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Journal of Advances in Medicine Science
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ARTICLE

Clinical Distribution and Drug Resistance of 224 Strains of Pseudomonas Aeruginosa

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ARTICLE INFO

Article history
Received: 18 September 2019
Revised: 25 September 2019
Accepted: 22 October 2019
Published Online: 31 October 2019

Keywords:
Pseudomonas aeruginosa
Drug resistance rate
Antibiotics

ABSTRACT

Objective: To provide evidence for a rational and effective prevention and treatment of Pseudomonas aeruginosa, the clinical characteristics and the resistance to various antibiotics of were investigated. **Methods:** A retrospective analysis of 224 strains of Pseudomonas aeruginosa isolated from various specimens from various clinical departments of our hospital (April 1, 2018 to June 31, 2019) were conducted. Identification and drug susceptibility test of isolated strains was performed using a fully automatic bacterial identification analyzer (MicroScan WalkAway-96 plus), and data analysis was performed using WH0NET5.6 software. **Results:** Among all the bacteria isolated in our hospital during the above period, Pseudomonas aeruginosa accounted for 10.09% of them all and 12.57% of Gram-negative bacilli, respectively. These isolates were mainly derived from sputum specimens (68.75%), mainly from male patients (70.54%), and mostly 61-70 (27.23%) or 51-60 (22.77%) years old. Pseudomonas aeruginosa isolates are mainly from Rehabilitation Ward, ICU, and Liver Transplantation Unit, accounted for 29.91%, 12.95% and 10.27% of all isolates, respectively. The sensitivity of Pseudomonas aeruginosa to various antibacterial drugs, in the order of high to low were carbapenems, aztreonam, quinolones, cephalosporins, piperacillin/ tazobactam, aminoglycoside, with a lowest resistance rate (2.4%) to amikacin and a highest resistance rate to imipenem (33.0%). **Conclusion:** The isolation rate of Pseudomonas aeruginosa was relatively stable during the study period, and among all the P. aeruginosa detected, most of them were from the respiratory secretions of elderly male patients. The resistance rate of Pseudomonas aeruginosa isolates to various antibiotics is mainly within 30%. Clinical units such as Rehabilitation Ward, ICU, and Liver Transplantation Unit have a high detection rate; therefore, these departments should be monitored in a focused manner. Our research provides a scientific basis for the rational use of antibiotics and a better control of Pseudomonas aeruginosa infection.

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DOI: https://doi.org/10.30564/jams.v2i4.1212

1. Introduction

Pseudomonas aeruginosa is a common conditional pathogen in clinical practice, widely distributed in the natural environment and exists in human skin, respiratory tract and intestine. When the body's natural defenses declines due to surgery, chemotherapy, radiotherapy, hormone therapy, etc. they tend to cause pulmonary infections, urinary tract infections, otitis media, bacteremia and infections of burn wound[1-3]. In recent years, due to the widespread use of broad-spectrum antibacterial drugs, the drug resistance of the bacteria has increased significantly, and caused a severe challenge to an effective anti-infective in clinic settings. In this study, we analyzed the characteristics, such as drug resistance, of 224 strains of Pseudomonas aeruginosa isolated from our hospital from April 1, 2018 to June 31, 2019, and expects for a reliable basis for a rational antibiotic policy and a better prevention of infection in the future.

2. Materials and Methods

2.1 Strain Specimens and Standard Strains

After removing duplicate strains isolated from the same site of the same patient, 224 strains of Pseudomonas aeruginosa isolated from various specimens from every clinical departments of Lingnan Hospital of the Third Affiliated Hospital of Sun Yat-sen University (April 1, 2018 to June 30, 2019) were included in this analysis. Escherichia coli ATCC25922 and Pseudomonas aeruginosa ATCC27853 were used as quality control strains and provided by the Guangdong Center for Clinical Laboratory.

2.2 Instruments and Reagents

MicroScan Walk-Away 96 plus (Siemens AG, Germany), a fully automated bacterial identification and susceptibility analyzer (including supporting reagents and slats) was used. Blood agar plate and chocolate agar plate were provided by Crmicrobio Trading Co., Ltd (Jiangmen, China).

2.3 Strain Identification and Drug Sensitivity Test

The culture operations of the specimens sent by the clinical departments are strictly carried out in accordance with the National Clinical Laboratory Procedures (4th Edition). Identification and susceptibility testing of all strains were performed using MicroScan Walk-Away 96 plus, determination of the drug susceptibility test results was carried out in accordance with the CLSI 2018 standard.

2.4 Statistical Processing

Data analysis was performed using WH0NET5.6 and Excel 2007 software.

3. Results

3.1 Isolation Rate of Pseudomonas Aeruginosa

Pseudomonas aeruginosa accounted for 10.09% of all the bacteria isolated in our hospital from April 1, 2018 to June 30, 2019, and for Gram-negative bacilli, 12.57% of them were Pseudomonas aeruginosa, as shown in Table 1.

Table1. Isolation rate of Pseudomonas aeruginosa

Date	Total number of strains	number of G-b strains	PA		
			number of strains	PA/ Total number of strains (%)	PA/ G-b (%)
April-June 2018 (summer)	465	378	43	9.25	11.38
July-September 2018 (autumn)	452	372	48	10.62	12.90
October-December 2018 (Winter)	388	315	46	11.86	14.60
January to March 2019 (spring)	410	321	32	7.80	9.97
April-June 2019 (summer)	506	396	55	10.87	13.89
Total	2221	1782	224	10.09	12.57

3.2 Gender and Age Distribution of Pseudomonas Aeruginosa Infections

Of all Pseudomonas aeruginosa strains detected, 158 strains (70.54%) were isolated from male patients, and 66 strains (29.46%) were isolated from female patients. It was isolated at all ages, but mainly from 61 -70 (27.23%) and 51-60 (22.77%) years old patients. In the remaining groups, the detection rate of Pseudomonas aeruginosa in patients aged 71-80 years was 14.73%, and it was 13.39% in the group of 41-50 years old patients, as shown in Table 2.

Table 2. Gender and age distribution of Pseudomonas aeruginosa infections.

age	number of patients	percentage (%)
<1	2	0.89
1-10	4	1.79
11-20	7	3.13
21-30	14	6.25
31-40	16	7.14
41-50	30	13.39
51-60	51	22.77
61-70	61	27.23
71-80	33	14.73
81-90	6	2.68
Total	224	100.00

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DOI: https://doi.org/10.30564/jams.v2i4.1212

3.3 Distribution of Pseudomonas Aeruginosa Infections in Clinical Units

The Pseudomonas aeruginosa cases detected were mainly from the Rehabilitation Ward (29.91%), ICU (12.95%), Liver Transplantation Unit (10.27%) and Neurosurgery department (8.48%). See Table 3.

Table 3. Distribution of Pseudomonas aeruginosa infections in clinical units

clinical units	number of cases	percentage（%）
Rehabilitation Ward	67	29.91
ICU	29	12.95
Liver Transplantation Unit	23	10.27
Neurosurgery department	19	8.48
Respiratory Ward	10	4.46
Department of Infected disease	9	4.02
Cardiac surgery unit	8	3.57
Urological ward	8	3.57
Wound care clinic	6	2.68
Rheumatology unit	6	2.68
Others	39	17.41
Total	224	100.00

3.4 The Distribution of Pseudomonas Aeruginosa Positive Specimen

The Pseudomonas aeruginosa strains detected were mainly isolated from samples such as sputum, urine, wound secretions, drainage, organ lavage and blood, as shown in Table 4.

Table 4. The distribution of Pseudomonas aeruginosa positive Specimen

Source of specimen	number of cases	percentage（%）
sputum	154	68.75
urine	16	7.14
wound secretions	15	6.70
drainage	9	4.02
organ lavage	8	3.57
blood	5	2.23
others	17	7.59

3.5 Susceptibility of Pseudomonas Aeruginosa to Various Antimicrobial Agents

The Susceptibility of Pseudomonas aeruginosa strains to various antibiotics in this study, ranked from high to low, was as follows: imipenem, meropenem, aztreonam, levofloxacin, ring Ciprofloxacin, ceftazidime, cefepime, piperacillin/tazobactam, gentamicin, tobramycin and amikacin. We observed a lowest resistance rate to amikacin (2.4%), while the resistance to imipenem was the highest (33.0%). The resistance rate of those Pseudomonas aeruginosa strains to carbapenem antibiotics increased in 2018, but declined in 2019, and it dropped to the lowest in the second quarter of 2019 when the resistance rates to imipenem and meropenem were 25.5% and 18.2%, respectively. See Table 5.

4. Discussion

Pseudomonas aeruginosa is one of the most common conditional pathogenic bacteria in nosocomial infections[4]. Because of its unique characteristics, such as easy coloni-

Table 5. Susceptibility of Pseudomonas aeruginosa strains to antimicrobial agents (%)

	In total		Summer,2018		Autumn,2018		Winter,2018		Spring,2019		Summer, 2019	
antimicrobial agents	R	S	R	S	R	S	R	S	R	S	R	S
Piperacillin/tazobactam	11.5	78.2	9.3	79.1	6.2	91.7	13.0	67.4	12.5	78.1	16.4	74.5
Ceftazidime	13.4	80.4	14.0	83.7	4.2	93.8	17.4	73.9	9.4	78.1	21.8	72.7
Cefepime	11.8	75.4	16.3	76.7	4.2	87.5	10.9	71.7	9.4	71.9	18.2	69.1
Aztreonam	24.9	57.7	34.9	55.8	16.7	62.5	30.4	54.3	18.8	59.4	23.6	56.4
Imipenem	33.0	60.1	30.2	67.4	37.5	54.2	43.5	39.1	28.1	68.8	25.5	70.9
Meropenem	27.6	66.9	23.3	69.8	31.2	60.4	37.0	54.3	28.1	71.9	18.2	78.2
Amikacin	2.4	90.5	0.0	88.4	4.2	89.6	0.0	95.7	6.2	84.4	1.8	94.5
Gentamicin	10.1	75.8	11.6	69.8	4.2	83.3	10.9	80.4	9.4	78.1	14.5	67.3
Tobramycin	5.5	92.1	4.7	90.7	4.2	95.8	6.5	91.3	3.1	93.8	9.1	89.1
Ciprofloxacin	18.4	75.3	18.6	72.1	10.4	83.3	15.2	73.9	18.8	78.1	29.1	69.1
Levofloxacin	21.3	69.0	27.9	67.4	16.7	70.8	19.6	69.6	18.8	71.9	23.6	65.5

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zation, variation and multi-drug resistance[5], the infection with Pseudomonas aeruginosa often presents a great threat to patients, especially those with low immune function and those who were admitted to intensive care units[6]. It is of great benefit to study the clinical and pathogenic characteristics of Pseudomonas aeruginosa in clinical settings.

In this study, the detection rate of Pseudomonas aeruginosa was 10.09%, which was consistent with the report of Longo et al.[7], in which, Pseudomonas aeruginosa infections accounts for 10%-15% of nosocomial infections. 68.75% of our isolates were from respiratory specimens. The high retention rate of sputum specimen from those affected patients plays a part, but the most possible reason, as reported elsewhere[8], is that Pseudomonas aeruginosa is the main Gram-negative bacillus causing hospital-acquired pneumonia and ventilator-associated pneumonia, most possible due to the reduction of the respiratory function by the polysaccharide capsule of Pseudomonas aeruginosa. 50% of the isolates were from 51-70 years old patients, and 53.13% of the isolates were from Rehabilitation Ward, ICU, and Liver Transplantation Unit. This situation is mainly related to the fact that patients of the above-mentioned age group or from the above-mentioned wards have more primary disease, generally have lower immunity, are subjected to various invasive operations, prolonged hospital stays and the frequent use of broad-spectrum antibacterials, etc.

Pseudomonas aeruginosa has multiple drug resistance mechanisms[9-11], mainly, active efflux systems, changes of target sites, Bacterial biofilm, inactivated enzyme, and foreign resistance genes. According to the results of 2017 CHINET China bacterial resistance monitoring[12], the resistance rate of 16562 strains of Pseudomonas aeruginosa to antimicrobial agents were as follows: aztreonam (31.4%), imipenem (23.6%), ceftazidime (21.4%), Meropenem (20.9%), Cefepime (18.7%), Ciprofloxacin (14.8%), Piperacillin/tazobactam (13.4%) , Gentamicin (10.7%) and Amikacin (6.1%). In our study, except for the slightly higher resistance rates to imipenem, meropenem, and ciprofloxacin, the resistance rates for the remaining antibiotics were relatively lower than those of the above study. The resistance to aztreonam, quinolones, cephalosporins and piperacillin/tazobactam of the strains that were in our research were between 11.5% and 24.9%. In the past decade, carbapenems have been considered as the last line of defense against Gram-negative bacilli. But with the increasing use of those drugs, the probability of detecting carbapenem-resistant Pseudomonas aeruginosa is gradually increasing[13]. In this study, we also noticed an increased resistance rate to carbapenem antibiotics in 2018, however, in 2019, the resistance to imipenem and meropenem were controlled and a correspondingly downward trend emerged. In the second quarter of 2019, resistance rates to the two drugs fell to a minimum of 25.5% and 18.2%, respectively. This was in line with our hospitals' close monitoring of microbial resistance as well as our clinicians' effect of strict controlling the use of antibiotics, in particular, carbapenem antibiotics. Pseudomonas aeruginosa has the lowest resistance rate to aminoglycosides, especially amikacin (2.4%). This may be due to the fact that aminoglycosides are nephrotoxic and are rarely used in clinic, and also because of the substrate specificity of aminoglycoside modifying enzyme mediated resistance.

5. Conclusion

In summary, Pseudomonas aeruginosa is widely distributed in clinical practice and is one of the most important pathogen of nosocomial infections. To effectively prevent and control Pseudomonas aeruginosa related nosocomial infections, as discussed above, medical staff should pay great attention to the rational use of drugs, proper choice of antibiotics, the monitoring of pathogens and microbial resistance.

References

[1] Newman J W, Floyd R V, Fothergill J L. The contribution of Pseudomonas aeruginosa virulence factors and host factors in the establishment of urinary tract infections[J]. FEMS Microbiol Lett, 2017, 364(15).

[2] Palmer G C, Whiteley M. Metabolism and Pathogenicity of Pseudomonas aeruginosa Infections in the Lungs of Individuals with Cystic Fibrosis[J]. Microbiol Spectr, 2015, 3(4).

[3] Serra R, Grande R, Butrico L, et al. Chronic wound infections: the role of Pseudomonas aeruginosa and Staphylococcus aureus[J]. Expert Rev Anti Infect Ther, 2015, 13(5):605-613.

[4] Moosavian M, Rahimzadeh M. Molecular detection of metallo-beta-lactamase genes, bla IMP-1, bla VIM-2 and bla SPM-1 in imipenem resistant Pseudomonas aeruginosa isolated from clinical specimens in teaching hospitals of Ahvaz, Iran[J]. Iran J Microbiol, 2015, 7(1):2-6.

[5] Gholami S, Tabatabaei M, Sohrabi N. Comparison of biofilm formation and antibiotic resistance pattern of Pseudomonas aeruginosa in human and environmental isolates[J]. Microb Pathog, 2017, 109:94-98.

[6] de Bentzmann S, Plesiat P. The Pseudomonas aeruginosa opportunistic pathogen and human infections[J]. Environ Microbiol, 2011, 13(7):1655-1665.

[7] Longo B, Pantosti A, Luzzi I, et al. Molecular find-

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ings and antibiotic-resistance in an outbreak of Acinetobacter baumannii in an intensive care unit[J]. Ann Ist Super Sanita, 2007, 43(1):83-88.

[8] Barbier F, Andremont A, Wolff M, et al. Hospital-acquired pneumonia and ventilator-associated pneumonia: recent advances in epidemiology and management[J]. Curr Opin Pulm Med, 2013, 19(3):216-228.

[9] Al-Wrafy F, Brzozowska E, Gorska S, et al. Pathogenic factors of Pseudomonas aeruginosa - the role of biofilm in pathogenicity and as a target for phage therapy[J]. Postepy Hig Med Dosw (Online), 2017, 71(0):78-91.

[10] Potron A, Poirel L, Nordmann P. Emerging broad-spectrum resistance in Pseudomonas aeruginosa and Acinetobacter baumannii: Mechanisms and epidemiology[J]. Int J Antimicrob Agents, 2015, 45(6):568-585.

[11] Wolter D J, Lister P D. Mechanisms of beta-lactam resistance among Pseudomonas aeruginosa[J]. Curr Pharm Des, 2013, 19(2):209-222.

[12] F Hu, Y Guo, D Zhu, et al. 2017 CHINET China bacterial resistance surveillance[J]. Chinese Journal of Infection and Chemotherapy, 2018, 18(03):241-251.

[13] Riera E, Cabot G, Mulet X, et al. Pseudomonas aeruginosa carbapenem resistance mechanisms in Spain: impact on the activity of imipenem, meropenem and doripenem[J]. J Antimicrob Chemother, 2011, 66(9):2022-2027.

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DOI: https://doi.org/10.30564/jams.v2i4.1212