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ORIGINAL PAPER

# Etiologic Diagnosis and Clinical Treatment of Multiple Drug-Resistant Bacteria Infection in Elderly Patients with Stroke-Associated Pneumonia After Neurosurgery

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**Abstract** Our objective is to analyze the etiology and antibiotics resistance rate of multiple drug-resistant bacteria infection in elderly patients with stroke-associated pneumonia from Neurosurgery Department, providing a reference for clinical treatment. Sputum of 372 elderly patients with stroke-associated pneumonia (SAP) from Neurosurgery Department was collected for sputum culture and drug sensitivity test, and pathogenic bacteria distribution and drug resistance rate of antibiotics were discussed. Among 372 pathogenic bacteria, there were 95 cases with Gram-positive cocci, the percentage was 15.32 %; there were 277 cases with Gram-negative bacilli, the percentage was 59.95 %; there were 54 cases with fungus, the percentage was 14.51 %; the common Gram-positive cocci included *Staphylococcus aureus, Staphylococcus haemolyticus* and *Staphylococcus epidermidis*, with percentages of 15.32 %, 2.96 % and 4.30 % respectively; the common Gram-negative bacilli included *Pseudomonas aeruginosa, Escherichia coli* and *Klebsiella pneumoniae*, with percentages of 23.92 %, 14.25 % and 9.95 % respectively; the highest drug resistance rates of *Staphylococcus aureus* were 100.00 % to penicillin, erythrocin and oxacillin, the highest drug resistance rate of *Staphylococcus epidermidis* was 87.50 % to erythrocin, the highest drug resistance rate of *Staphylococcus haemolyticus* was 100.00 % to penicillin and erythrocin, the lowest drug resistance rates of three Gram-negative bacilli were 0 % to teicoplanin and vancomycin; the highest drug resistance rates of *Escherichia coli* were 100.00 % to ceftriaxone and ticarcillin, and the lowest drug resistance rate was 11.32 % to ciprofloxacin; the highest drug resistance rate of *Pseudomonas aeruginosa* was 100.00 % to ceftriaxone, and the lowest drug resistance rate was 22.47 % to imipenem; the highest drug resistance rate of *Klebsiella pneumoniae* was 81.08 % to aztreonam, and the lowest drug resistance rate was 0.00 % to imipenem. Stroke-associated pneumonia is common clinically in elderly patients from Neurology Department, the early-stage and rational use of antibiotics should be applied according to the etiologic distribution and drug resistance characteristics. Meanwhile, prevention measures should be applied.

**Keywords** Multiple resistant bacteria · Stroke-associated pneumonia · Etiology · Antibiotics

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## Introduction

In recent years, patients in Neurosurgery Department, especially elderly patients, are liable to have lung infection due to the weakened defense function of respiratory tract and reduced immunity [1–3]. The incidence rate of stroke-associated pneumonia [4–6] is high in patients from Neurosurgery Department, which prolongs the hospitalization time and significantly affects the prognosis [7–9] of patients. As the drug resistance [10–13] of

bacteria becomes more and more serious, the selection of appropriate antibiotics has been extremely important to SAP patients. In our study, we aimed to analyze the etiology and clinical treatment of multi-drug resistance bacteria infection in elderly patients with SAP from Neurosurgery Department.

## Materials and Methods

### General Data

Three hundred and seventy two elderly patients with SAP admitted in Neurosurgery Department of our hospital during June, 2010-January, 2014 were selected, including 195 male patients and 177 female patients. The age was 60 ~ 87, and the average age was 74.2 ± 5.1.

### Diagnostic Criteria and Exclusion Criteria

#### *Diagnostic Criteria*

All of 372 patients conformed to the related diagnostic criteria of SAP criteria: 1. There was pathogenic bacteria growth in sputum culture; 2. There was hemogram change, the percentage of neutrophils was more than 80 %, peripheral blood white blood cell count was $\leq 4 \times 10^9$/L or $\geq 10 \times 10^9$/L; 3. Patients had fever, with temperature $\geq$38 °C; 4. There were moist rales in lung or there were signs of pulmonary consolidation, breath sounds were decreased; 5. Chest imageological examination showed there was progressive infiltration in lung.

#### *Exclusion Criteria*

1. Patients who were not conformed to diagnostic criteria; 2. Patients had lung infection before stroke; 3. Patients who died or were discharged within 24 hours after admission.

### Collection of Samples

Deep sputum [14] of 372 patients was collected and sent to bacteriology laboratory.

### Multi-drug Resistance Bacteria and Drug Resistance

The above collected sputum samples were routinely separated, Kirby-Bayer disc diffusion method was used for drug sensitivity test. Drug-susceptibility disk and antimicrobial drug disk [15, 16] were purchased from Oxoid Limited, the results were determined according to 2010 version criteria made by Clinical and Laboratory Standards Institute(CLSI), and the drug-resistance was recorded.

### Statistical Analysis

SPSS19.0 was used to analyze the data in our research, $P < 0.05$ was considered as statistically significant.

## Results

### Constituent Ratio of Pathogenic Bacteria Detected in SAP

Among 372 pathogenic bacteria, there were 95 cases with Gram-positive cocci, and the percentage was 15.32 %; there were 277 cases with Gram-negative bacilli, and the percentage was 59.95 %; there were 54 cases with fungus, and the percentage was 14.51 %. As shown in Table 1.

### The Drug Resistance Rates of Gram-Positive Bacteria to Antibiotics

The highest drug resistance rates of *Staphylococcus aureus* were 100.00 % to penicillin, erythrocin, and oxacillin, the lowest drug resistance rates were 0 % to teicoplanin and vancomycin; the highest drug resistance rate of *Staphylococcus epidermidis* was 87.50 % to erythrocin, the lowest drug resistance rate was 0 % to teicoplanin and vancomycin; the highest drug resistance rate of *Staphylococcus haemolyticus* was 100.00 % to penicillin and erythrocin, the lowest drug resistance rates was 0 % to teicoplanin and vancomycin. As shown in Table 2.

**Table 1** Constituent ratio of pathogenic bacteria detected in SAP (%)

| Pathogenic bacteria | Number of cases | Percentage |
|---|---|---|
| Gram-positive cocci | 95 | 25.54 |
| *Staphylococcus aureus* | 57 | 15.32 |
| *Staphylococcus haemolyticus* | 11 | 2.96 |
| *Staphylococcus epidermidis* | 16 | 4.30 |
| *Pneumococcus* | 5 | 1.34 |
| Others | 6 | 1.61 |
| Gram-negative bacilli | 223 | 59.95 |
| *Escherichia coli* | 53 | 14.25 |
| *Pseudomonas aeruginosa* | 89 | 23.92 |
| *Klebsiella pneumoniae* | 37 | 9.95 |
| *Acinetobacter baumannii* | 28 | 7.53 |
| *Enterobacter aerogenes* | 6 | 1.61 |
| *Pseudomonas alcaligenes* | 5 | 1.34 |
| Others | 5 | 1.34 |
| Fungus | 54 | 14.51 |
| Total | 372 | 100.00 |

**Table 2** The drug resistance rate of main multi-drug resistance Gram-positive bacteria to antibiotics (%)

| Antibiotics | *Staphylococcus aureus* ($n = 57$) | *Staphylococcus epidermidis* ($n = 16$) | *Staphylococcus haemolyticus* ($n = 11$) |
|---|---|---|---|
| Penicillin | 100.00 | 43.75 | 100.00 |
| Erythromycin | 100.00 | 87.50 | 100.00 |
| Oxacillin | 100.00 | 50.00 | 81.82 |
| Gentamicin | 80.70 | 56.25 | 90.91 |
| Ciprofloxacin | 100.00 | 25.00 | 90.91 |
| Tetracycline | 87.72 | 25.00 | 27.27 |
| Moxifloxacin | 52.63 | 18.75 | 18.18 |
| Vancomycin | 0 | 0 | 0 |
| Teicoplanin | 0 | 0 | 0 |

**Table 3** The drug resistance rate of main multi-drug resistance Gram-negative bacteria to antibiotics (%)

| Antibiotics | *Escherichia coli* ($n = 53$) | *Pseudomonas aeruginosa* ($n = 89$) | *Klebsiella pneumoniae* ($n = 37$) |
|---|---|---|---|
| Ceftriaxone | 100.00 | 100.00 | 67.57 |
| Ceftazidime | 58.49 | 31.46 | 67.75 |
| Piperacillin | 60.38 | 33.71 | 5.41 |
| Aztreonam | 71.70 | 41.57 | 81.08 |
| Ticarcillin | 100.00 | 98.88 | 67.75 |
| Gentamicin | 60.38 | 51.69 | 37.84 |
| Ciprofloxacin | 11.32 | 51.69 | 67.75 |
| Imipenem | 60.38 | 22.47 | 0.00 |

### The Drug Resistance Rates of Gram-Negative Bacteria to Antibiotics

The highest drug resistance rates of *Escherichia coli* were 100.00 % to ceftriaxone and ticarcillin, and the lowest drug resistance rate was 11.32 % to ciprofloxacin; the highest drug resistance rate of *Pseudomonas aeruginosa* was 100.00 % to ceftriaxone, and the lowest drug resistance rate was 22.47 % to imipenem; the highest drug resistance rate of *Klebsiella pneumoniae* was 81.08 % to aztreonam, and the lowest drug resistance rate was 0.00 % to imipenem. As shown in Table 3.

## Discussion

SAP is a common complication in elderly patients after surgery, and is also the important reason which causes deterioration of patient's condition even death [17–19]. The morbidity is up to 20–50 %, which is significantly life threatening. Therefore, we should focus not only on the treatment of primary disease in elderly patients but also take effective measure to treat SAP to significantly improve the life quality and prognosis of patients in Neurosurgery Department. Furthermore, multi-drug resistance bacteria infection [20–22] can prolong the hospitalization time of SAP patients increase the hospitalization cost and even increase the mortality [23, 24]. Gram-negative bacteria are most common in SAP patients with multi-drug resistance bacteria infection. Our results showed that there were 277 cases of Gram-negative bacilli among 372 cases with percentage of 59.95 %, the most common Gram-negative vacilli included 23.92 % of *Pseudomonas aeruginosa*, 14.25 % of *Escherichia coli*, and 9.95 % of *Klebsiella pneumoniae*.

Improving the diagnostic and treatment level, and understanding the etiologic feature and pathogenesis of SAP are extremely important. The pathogenesis of SAP [25, 26] includes: 1. Stress response in elderly patients can induce lung injury and cause central respiratory dysfunction; 2. Release of cytokines and neuroendocrine change can both weaken the humoral immunity and cell-mediated immunity; 3. Elderly patients usually have dysphagia and disturbance of consciousness to cause aspiration and further cause lung infection. Because SAP is common in elderly patients with various primary diseases and risk factors [27–29], there are diverse pathogenic bacteria in infection.

In the results, *Staphylococcus aureus* is highly resistant to penicillin, erythromycin, and oxacillin, and highly sensitive to teicoplanin and vancomycin; *Staphylococcus epidermidis* is highly resistant to erythromycin, and highly sensitive to teicoplanin and vancomycin; *Staphylococcus haemolyticus* is highly resistant to penicillin and erythromycin, and highly sensitive to teicoplanin and vancomycin; *Escherichia coli* is highly resistant to ceftriaxone and ticarcillin, and highly sensitive to ciprofloxacin; *Pseudomonas aeruginosa* is highly resistant to ceftriaxone, and highly sensitive to imipenem; *Klebsiella pneumoniae* is highly resistant to aztreonam, and highly sensitive to imipenem.

In conclusion, SAP is common in elderly patients. The multi-drug resistance of SAP is a part of nosocomial infection and is also a local manifestation of nosocomial infection. In clinical, we should strengthen the prevention of nosocomial infection and strictly select the antibiotics considering the result of drug sensitivity test for treatment to avoid the multi-drug resistance caused by irrational application of antibiotic.

**Conflict of interest** The authors have not declared any conflicts of interest.

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