较前次增加 2.2 个百分点,对比 2011 年以来结果[14],略有增加趋势。泛耐药(Extensively drug-resistant, XDR)菌占 17.0%,2 株细菌对所测药物全部耐药。碳青霉烯类耐药率较 CARSS[8]和CHINET[9]高 6 ~11 个百分点。SENTRY[11]和 ATLAS[12]数据显示,碳青霉烯类耐药率全球平均分别为 13.8% ~15.8%和 17.1% ~23.3%,拉美地区略高于其他地区。鲍曼不动杆菌对碳青霉烯类等多数药物耐药率稳定,MDR 占 78.3%,XDR 占 71.0%,9 株细菌对所测药物全部

耐药(1.5%),较前次结果持平。碳青霉烯类耐药率与CHINET[9]结果相似,较CARSS[8]高约15个百分点。EARS-NET显示[10],鲍曼不动杆菌对碳青霉烯类、氨基糖苷类和氟喹诺酮类耐药率在36.7%~42.4%,但其中不同国家差异巨大,3类药物最高耐药率均超过90%。ATLAS[12]数据显示,鲍曼不动杆菌对碳青霉烯类耐药率全球平均为68.2%~68.5%,不同地区差异较大,非洲、中东及拉美地区耐药超过75%,亚、欧在70%左右,北美和大洋洲低于40%。

流感嗜血杆菌β-内酰胺酶阳性率为68.7%,产酶率及氨苄西林耐药率自2017年以来呈上升趋势[15];副流感嗜血杆菌产酶率为35.3%,产酶率及氨苄西林耐药率略低于上届监测,但较2021年之前仍有升高。流感嗜血杆菌对氨苄西林耐药率略高于CHINET[9]结果。全球数据显示,中国、印度和韩国氨苄西林耐药流感嗜血杆菌比例明显高于其他国家,中国阿奇霉素不敏感流感嗜血杆菌比例居首[12]。

头孢他啶/阿维巴坦和依拉环素为本次监测新增药物。头孢他啶/阿维巴坦对革兰氏阴性菌具有良好抗菌作用,特别对肠杆菌目细菌,敏感率可达95.5%。其中CRKP对头孢他啶/阿维巴坦敏感率>90%,与意大利BIANCO等[16]报道的93.9%相似。CRKP对头孢他啶/阿维巴坦耐药主要由于KPC酶突变亚型的增多与表达[16],本次监测中1株单产KPC-33型酶CRKP即表现为耐药,此外3株KPC-2合并金属酶菌株也均表现为耐药。非发酵革兰氏阴性菌中,头孢他啶/阿维巴坦对铜绿假单胞菌和洋葱伯克霍尔德菌复合群具有较好活性,MIC_{90}值≤16 mg·L^{-1},铜绿假单胞菌敏感率为88.6%。ZOMORODI等[17]综述了头孢他啶/阿维巴坦对洋葱伯克霍尔德菌复合群的体外抗菌活性,MIC范围在<0.5~128 mg·L^{-1},MIC_{50}值多为4 mg·L^{-1},MIC_{90}值在2.4~16 mg·L^{-1},MIC值为头孢他啶单药的1/4或更低,与本次监测结果基本一致。相比CHINET[9]结果,肠杆菌属敏感率略高(95.5% *vs.* 93.6%),铜绿假单胞菌略低(88.6% *vs.* 92.5%)。

依拉环素具有广泛而良好的抗菌活性,对本次监测的3 695株革兰氏阴性菌中3 693株MIC值均≤4 mg·L^{-1}。MIC_{50}值在0.016~0.5 mg·L^{-1},MIC_{90}值在0.03~2 mg·L^{-1},对肠杆菌目细菌MIC值为替加环素的1~1/2,对鲍曼不动杆菌、嗜血杆菌属细菌、卡他莫拉菌多为替加环素的1/4,细菌敏感率基本>90%,碳青霉烯类不敏感大肠埃希菌仍对其100%敏感。特别对鲍曼不动杆菌MIC值在测试药物中最低,细菌敏感率最高。较HAWSER等[18]报道的2017至2020年全球监测MIC结果基本一致或低1个稀释度,采用相同判定标准时,细菌敏感率也基本一致。台湾地区2020至2022年耐药监测[19]显示,依拉环素对亚胺培南不敏感大肠埃希菌和肺炎克雷伯菌MIC_{50}和MIC_{90}值分别为0.5和0.5 mg·L^{-1}、1和2 mg·L^{-1},略高于本研究。

CLSI[2]未颁布依拉环素折点,此前研究多采用FDA[4]或EUCAST[3]颁布的标准。然而FDA与EUCAST标准间存在诸多不同,FDA对同为新一代四环素类药物的替加环素和依拉环素,折点间也存在较大差异,导致部分菌种(主要为肠杆菌目菌种)敏感率无可比性,多有学者在文章中谈到此问题[18-19]。ChinaCAST于2024年颁布了依拉环素临床折点,本研究均采用我国标准。

吉米沙星2006年在我国上市[20],2009至2010年曾对其监测[21]。本次监测结果显示吉米沙星对流感嗜血杆菌具有很好抗菌作用,MIC_{50}和MIC_{90}值分别为0.008和0.25 mg·L^{-1},为莫西沙星的1/2~1/4;对卡他莫拉菌MIC值在0.004~0.12 mg·L^{-1},是其他测试喹诺酮类药物的1/2~1/4。较2009至2010年监测结果,对流感嗜血杆菌和卡他莫拉菌抗菌作用保持一致。吉米沙星得到美国胸科学会和感染疾病学会成人社区获得性肺炎诊断和治疗指南(2019版)、韩国成人社区获得性肺炎抗菌药物应用指南(2018版)和中国成人社区获得性肺炎诊断和治疗指南(2016版)的推荐[22-24],同时可作为慢性支气管炎急性发作、急性鼻窦炎等治疗药物选择之一,治疗社区获得性呼吸道感染性疾病。

总之,大肠埃希菌和肺炎克雷伯菌中ESBLs表型检出率持续下降,CRKP和氨苄西林耐药流感嗜血杆菌检出率呈上升趋势,需持续关注。

本研究获得云顶新耀医药科技有限公司、齐鲁制药有限公司、西藏仟源药业有限公司、北京寻安信息咨询有限公司、浙江医药股份有限公司新昌制药厂、广州白云山医药集团股份有限公司白云山制药总厂支持。

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(**收稿日期** 2025 - 07 - 10)

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