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· 论 著 ·

## 全国细菌耐药监测网 2021 年肾内科患者分离细菌耐药监测报告

全国细菌耐药监测网

**[摘要]** **目的** 了解全国肾内科住院患者常见病原菌分布及耐药性。**方法** 对 2021 年全国细菌耐药监测网 (CARSS) 成员单位上报的所有肾内科住院患者分离菌及其耐药性进行分析。**结果** 肾内科住院患者共分离细菌 122 203 株, 主要来源于尿、痰及血标本, 占比分别为 49.2%、16.7% 和 13.4%, 其中, 革兰阴性菌共 81 994 株 (67.1%), 革兰阳性菌共 40 209 株 (32.9%)。最常见的前 5 位病原菌分别为大肠埃希菌 (39 914 株, 32.7%)、肺炎克雷伯菌 (12 695 株, 10.4%)、金黄色葡萄球菌 (11 977 株, 9.8%)、铜绿假单胞菌 (6 583 株, 5.4%) 及屎肠球菌 (5 821 株, 4.8%)。头孢曲松耐药的大肠埃希菌、肺炎克雷伯菌检出率分别为 47.2% (15 704/33 272)、30.7% (3 091/10 070); 耐碳青霉烯类的大肠埃希菌、肺炎克雷伯菌和阴沟肠杆菌检出率分别为 1.0% (388/38 813)、8.2% (1 000/12 206) 和 4.8% (135/2 813)。鲍曼不动杆菌对亚胺培南、美罗培南、多黏菌素和替加环素的耐药率分别为 27.6% (972/3 523)、29.6% (813/2 748)、1.3% (8/625) 和 2.2% (38/1 730); 铜绿假单胞菌对亚胺培南、美罗培南和多黏菌素的耐药率分别为 10.1% (640/6 335)、8.4% (477/5 678) 和 1.2% (11/955)。耐甲氧西林金黄色葡萄球菌 (MRSA) 和耐甲氧西林凝固酶阴性葡萄球菌 (MRCNS) 检出率分别为 23.3% (2 787/11 977) 和 68.5% (7 290/10 644), 未检测到对万古霉素耐药的葡萄球菌。屎肠球菌、粪肠球菌对万古霉素的耐药率分别为 1.1% (65/5 740)、0.1% (7/4 738)。**结论** 肾内科住院患者分离的革兰阴性菌以大肠埃希菌和肺炎克雷伯菌为主, 革兰阳性菌以金黄色葡萄球菌为主。革兰阴性菌对碳青霉烯类、哌拉西林/他唑巴坦、头孢哌酮/舒巴坦、头孢他啶/阿维巴坦耐药率较低, 革兰阳性菌对万古霉素、替考拉宁、利奈唑胺耐药率较低。临床应根据肾内科患者的药敏结果及疾病特点, 合理选用抗菌药物。

**[关键词]** 临床分离菌; 病原菌; 耐药性; 肾内科; 全国细菌耐药监测网

**[中图分类号]** R181.3<sup>+</sup>2 R378

## Antimicrobial resistance of bacteria isolated from patients in department of nephrology: surveillance report from China Antimicrobial Resistance Surveillance System, 2021

*China Antimicrobial Resistance Surveillance System*

**[Abstract]** **Objective** To understand the distribution and antimicrobial resistance of frequently isolated pathogenic bacteria from hospitalized patients in nephrology department in China. **Methods** All isolated pathogenic bacteria from hospitalized patients in nephrology department reported by member units of China Antimicrobial Resistance Surveillance System (CARSS) in 2021 and their antimicrobial resistance were analyzed. **Results** A total of 122 203 bacterial strains were isolated from hospitalized patients in nephrology department, mainly from urine, sputum and blood, accounting for 49.2%, 16.7% and 13.4%, respectively. 81 994 strains (67.1%) were Gram-negative bacteria and 40 209 strains (32.9%) were Gram-positive bacteria. The top 5 frequently isolated pathogens were *Escherichia coli* (39 914, 32.7%), *Klebsiella pneumoniae* (12 695, 10.4%), *Staphylococcus aureus* (11 977, 9.8%), *Pseudomonas aeruginosa* (6 583, 5.4%) and *Enterococcus faecium* (5 821, 4.8%). The detection rate of ceftriaxone-resistant *Escherichia coli* and *Klebsiella pneumoniae* were 47.2% (15 704/33 272) and 30.7% (3 091/10 070), respectively. The detection rates of carbapenem-resistant *Escherichia coli*, *Klebsiella pneumoniae* and *Enterobacter*

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*cloacae* were 1.0% (388/38 813), 8.2% (1 000/12 206) and 4.8% (135/2 813), respectively. The resistance rates of *Acinetobacter baumannii* to imipenem, meropenem, polymyxin and tigecycline were 27.6% (972/3 523), 29.6% (813/2 748), 1.3% (8/625) and 2.2% (38/1 730), respectively. The resistance rates of *Pseudomonas aeruginosa* to imipenem, meropenem and polymyxin were 10.1% (640/6 335), 8.4% (477/5 678) and 1.2% (11/955), respectively. The detection rates of methicillin-resistant *Staphylococcus aureus* (MRSA) and methicillin-resistant coagulase-negative *Staphylococcus* (MRCNS) were 23.3% (2 787/11 977) and 68.5% (7 290/10 644), respectively. No vancomycin-resistant *Staphylococcus* was detected. The resistance rates of *Enterococcus faecium* and *Enterococcus faecalis* to vancomycin were 1.1% (65/5 740) and 0.1% (7/4 738), respectively. **Conclusion** Gram-negative bacteria isolated from hospitalized patients in nephrology department are mainly *Escherichia coli* and *Klebsiella pneumoniae*, and Gram-positive bacteria are mainly *Staphylococcus aureus*. The resistance rates of Gram-negative bacteria to carbapenems, piperacillin/tazobactam, cefoperazone/sulbactam, and ceftazidime/avibactam are low, and the resistance rates of Gram-positive bacteria to vancomycin, teicoplanin, and linezolid are low. Antimicrobial agents should be selected rationally according to antimicrobial susceptibility testing results and disease features of patients in nephrology department.

**[Key words]** clinically isolated bacteria; pathogenic bacteria; antimicrobial resistance; department of nephrology; China Antimicrobial Resistance Surveillance System

肾内科大多数患者存在肾脏基础疾病,如慢性肾脏疾病、急性肾炎、尿路感染等,患者多免疫功能低下、营养状况差,发生医院感染的可能性较大<sup>[1]</sup>。随着抗菌药物的广泛使用,肾内科感染疾病中,病原菌对抗菌药物耐药已成为严重问题<sup>[2]</sup>。为了指导临床更合理的用药,本研究对全国细菌耐药监测网(China Antimicrobial Resistance Surveillance System, CARSS)2021 年肾内科常见病原菌分布及耐药性进行分析。

## 1 资料与方法

1.1 数据来源 全部监测数据来源于 2020 年 10 月—2021 年 9 月 CARSS 成员单位上报数据中肾内科住院患者分离病原菌及药敏试验数据。经系统自动审核和人工审核后,纳入数据分析的医院共 1 373 所,其中,二级医院 363 所(26.4%),三级医院 1 010 所(73.6%)。以保留同一患者相同细菌第一株的原则剔除重复菌株。

1.2 细菌鉴定及药敏试验 所有网点医院按照 CARSS 的统一技术方案进行抗菌药物敏感性试验,药敏试验方法包括纸片扩散法、最低抑菌浓度(MIC)法和 E-test 法。革兰阴性菌检测的抗菌药物

为阿米卡星、庆大霉素、妥布霉素、米诺环素、氨苄西林、阿莫西林/克拉维酸、替卡西林/克拉维酸、氨苄西林/舒巴坦、哌拉西林/他唑巴坦、头孢哌酮/舒巴坦、头孢唑林、头孢呋辛、头孢曲松、头孢噻肟、头孢他啶、头孢吡肟、头孢替坦、头孢西丁、氨曲南、亚胺培南、美罗培南、厄他培南、环丙沙星、左氧氟沙星、复方磺胺甲噁唑、氯霉素、替加环素、多黏菌素 B、头孢他啶/阿维巴坦;革兰阳性菌检测的抗菌药物为青霉素 G、庆大霉素、利福平、左氧氟沙星、复方磺胺甲噁唑、克林霉素、红霉素、利奈唑胺、万古霉素、替考拉宁,高浓度庆大霉素及高浓度链霉素。药敏结果分为敏感、中介和耐药,由于篇幅限制,中介结果不在结果中展示。

1.3 质量控制 按照美国临床实验室标准化协会(CLSI)要求进行质量控制,在稳定试验条件下每周施行一次常规质量控制程序。质控菌株包括大肠埃希菌 ATCC 25922、金黄色葡萄球菌 ATCC 29213、金黄色葡萄球菌 ATCC 25923、肺炎克雷伯菌 ATCC 700603、阴沟肠杆菌 ATCC 700323、铜绿假单胞菌 ATCC 27853、肺炎链球菌 ATCC 49619。

1.4 数据分析 药敏结果统计应用 WHONET 5.6 软件。替加环素折点主要依据替加环素体外药敏试验操作规程专家共识<sup>[3-4]</sup>,头孢哌酮/舒巴坦参

考注射用头孢哌酮/舒巴坦说明书建议的药敏方法和折点,其他抗菌药物敏感性判断采用 CLSI 2021 标准<sup>[5]</sup>。

## 2 结果

2.1 病原菌来源 2021 年 CARSS 肾内科患者分离病原菌 122 203 株,主要来源于尿、痰及血标本,共占 79.3%,其余分别来源于腹腔积液、脓、胸腔积液、粪便、肺泡灌洗液、胆汁等。见图 1。

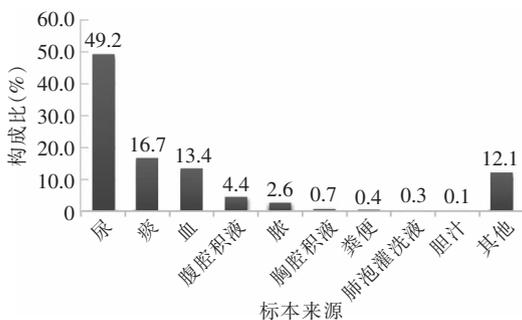


图 1 2021 年 CARSS 肾内科分离细菌标本分布

Figure 1 Distribution of bacterial specimens from hospitalized patients in department of nephrology, CARSS, 2021

2.2 病原菌构成 2021 年肾内科分离细菌 122 203 株,革兰阴性菌 81 994 株(67.1%),革兰阳性菌 40 209 株(32.9%)。分离病原菌居首位的为大肠埃希菌(39 914 株,32.7%),其次分别为肺炎克雷伯菌(12 695 株,10.4%)、金黄色葡萄球菌(11 977 株,9.8%)、铜绿假单胞菌(6 583 株,5.4%)、屎肠球菌(5 821 株,4.8%)。肾内科分离菌居前 10 位的细菌见图 2。

### 2.3 病原菌耐药情况

2.3.1 革兰阴性菌耐药情况 肾内科患者分离菌前 10 位细菌中,肠杆菌目细菌占比最多,从高到低依次为大肠埃希菌、肺炎克雷伯菌、阴沟肠杆菌、奇异变形杆菌。大肠埃希菌对碳青霉烯类、阿米卡星、头孢替坦、哌拉西林/他唑巴坦、头孢哌酮/舒巴坦、头孢他啶/阿维巴坦、替加环素、多黏菌素 B 较敏

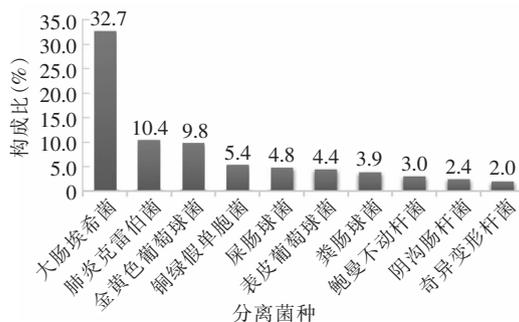


图 2 2021 年 CARSS 肾内科分离居前 10 位的菌种分布

Figure 2 Distribution of the top 10 isolated bacteria in department of nephrology, CARSS, 2021

感,敏感率 >95%;对亚胺培南、美罗培南和厄他培南的耐药率依次为 1.0%、1.0%和 0.9%。肺炎克雷伯菌对碳青霉烯类、阿米卡星、头孢他啶/阿维巴坦、替加环素、多黏菌素 B 较敏感,敏感率约 90%;对亚胺培南、美罗培南和厄他培南的耐药率依次为 8.6%、8.9%和 6.2%。阴沟肠杆菌对碳青霉烯类、阿米卡星、替加环素、多黏菌素 B 较敏感,敏感率均 >90%,对碳青霉烯类药物的耐药率约为 5%。奇异变形杆菌对美罗培南、厄他培南、阿米卡星、头孢他啶、头孢替坦、氨曲南、替卡西林/克拉维酸、哌拉西林/他唑巴坦、头孢哌酮/舒巴坦、头孢他啶/阿维巴坦较敏感,敏感率 >95%;对美罗培南、厄他培南的耐药率分别为 0.9%、0.8%。其中,大肠埃希菌、肺炎克雷伯菌、奇异变形杆菌对头孢曲松耐药率分别为 47.2%、30.7%、37.0%。大肠埃希菌、肺炎克雷伯菌和阴沟肠杆菌对亚胺培南的耐药率分别为 1.0%(388/38 813)、8.2%(1 000/12 206)和 4.8%(135/2 813)。

非发酵菌以铜绿假单胞菌和鲍曼不动杆菌为主。铜绿假单胞菌对阿米卡星、妥布霉素、多黏菌素 B、头孢他啶/阿维巴坦较敏感,敏感率均 >95%,对亚胺培南、美罗培南、阿米卡星的耐药率分别为 10.1%、8.4%、2.5%。鲍曼不动杆菌对多黏菌素 B、替加环素持较高的体外抗菌活性,敏感率依次为 98.7%、92.0%,对亚胺培南、美罗培南、米诺环素的耐药率分别为 27.6%、29.6%、8.3%。见表 1~3。

表 1 2021 年 CARSS 肾内科住院患者分离的常见肠杆菌目细菌对抗菌药物的药敏试验结果

Table 1 Antimicrobial susceptibility testing results of frequently isolated Enterobacterales isolated from hospitalized patients in department of nephrology, CARSS, 2021

| 抗菌药物      | 大肠埃希菌  |         |         | 肺炎克雷伯菌 |         |         | 阴沟肠杆菌 |         |         | 奇异变形杆菌 |         |         |
|-----------|--------|---------|---------|--------|---------|---------|-------|---------|---------|--------|---------|---------|
|           | 检测株数   | 耐药率 (%) | 敏感率 (%) | 检测株数   | 耐药率 (%) | 敏感率 (%) | 检测株数  | 耐药率 (%) | 敏感率 (%) | 检测株数   | 耐药率 (%) | 敏感率 (%) |
| 氨苄西林      | 28 973 | 82.2    | 16.2    | -      | -       | -       | 828   | 84.4    | 6.5     | 1 729  | 62.5    | 36.8    |
| 氨苄西林/舒巴坦  | 28 186 | 37.1    | 41.2    | 8 482  | 33.8    | 59.6    | 780   | 55.5    | 33.5    | 1 696  | 32.7    | 56.4    |
| 哌拉西林/他唑巴坦 | 39 200 | 2.9     | 94.3    | 12 488 | 12.8    | 83.5    | 2 812 | 11.3    | 80.8    | 2 406  | 1.2     | 97.8    |
| 阿莫西林/克拉维酸 | 20 760 | 10.8    | 68.9    | 6 312  | 18.9    | 67.8    | 784   | 86.7    | 7.5     | 778    | 18.4    | 67.0    |
| 替卡西林/克拉维酸 | 3 856  | 12.5    | 66.9    | 1 531  | 26.8    | 63.8    | 340   | 26.2    | 65.0    | 292    | 2.1     | 93.5    |
| 头孢唑林      | 3 237  | 61.7    | 25.3    | 3 397  | 33.0    | 52.8    | 1 131 | 98.4    | 0.9     | 259    | 63.7    | 21.6    |
| 头孢呋辛      | 28 086 | 48.6    | 48.0    | 8 738  | 33.8    | 63.5    | 1 444 | 45.8    | 37.3    | 1 625  | 47.4    | 51.8    |
| 头孢他啶      | 37 744 | 20.8    | 73.2    | 11 944 | 21.9    | 75.2    | 2 717 | 24.6    | 73.5    | 2 342  | 7.1     | 91.1    |
| 头孢曲松      | 33 272 | 47.2    | 52.4    | 10 070 | 30.7    | 68.8    | 1 975 | 32.6    | 65.6    | 1 936  | 37.0    | 61.9    |
| 头孢噻肟      | 10 888 | 46.4    | 52.7    | 3 179  | 31.5    | 67.2    | 737   | 34.1    | 62.1    | 622    | 41.5    | 56.6    |
| 头孢吡肟      | 38 182 | 22.8    | 69.1    | 12 133 | 20.6    | 76.5    | 2 760 | 11.6    | 83.0    | 2 348  | 8.5     | 80.7    |
| 头孢哌酮/舒巴坦  | 25 807 | 4.2     | 90.2    | 8 072  | 12.4    | 82.9    | 1 797 | 9.8     | 84.7    | 1 549  | 0.5     | 98.1    |
| 头孢他啶/阿维巴坦 | 732    | 4.0     | 96.0    | 277    | 6.5     | 93.5    | 51    | 23.5    | 76.5    | 42     | 2.4     | 97.6    |
| 头孢西丁      | 19 688 | 8.9     | 85.8    | 6 318  | 16.5    | 81.0    | 743   | 92.6    | 5.9     | 1 202  | 6.6     | 88.4    |
| 头孢替坦      | 13 210 | 2.0     | 97.3    | 3 790  | 9.2     | 89.8    | 484   | 37.4    | 57.4    | 794    | 1.1     | 98.1    |
| 氨曲南       | 29 742 | 29.9    | 66.8    | 9 151  | 25.9    | 73.2    | 2 151 | 25.0    | 72.9    | 1 761  | 4.9     | 93.9    |
| 亚胺培南      | 38 813 | 1.0     | 98.6    | 12 206 | 8.6     | 89.9    | 2 813 | 4.8     | 92.7    | 37     | -       | -       |
| 美罗培南      | 25 223 | 1.0     | 98.8    | 8 013  | 8.9     | 90.5    | 1 872 | 4.9     | 94.9    | 1 534  | 0.9     | 98.6    |
| 厄他培南      | 23 003 | 0.9     | 98.9    | 6 397  | 6.2     | 93.3    | 1 307 | 5.2     | 92.3    | 1 154  | 0.8     | 97.9    |
| 阿米卡星      | 39 164 | 1.8     | 97.7    | 12 349 | 6.9     | 93.0    | 2 849 | 1.1     | 98.4    | 2 388  | 2.7     | 96.1    |
| 庆大霉素      | 31 022 | 34.2    | 64.8    | 9 480  | 19.2    | 79.7    | 2 250 | 11.4    | 87.3    | 1 843  | 25.9    | 55.6    |
| 妥布霉素      | 21 390 | 13.3    | 64.6    | 6 645  | 12.8    | 77.4    | 1 555 | 9.5     | 84.2    | 1 225  | 17.7    | 55.3    |
| 氯霉素       | 4 405  | 21.7    | 74.0    | 1 875  | 28.5    | 67.3    | 508   | 18.7    | 76.6    | 285    | 62.1    | 34.7    |
| 替加环素      | 15 401 | 0.1     | 99.8    | 4 751  | 2.2     | 95.6    | 1 049 | 1.9     | 96.5    | -      | -       | -       |
| 左氧氟沙星     | 38 138 | 51.2    | 45.4    | 12 164 | 21.1    | 75.7    | 2 749 | 12.5    | 84.7    | 2 348  | 29.1    | 60.9    |
| 环丙沙星      | 29 612 | 54.8    | 43.3    | 9 134  | 24.9    | 71.6    | 2 169 | 16.9    | 79.3    | 1 750  | 42.8    | 50.8    |
| 复方磺胺甲噁唑   | 37 235 | 50.9    | 49.1    | 11 799 | 29.6    | 70.3    | 2 674 | 22.4    | 77.6    | 2 310  | 62.9    | 37.0    |
| 多黏菌素 B    | 2 750  | 1.6     | 98.4    | 1 076  | 2.0     | 98.0    | 234   | 9.4     | 90.6    | 130    | 94.6    | 5.4     |

注：- 表示无数据。

表 2 2021 年 CARSS 肾内科住院患者分离的铜绿假单胞菌对抗菌药物的药敏试验结果

Table 2 Antimicrobial susceptibility testing results of *Pseudomonas aeruginosa* isolated from hospitalized patients in department of nephrology, CARSS, 2021

| 抗菌药物      | 检测株数  | 耐药率 (%) | 敏感率 (%) | 抗菌药物   | 检测株数  | 耐药率 (%) | 敏感率 (%) |
|-----------|-------|---------|---------|--------|-------|---------|---------|
| 哌拉西林      | 2 935 | 10.9    | 81.6    | 美罗培南   | 5 678 | 8.4     | 88.7    |
| 哌拉西林/他唑巴坦 | 6 222 | 6.9     | 85.3    | 阿米卡星   | 6 435 | 2.5     | 96.2    |
| 头孢他啶      | 6 250 | 9.9     | 86.2    | 庆大霉素   | 4 306 | 6.2     | 90.2    |
| 头孢吡肟      | 6 404 | 6.6     | 86.9    | 妥布霉素   | 5 209 | 4.8     | 94.4    |
| 头孢哌酮/舒巴坦  | 4 055 | 7.7     | 83.8    | 左氧氟沙星  | 6 358 | 9.6     | 84.9    |
| 头孢他啶/阿维巴坦 | 108   | 4.6     | 95.4    | 环丙沙星   | 6 250 | 8.8     | 88.3    |
| 氨曲南       | 3 945 | 15.3    | 70.0    | 多黏菌素 B | 955   | 1.2     | 98.8    |
| 亚胺培南      | 6 335 | 10.1    | 86.2    |        |       |         |         |

**表 3** 2021 年 CARSS 肾内科住院患者分离的鲍曼不动杆菌对抗菌药物的药敏试验结果

**Table 3** Antimicrobial susceptibility testing results of *Acinetobacter baumannii* isolated from hospitalized patients in department of nephrology, CARSS, 2021

| 抗菌药物      | 检测株数  | 耐药率(%) | 敏感率(%) |
|-----------|-------|--------|--------|
| 氨苄西林/舒巴坦  | 2 256 | 27.6   | 69.4   |
| 哌拉西林/他唑巴坦 | 2 877 | 30.7   | 65.9   |
| 头孢他啶      | 3 472 | 28.9   | 66.7   |
| 头孢曲松      | 1 927 | 28.3   | 31.0   |
| 头孢噻肟      | 680   | 32.2   | 37.6   |
| 头孢吡肟      | 3 636 | 26.7   | 68.8   |
| 头孢哌酮/舒巴坦  | 2 446 | 19.8   | 73.8   |
| 亚胺培南      | 3 523 | 27.6   | 71.7   |
| 美罗培南      | 2 748 | 29.6   | 69.2   |
| 阿米卡星      | 2 410 | 19.8   | 78.6   |
| 庆大霉素      | 2 462 | 26.3   | 69.9   |
| 妥布霉素      | 2 735 | 24.4   | 73.7   |
| 米诺环素      | 2 008 | 8.3    | 81.2   |
| 替加环素      | 1 730 | 2.2    | 92.0   |
| 左氧氟沙星     | 3 580 | 24.4   | 70.9   |
| 环丙沙星      | 3 381 | 30.9   | 68.2   |
| 多黏菌素 B    | 625   | 1.3    | 98.7   |

2.3.2 革兰阳性菌耐药情况 11 977 株金黄色葡萄球菌中耐甲氧西林金黄色葡萄球菌(MRSA)2 787 株(23.3%),甲氧西林敏感的金黄色葡萄球菌(MSSA)9 190 株(76.7%),未发现对万古霉素、替考拉宁、利奈唑胺耐药的金黄色葡萄球菌,也未检出对万古霉素、替考拉宁、利奈唑胺的非敏感株。10 644 株凝固酶阴性的葡萄球菌中耐甲氧西林凝固酶阴性葡萄球菌(MRCNS)7 290 株(68.5%),甲氧西林敏感的凝固酶阴性葡萄球菌(MSCNS)3 354 株(31.5%),未发现对万古霉素、替考拉宁耐药的菌株,MRCNS 对利奈唑胺的耐药率为 0.1%。屎肠球菌对万古霉素、替考拉宁、利奈唑胺的耐药率分别为 1.1%、1.8%、0.5%。粪肠球菌对万古霉素、替考拉宁、利奈唑胺的耐药率依次为 0.1%、0.5%、2.3%。见表 4~6。

**表 4** 2021 年 CARSS 肾内科住院患者分离的金黄色葡萄球菌对抗菌药物的药敏试验结果

**Table 4** Antimicrobial susceptibility testing results of *Staphylococcus aureus* isolated from hospitalized patients in department of nephrology, CARSS, 2021

| 抗菌药物    | MRSA  |        |        | MSSA  |        |        |
|---------|-------|--------|--------|-------|--------|--------|
|         | 检测株数  | 耐药率(%) | 敏感率(%) | 检测株数  | 耐药率(%) | 敏感率(%) |
| 青霉素 G   | 2 689 | 100    | 0      | 8 496 | 87.2   | 12.8   |
| 苯唑西林    | 2 787 | 100    | 0      | 9 190 | 0      | 100    |
| 庆大霉素    | 2 766 | 14.9   | 82.9   | 8 902 | 6.7    | 91.2   |
| 万古霉素    | 2 749 | 0      | 100    | 8 870 | 0      | 100    |
| 替考拉宁    | 1 310 | 0      | 100    | 4 267 | 0      | 100    |
| 利奈唑胺    | 2 724 | 0      | 100    | 8 839 | 0      | 100    |
| 红霉素     | 2 726 | 71.3   | 27.7   | 8 817 | 40.2   | 58.4   |
| 克林霉素    | 2 563 | 51.6   | 47.8   | 8 301 | 16.8   | 81.9   |
| 左氧氟沙星   | 2 488 | 23.4   | 74.6   | 7 908 | 10.2   | 88.2   |
| 复方磺胺甲噁唑 | 2 639 | 10.8   | 89.2   | 8 442 | 13.1   | 86.9   |
| 利福平     | 2 700 | 5.1    | 92.0   | 8 612 | 1.0    | 98.2   |

**表 5** 2021 年 CARSS 肾内科住院患者分离的凝固酶阴性葡萄球菌对抗菌药物的药敏试验结果

**Table 5** Antimicrobial susceptibility testing results of coagulase negative *Staphylococcus* isolated from hospitalized patients in department of nephrology, CARSS, 2021

| 抗菌药物    | MRCNS |        |        | MSCNS |        |        |
|---------|-------|--------|--------|-------|--------|--------|
|         | 检测株数  | 耐药率(%) | 敏感率(%) | 检测株数  | 耐药率(%) | 敏感率(%) |
| 青霉素 G   | 6 748 | 100    | 0      | 2 754 | 72.4   | 27.6   |
| 苯唑西林    | 7 290 | 100    | 0      | 3 354 | 0      | 100    |
| 庆大霉素    | 7 176 | 23.1   | 66.0   | 2 996 | 5.0    | 91.1   |
| 万古霉素    | 7 196 | 0      | 100    | 3 006 | 0      | 100    |
| 替考拉宁    | 2 830 | 0      | 100    | 1 246 | 0      | 100    |
| 利奈唑胺    | 7 077 | 0.1    | 99.9   | 2 985 | 0      | 100    |
| 红霉素     | 7 043 | 74.5   | 23.7   | 2 932 | 49.2   | 48.5   |
| 克林霉素    | 6 490 | 32.4   | 65.9   | 2 719 | 12.6   | 85.7   |
| 左氧氟沙星   | 6 480 | 61.8   | 35.0   | 2 671 | 18.0   | 80.2   |
| 复方磺胺甲噁唑 | 6 865 | 45.0   | 54.9   | 2 877 | 23.4   | 76.5   |
| 利福平     | 7 019 | 8.9    | 90.5   | 2 866 | 2.0    | 97.7   |

表 6 2021 年 CARSS 肾内科住院患者分离的屎肠球菌、粪肠球菌对抗菌药物的药敏试验结果

Table 6 Antimicrobial susceptibility testing results of *Enterococcus faecium* and *Enterococcus faecalis* isolated from hospitalized patients in department of nephrology, CARSS, 2021

| 抗菌药物    | 屎肠球菌  |         |         | 粪肠球菌  |         |         |
|---------|-------|---------|---------|-------|---------|---------|
|         | 检测株数  | 耐药率 (%) | 敏感率 (%) | 检测株数  | 耐药率 (%) | 敏感率 (%) |
| 氨苄西林    | 5 642 | 93.2    | 6.8     | 4 636 | 4.9     | 95.1    |
| 高浓度庆大霉素 | 4 837 | 41.1    | 58.9    | 3 999 | 38.1    | 61.8    |
| 高浓度链霉素  | 3 044 | 33.0    | 66.9    | 2 396 | 26.5    | 73.4    |
| 万古霉素    | 5 740 | 1.1     | 98.8    | 4 738 | 0.1     | 99.7    |
| 替考拉宁    | 2 513 | 1.8     | 97.9    | 2 178 | 0.5     | 99.3    |
| 利奈唑胺    | 5 640 | 0.5     | 98.4    | 4 428 | 2.3     | 94.8    |
| 左氧氟沙星   | 4 625 | 89.4    | 6.0     | 3 692 | 35.6    | 62.1    |
| 环丙沙星    | 3 860 | 91.6    | 4.5     | 2 835 | 38.8    | 55.1    |
| 利福平     | 922   | 71.1    | 19.1    | 741   | 57.8    | 24.2    |

### 3 讨论

2021 年 CARSS 数据显示,肾内科住院患者临床标本分离的病原菌中,革兰阴性杆菌占比高于革兰阳性球菌,与相关报道<sup>[6-7]</sup>一致,排在前三位的病原菌分别为大肠埃希菌、肺炎克雷伯菌和金黄色葡萄球菌。

革兰阴性菌是引起肾内科患者感染的主要病原菌,以大肠埃希菌和肺炎克雷伯菌为主,共占 43.1%。大肠埃希菌及肺炎克雷伯菌对第一、二、三代头孢菌素具有较高的耐药率,且可通过质粒水平传播耐药性,临床治疗效果有限,病死率较高,已成为重大的公共卫生问题<sup>[8]</sup>。碳青霉烯类抗生素被认为是治疗多重耐药革兰阴性菌的一线药物<sup>[9]</sup>。本研究中,大肠埃希菌对碳青霉烯类抗生素耐药率为 0.9%~1.0%,肺炎克雷伯菌对碳青霉烯类抗生素的耐药率为 6.2%~8.9%,阴沟肠杆菌对碳青霉烯类药物的耐药率约为 5%。产碳青霉烯酶为全球耐碳青霉烯类肠杆菌目细菌(CRE)的主要耐药机制之一,且基因易水平传播<sup>[10-11]</sup>,提示临床一旦发生 CRE 感染,应上报医院感染部门并采取感染防控措施<sup>[12]</sup>。国内产碳青霉烯酶的 CRE 以 KPC-2 型为主要流行基因型,其次为 NDM 基因型,不同基因型的临床治疗策略及预后有所不同<sup>[13-14]</sup>,建议必要时检测酶型。

头孢他啶/阿维巴坦、替加环素、黏菌素,以及联合用药是治疗 CRE 等多重耐药菌的最后一道防线<sup>[15-18]</sup>。肾内科分离病原菌中,非发酵菌主要以铜绿假单胞菌、鲍曼不动杆菌为主,分别占比 5.4%、3.0%,铜绿假单胞菌对各类抗菌药物的敏感性优于鲍曼不动杆菌。本研究显示,铜绿假单胞菌对头孢吡肟、哌拉西林/他唑巴坦、头孢哌酮/舒巴坦的耐药率低于对碳青霉烯类药物的耐药率,临床选取药物需参照药敏试验结果。鲍曼不动杆菌对大多数抗菌药物呈现出较高耐药性,尽管对多黏菌素 B 的敏感率 >95%,但该药物不良反应大,而肾内科绝大多数患者有肾脏基础疾病,临床治疗中应谨慎选用。

肾内科住院患者革兰阳性菌感染以金黄色葡萄球菌为主,占 9.8%,其次为屎肠球菌、表皮葡萄球菌、粪肠球菌,这与国内外报道<sup>[19-20]</sup>的以屎肠球菌为主,其次为金黄色葡萄球菌有所不同。本研究数据显示,MRSA 和 MRCNS 的分离率分别为 23.3%、68.5%,耐甲氧西林葡萄球菌为多重耐药菌株,临床使用  $\beta$ -内酰胺类抗生素治疗无效,优先选择糖肽类、噁唑烷酮类抗生素治疗。本研究显示,葡萄球菌中未发现对万古霉素、替考拉宁的非敏感株,提示在患者发生耐甲氧西林葡萄球菌感染时可首选万古霉素和替考拉宁治疗。屎肠球菌对万古霉素、替考拉宁的耐药性高于粪肠球菌,但总体耐药率均较低,肾内科患者在感染肠球菌时可优先考虑选择糖肽类抗生素治疗。此外,万古霉素、替考拉宁长期使用易产生肾毒性<sup>[21-23]</sup>,肾内科患者在使用该药物治疗时,应定期监测肾功能,及时调整用药方案。对于治疗窗窄、不良反应大的药物如万古霉素,则尽可能监测血药浓度,对不同患者针对性进行个体化治疗,精准用药以获得最佳疗效。

综上所述,本研究为肾内科患者抗感染治疗提供了新的参考依据,但也存在一定局限性。下一步将结合肾内科患者危险因素及耐药率变迁进行相关研究,以期更好地指导肾内科患者规范、合理使用抗菌药物,减缓耐药性发生。

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