Changing trend of antimicrobial resistance among pathogens isolated from lower respiratory tract at a university-affiliated hospital of China, 2006-2010

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ABSTRACT

Objective: To investigate the distribution and the antimicrobial resistance of pathogens in lower respiratory tract infection from 2006 to 2010.

Methods: The sputum specimens from inpatients with lower respiratory tract infection in the First Affiliated Hospital of Nanjing Medical University during the past five years were cultured and identified; the antimicrobial resistance was analyzed by the software WHONET 5.4.

Results: A total of 12,191 isolates were characterized in sputum samples: 73.5% were Gram-negative bacteria, 13.7% were Gram-positive bacteria, and 12.8% were fungi. The isolation rate of *Acinetobacter* was significantly increasing from 12.8% in 2006 to 26.4% in 2010. The Gram-negative bacterial resistance rate to the second and third generation cephalosporin increased year by year. Decreasing trend, 78.7% in 2006 decreased to 63.5% in 2010 (R^2=0.93 and P<0.01), in resistance to clindamycin against *Staphylococcus aureus* was observed. Worth noting is the drug resistance of *Acinetobacter* and *Klebsiella pneumoniae* to carbapenem significantly increased (R^2>0.3 and P≤0.05).

Conclusions: The antimicrobial resistance of pathogens in lower respiratory tract infection increased in recent years. The hospitals and government departments should strengthen management of the use of some antibiotics, such as the second/third generation cephalosporin and carbapenem, in order to enhance the effectiveness of medication.

KEY WORDS Antimicrobial resistance; *Acinetobacter*; *Staphylococcus aureus*; lower respiratory tract; carbapenem

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Introduction

Lower respiratory tract infections (LRTI) are common bacterial infections among patients in hospital and result in high overall mortality (1,2). It is reported that LRTI account for 3% to 5% of deaths in adults, especially over the age of 60 years, most common pathogens of LRTI are *Pseudomonas, Acinetobacter, Klebsiella, Citrobacter,* and *Escherichia coli* (3-5). At present, therapy for community-acquired lower respiratory tract infections (LRTI) is often empirical, and how to choose an effective antimicrobial agent is a new challenge to the clinicians, as the composition and the resistance to antimicrobial agents of infection pathogens was changing frequently. The knowledge of likely prevalent strains along with their antimicrobial resistance pattern will help in better management of patients and framing the antibiotic policy.

The present study, the pathogens profile and their antimicrobial resistance in lower respiratory tract infection from January 2006 to December 2010 in the First Affiliated Hospital of Nanjing Medical University was retrospectively reviewed in order to provide evidence for clinical therapy.

Material and methods

Patients

Patients with lower respiratory tract infections (LRTI) were enrolled from January 2006 to December 2010 in the First

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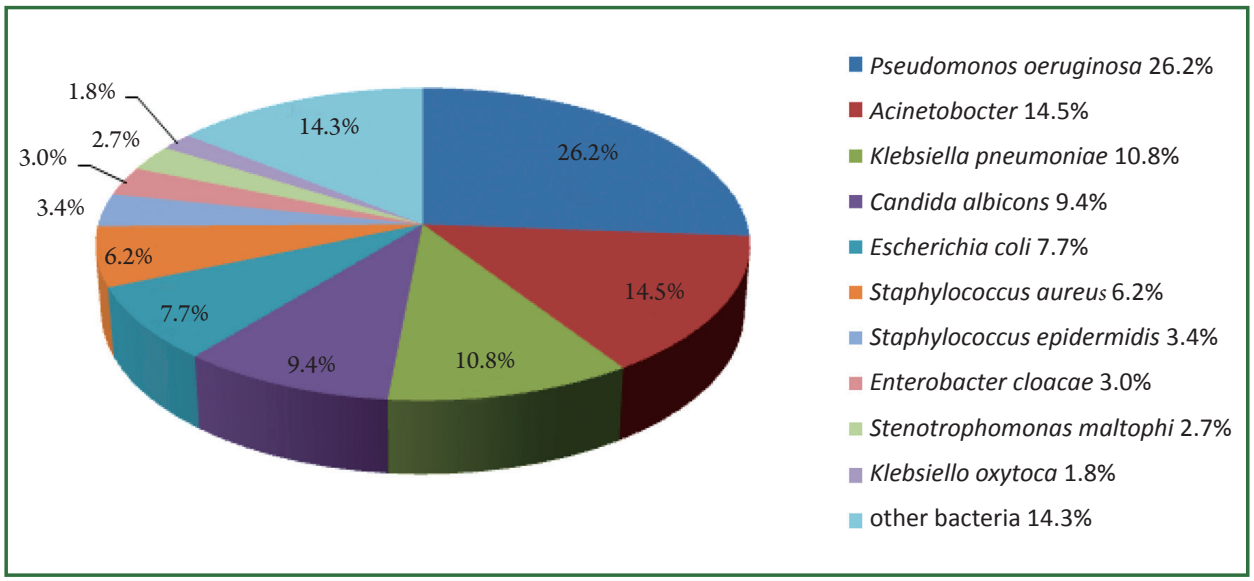

Figure 1. The distribution of the top 10 frequently isolated pathogens, 2006 to 2010.

Affiliated Hospital of Nanjing Medical University (6). The sputum specimens of only new patients who were enrolled for the first time were included in the study. Single or mixed growth from one patient and consecutive samples from the new patients were included in the study. If the repeat sample was received from the same patient who was already enrolled, it was not included in the study. Acquisition and inoculation of the sputum samples were all accorded to standard operating procedures, following Clinical and Laboratory Standards Institute guidelines (CLSI) (7).

Bacterial identification and antimicrobial susceptibility testing

The bacterial isolates were identified and performed antimicrobial susceptibility testing predominantly through disk susceptibility testing, supplemented by the Vitek 2 system, following Clinical and Laboratory Standards Institute guidelines (CLSI) (7). Antimicrobial agents tracked include: penicillins (penicillin G), cephalosporins (cefazolin, cefuroxime, ceftriaxone, ceftazidime, and cefepime), monobactams (aztreonam), cephamycins (cefoxitin), carbapenems (imipenem and meropenem), compound agents (amoxicillin/clavulanate, ampicillin/sulbactam, piperacillin/tazobactam, cefoperazone/sulbactam), aminoglycosides (amoxicillin), fluoroquinolones (ciprofloxacin and levofloxacin), sulfonamides (cotrimoxazole), macrolides (erythromycin), lincomycins (clindamycin), glycopeptides (vancomycin and teicoplanin). Microbiologic data were extracted from the laboratory information system and converted centrally into a standard format using WHONET 5.4 (WHO, Geneva, Switzerland), with duplicates eliminated according to the guidelines of the CLSI. The following controls strains were included: *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, *Staphylococcus aureus* ATCC 25923.

Statistical analysis

WHONET 5.4 microbiology laboratory data management software World Health Organization recommended was used for statistical analysis. Changing trends in this use were analyzed by linear regression (R^2>0.3 and P≤0.05) (8).

Results

Pathogens distribution

During the study period, a total of 12,191 isolates were characterized in sputum samples from all patients with LRTI. Of these pathogens, 73.5% (8956/12191) were Gram-negative bacteria, 13.7% (1671/12191) were Gram-positive bacteria and 12.8% (1555/12191) were fungi. The top 10 frequently isolated pathogens were *Pseudomonas aeruginosa* (26.2%), *Acinetobacter* (14.5%), *Klebsiella pneumoniae* (10.8%), *Candida albicans* (9.4%), *Escherichia coli* (7.7%), *Staphylococcus aureus* (6.2%), *Staphylococcus epidermidis* (3.4%), *Enterobacter cloacae* (3.0%), *Stenotrophomonas maltophi* (2.7%) and *Klebsiella oxytoca* (1.8%) (Figure 1). These 10 species accounted for 85.7% of the total number of isolates. Figure 2 (A-F) showed the changing trend of the top 6 pathogens from 2006 to 2010. *Pseudomonas aeruginosa* accounted for top 1 from 2006 to 2009. The isolation rate of *Acinetobacter* was significantly increased from 12.8% in 2006 to 26.4% in 2010, more than *Pseudomonas aeruginosa* (24.4%) in 2010.

Antimicrobial resistance of Gram-negative bacteria

With regard to to Gram-negative bacteria (GNB), the

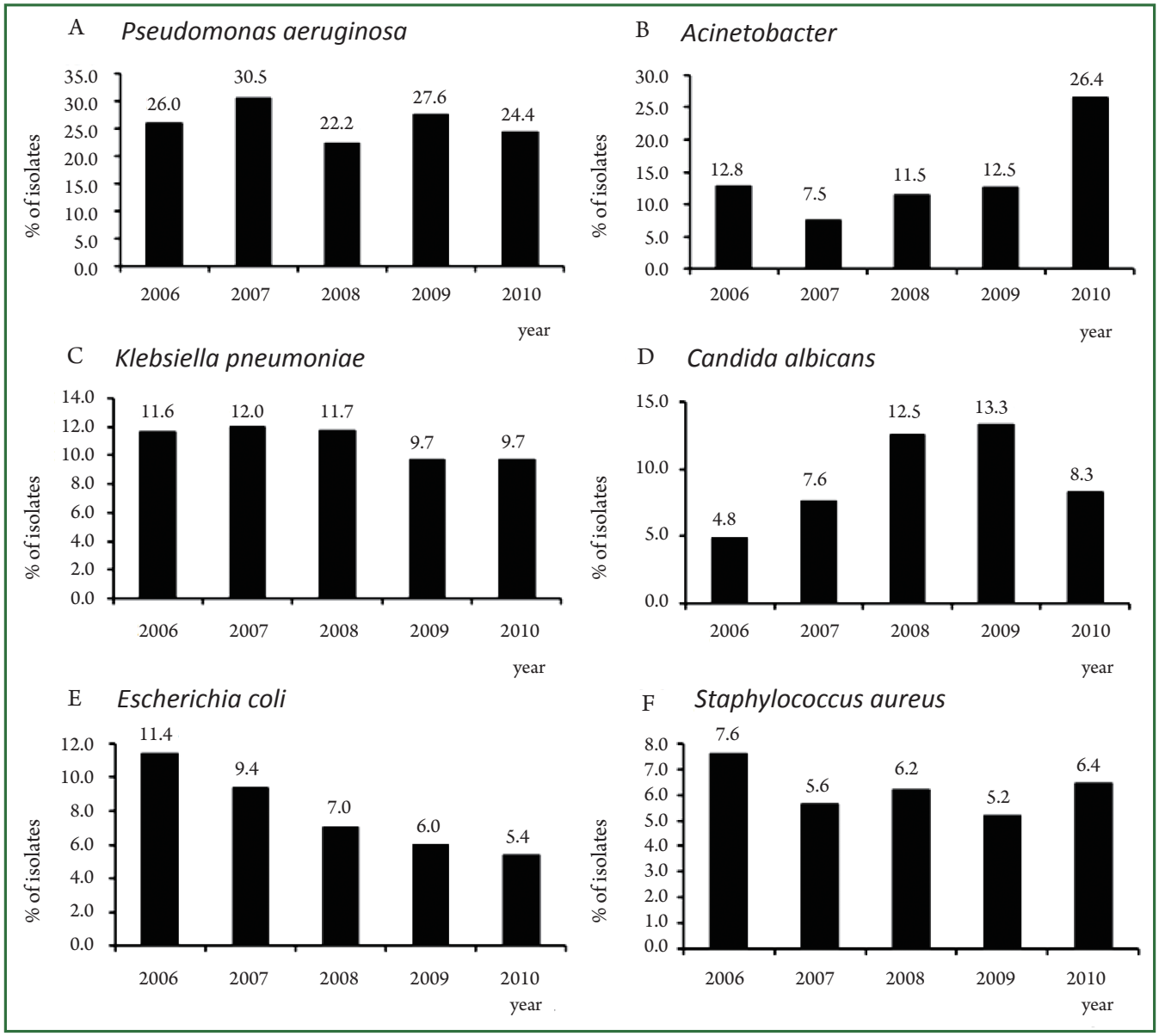

Figure 2. Changing trend of top 6 pathogens, 2006 to 2010.

resistance rate of all GNB to cephalosporins showed the increasing trend although not all showed significantly. Among GNB, the resistance rates were more than 90% in 2010 of *Escherichia coli* to all cephalosporins, a significant increase in the resistance rate with time was found for cefuroxime (R^2=0.86 and P=0.02) and ceftriaxone (R^2=0.78 and P=0.04) (Table 1). *Klebsiella pneumonia* had a more than 80% resistance rate in 2010 to all cephalosporins and significant increasing trends were observed to ceftazidime (R^2=0.91 and P=0.01) and ceftriaxone (R^2=0.95 and P<0.01) (Table 2). *Acinetobacter* resistance rate to all cephalosporins were more than 85% in 2010, significant increased against cefepime (R^2=0.78 and P=0.05) (Table 3). Significant increasing trends were also observed in *Citrobacter* to ceftazidime (R^2=0.80 and P=0.04) and ceftriaxone (R^2=0.82 and P=0.03) and *Pseudomonas aeruginosa* to ceftazidime (R^2=0.81 and P=0.04) (Table 4, 5). The same increasing trend was also found in GNB against aztreonam. *Citrobacter, Pseudomonas aeruginosa* and *Acinetobacter* resistance rate were all significant increased to aztreonam (R^2>0.3 and P≤0.05) and were all more than 60% in 2010 (Table 3, 4, 5). Worth noting is the drug resistance to carbapenem including imipenem and meropenem has become increasingly serious. Significant increasing trends were found to imipenem (R^2=0.78 and P=0.05, R^2=0.79 and P=0.04, respectively) and meropenem (R^2=0.81 and P=0.04, R^2=0.80 and P=0.04, respectively) of *Klebsiella pneumoniae* and *Acinetobacter* (Table 2, 3). Most GNB resistance rate increased to compound agents

Table 1. Trends in resistance rate of *Escherichia coli* to antibiotics, 2006 to 2010.

Antibiotics	2006	2007	2008	2009	2010	R^2	P	95% CI	Trend
Cefazolin	88.5	86.4	82.3	92.6	92.2	0.25	0.39	–2.94-5.66	Stable
Cefuroxime	84.1	89.9	89.7	95.3	94.7	0.86	0.02	0.68-4.63	Increasing
Ceftazidime	39.8	86.9	81.9	91.9	92.0	0.62	0.12	–4.91-26.79	Stable
Ceftriaxone	74.8	86.5	82.8	93.3	92.8	0.78	0.04	0.08-8.48	Increasing
Cefepime	53.9	88.2	82.2	92.1	92.4	0.63	0.11	–3.29-19.47	Stable
Aztreonam	52.8	88.6	82.3	92.2	91.6	0.60	0.12	–3.96-20.20	Stable
Imipenem	1.2	4.0	3.6	2.5	3.5	0.19	0.46	–0.87-1.49	Stable
Meropenem	2.8	4.2	7.6	3.0	3.5	<0.01	0.98	–2.26-2.30	Stable
Amoxicillin/clavulanate	46.9	32.5	36.8	37.1	50.3	0.06	0.70	–7.34-9.62	Stable
Ampicillin/sulbactam	66.7	54.5	49.5	67.6	100.0	0.41	0.24	–9.60-25.54	Stable
Piperacillin/tazobactam	26.7	19.6	16.6	18.4	20.7	0.30	0.34	–5.06-2.42	Stable
Cefoperazone/sulbactam	17.6	10.4	10.9	21.5	26.4	0.44	0.23	–3.13-8.87	Stable
Amoxicillin	29.7	25.5	24.0	20.9	10.1	0.88	0.01	–7.37-1.39	Decreasing
Levofloxacin	82.0	79.7	77.8	70.7	79.5	0.26	0.38	–5.70-2.90	Stable

Table 2. Trends in resistance rate of *Klebsiella pneumoniae* to antibiotics, 2006 to 2010.

Antibiotics	2006	2007	2008	2009	2010	R^2	P	95% CI	Trend
Cefazolin	62.3	63.5	58.8	54.5	74.1	0.10	0.60	–6.59-9.51	Stable
Cefuroxime	54.0	69.9	63.3	61.7	74.0	0.42	0.23	–3.64-10.00	Stable
Ceftazidime	28.6	43.7	58.8	55.7	72.1	0.91	0.01	4.09-15.71	Increasing
Ceftriaxone	40.6	48.6	59.4	59.7	72.2	0.95	<0.01	4.38-10.48	Increasing
Cefepime	30.4	63.1	60.1	56.6	72.5	0.61	0.12	–3.70-19.24	Stable
Aztreonam	35.9	65.2	60.1	56.7	73.4	0.56	0.14	–4.08-17.38	Stable
Imipenem	2.3	6.1	7.5	9.5	25.2	0.78	0.05	0 .06-9.78	Increasing
Meropenem	1.0	4.1	6.8	10.9	29.0	0.81	0.04	0 .68-1.88	Increasing
Amoxicillin/clavulanate	38.2	41.5	36.1	35.9	54.5	0.30	0.34	–4.81-10.21	Stable
Ampicillin/sulbactam	49.5	53.3	43.8	50.0	66.7	0.33	0.31	–5.03-11.25	Stable
Piperacillin/tazobactam	25.0	35.1	20.2	24.3	47.0	0.24	0.41	–7.67-14.31	Stable
Cefoperazone/sulbactam	15.0	10.3	10.6	20.0	38.2	0.59	0.13	–2.95-14.17	Stable
Amoxicillin	24.2	25.2	23.5	18.6	41.2	0.26	0.39	–5.87-11.35	Stable
Levofloxacin	40.6	43.2	31.3	32.6	52.6	0.06	0.69	–8.41-11.09	Stable

including ampicillin/sulbactam, piperacillin/tazobactam, cefoperazone/sulbactam except *Pseudomonas aeruginosa* remained stable. Among them, *Citrobacter* to ampicillin/sulbactam and piperacillin/tazobactam and *Acinetobacter* to piperacillin/tazobactam and cefoperazone/sulbactam showed significant increasing trends (R^2>0.3 and P≤0.05) (Table 3, 4). The only decreasing trend among GNB was observed in resistance to amoxicillin against *Escherichia coli* (R^2=0.88 and P=0.01) while increasing trends against *Pseudomonas aeruginosa* (R^2=0.82 and P=0.03) and *Acinetobacter* (R^2=0.84 and P=0.03) (Table 1, 3, 5).

Antimicrobial resistance of Gram-positive bacteria

With regard to Gram-positive bacteria (GPB), vancomycin was extremely effective against the most common bacteria (*Staphylococcus aureus*). No vancomycin-resistant isolate of *Staphylococcus aureus* was found. Few GPB was found resistant to teicoplanin. The GPB resistance rate remained high to penicillins, cephalosporins, piperacillin/tazobactam, levofloxacin and erythromycin and was more than 70% in 2010. The decreasing trend occurred in resistance rate to clindamycin (R^2=0.93 and P<0.01) against *Staphylococcus aureus* (Table 6).

Table 3. Trends in resistance rate of *Acinetobacter* to antibiotics, 2006 to 2010.

Antibiotics	2006	2007	2008	2009	2010	R^2	P	95% CI	Trend
Ceftazidime	65.8	69.3	61.2	83.6	93.3	0.67	0.09	–1.99-15.85	Stable
Ceftriaxone	71.0	93.5	87.8	96.1	98.8	0.69	0.08	–1.35-12.99	Stable
Cefepime	51.5	56.2	51.1	76.6	88.2	0.78	0.05	0.28-18.48	Increasing
Aztreonam	55.2	54.3	61.3	84.3	87.4	0.86	0.02	2.42-16.46	Increasing
Imipenem	14.4	17.0	13.9	60.2	86.3	0.79	0.04	1.20-36.20	Increasing
Meropenem	18.9	35.5	23.4	59.4	87.1	0.80	0.04	1.24-30.82	Increasing
Amoxicillin/clavulanate	71.1	75.9	61.7	84.7	94.3	0.49	0.19	–4.91-15.95	Stable
Piperacillin/tazobactam	51.0	57.4	52.8	82.2	91.3	0.81	0.04	1.16-19.92	Increasing
Cefoperazone/sulbactam	8.8	13.0	10.6	43.8	55.4	0.82	0.04	1.61-23.19	Increasing
Amoxicillin	55.8	59.8	57.7	69.6	75.1	0.84	0.03	0 .98-8.70	Increasing
Ciprofloxacin	55.6	87.5	66.7	100.0	82.1	0.35	0.29	–9.79-22.89	Stable
Levofloxacin	61.5	57.8	58.1	75.4	80.1	0.69	0.08	–1.27-12.23	Stable

Table 4. Trends in resistance rate of *Citrobacter* to antibiotics, 2006 to 2010.

Antibiotics	2006	2007	2008	2009	2010	R^2	P	95% CI	Trend
Cefuroxime	56.7	72.4	77.2	69.0	95.0	0.69	0.08	–1.72-16.36	Stable
Ceftazidime	28.6	40.0	56.6	47.1	80.0	0.80	0.04	0.91-1.07	Increasing
Ceftriaxone	37.5	71.4	73.4	75.0	95.0	0.82	0.03	1.59-22.12	Increasing
Cefepime	20.0	43.3	42.9	47.1	33.3	0.19	0.46	–8.38-14.46	Stable
Aztreonam	31.4	43.3	58.5	50.0	63.2	0.78	0.05	0.14-3.92	Increasing
Imipenem	20.0	11.1	15.8	6.9	23.8	0.00	0.93	–10.87-11.55	Stable
Meropenem	10.0	3.4	1.8	9.1	31.6	0.42	0.24	–5.70-15.48	Stable
Amoxicillin/clavulanate	77.1	85.7	85.5	78.8	90.5	0.33	0.31	–3.25-7.23	Stable
Ampicillin/sulbactam	61.9	63.0	69.4	75.0	82.0	0.96	<0.01	3.28-7.16	Increasing
Piperacillin/tazobactam	15.2	14.3	25.0	41.2	52.9	0.92	0.01	4.61-15.85	Increasing
Cefoperazone/sulbactam	11.4	10.3	10.5	42.9	19.0	0.29	0.35	–8.82-18.38	Stable
Amoxicillin	26.5	32.1	44.6	25.8	33.3	0.02	0.81	–7.94- 9.40	Stable
Levofloxacin	20.6	44.8	60.6	64.3	65.4	0.83	0.03	1.75-20.07	Increasing

Table 5. Trends in resistance rate of *Pseudomonas aeruginosa* to antibiotics, 2006 to 2010.

Antibiotics	2006	2007	2008	2009	2010	R^2	P	95% CI	Trend
Ceftazidime	60.8	68.3	65.4	74.4	74.9	0.81	0.04	0.43-6.43	Increasing
Ceftriaxone	81.1	95.0	93.0	96.8	96.2	0.61	0.12	–1.53-7.93	Stable
Cefepime	62.3	65.7	61.2	72.1	64.7	0.17	0.49	–3.38-5.62	Stable
Aztreonam	63.3	68.5	68.8	77.1	74.3	0.80	0.04	0.27-5.85	Increasing
Imipenem	52.5	61.8	51.5	60.5	63.2	0.34	0.31	–3.18-7.20	Stable
Meropenem	45.1	59.7	50.1	59.1	65.0	0.60	0.13	–2.01-9.85	Stable
Amoxicillin/clavulanate	95.8	94.5	92.3	97.1	95.5	0.03	0.78	–1.85-2.25	Stable
Piperacillin/tazobactam	65.1	66.8	59.5	73.2	70.2	0.25	0.39	–3.57-6.89	Stable
Cefoperazone/sulbactam	47.2	48.7	40.4	62.8	59.4	0.44	0.22	–4.18-11.88	Stable
Amoxicillin	57.0	56.2	58.9	63.6	63.2	0.82	0.03	0.29-3.66	Increasing
Ciprofloxacin	61.3	59.2	56.7	64.7	59.7	0.02	0.84	–3.17-3.64	Stable
Levofloxacin	68.6	67.7	66.1	67.2	63.4	0.74	0.06	–2.28-0.09	Stable

Table 6. Trends in resistance rate of *Staphylococcus aureus* to antibiotics, 2006 to 2010.

Antibiotics	2006	2007	2008	2009	2010	R^2	P	95% CI	Trend
Penicillin G	99.4	99.2	96.8	97.7	97.6	0.52	0.17	–1.41-0.39	Stable
Cefazolin	85.5	85.8	70.8	72.4	83.7	0.13	0.55	–9.72-6.32	Stable
Ceftriaxone	84.7	91.3	84.6	95.2	100.0	0.66	0.09	–1.06-7.96	Stable
Cefepime	84.8	89.0	84.4	92.7	88.2	0.24	0.40	–2.39-4.49	Stable
Cefoxitin	82.3	88.1	82.9	89.3	87.7	0.35	0.30	–1.82-4.22	Stable
Piperacillin/tazobactam	77.7	91.3	82.9	90.3	89.0	0.35	0.29	–3.26-7.58	Stable
Amoxicillin	63.1	56.8	66.7	70.5	71.0	0.63	0.11	–1.20-7.10	Stable
Levofloxacin	84.2	77.8	90.0	86.3	78.5	0.01	0.89	–6.30-5.72	Stable
Cotrimoxazole	42.1	46.0	38.4	42.3	22.9	0.54	0.16	–11.32-2.90	Stable
Erythromycin	86.3	86.7	86.0	86.4	77.0	0.51	0.18	–5.30-1.52	Stable
Clindamycin	78.7	76.6	68.5	64.4	63.5	0.93	0.01	–6.36-2.16	Decreasing
Teicoplanin	0.0	1.7	0.0	0.8	0.0	N	N	N	N
Vancomycin	0.0	0.0	0.0	0.0	0.0	N	N	N	N

N : The data is not suitable for statistical analysis.

Discussion

In this study, Gram-negative bacteria were the predominant pathogens causing LRTI. During the study period of the 5 years, the proportion of Gram-negative bacteria changed little. Candida infections had significantly increased while Gram-positive bacteria decreased. Opportunistic pathogens (such as *Candida albicans*) ratio gradually increased, which caused by dysbacteria because of long-term use of antibiotics. *Pseudomonas aeruginosa* remained the most common pathogen (26.5-30.5%) from 2006 to 2009. Wang *et al.* (8) also reported *Pseudomonas aeruginosa* was the most common pathogens causing hospital-acquired lower respiratory tract infections in North China and as found in a study in North America (9). The rate of isolation of *Acinetobacter* increased from 7.5% (2007) to 26.4% (2010) becoming the most common isolate in 2010 in this study. As opportunistic pathogen, *Acinetobacter* baumannii-infected patients are mainly immunocompromised critically ill patients, the elderly or the patients using immunosuppressive drugs. In this study, Most of *Acinetobacter baumannii* infection patients came from department of respiratory medicine, neurology, and intensive care units (ICU), because the patients in these sections were all in critical condition, tracheostomy, long hospital stay, lower immune defense, or suffering from a variety of disease, the bacteria was easy to cross-infection in the form of droplets or aerosols. And the severe resistance of *Acinetobacter baumannii* resulted in the hospital stay of patients who infected with *Acinetobacter baumannii* prolonged resulting in increased cross-infection, so that the isolation rate increased.

The resistance rate of GNB to most antibiotics showed the increasing trend especially for cephalosporins and carbapenems. *Escherichia coli*, *Klebsiella pneumonia* and *Acinetobacter* had high resistance rates to cephalosporins, which were all more than 70% in 2010. This is probably related to the irrational use of cephalosporins in our hospital in recent years. GNB resistant to cephalosporins had been very serious in China, which is different in Europe and America (10-12). Carbapenems was considered as the most effective antibiotic agent against Gram-negative bacteria in the past. But now, the resistance rates of GNB to carbapenems were increasing gradually. In this study, *Klebsiella pneumonia* resistance rate significant increased, which was more than 25% in 2010, possibly related to the prevalence of KPC carbapenemase (13). As more and more multi-resistant *Pseudomonas aeruginosa*, the study found that the efflux pump on the cell membrane of *Pseudomonas aeruginosa* is one of the main reasons of its multi-drug resistance, the outer membrane protein OprM is the most common among six efflux pumps (14).

Due to the wide application of broad-spectrum antibiotics, the resistance rates of *Acinetobacter* to most antibiotics have continually increased during recent decades, resistance to carbapenems is most concerning (15). The MYSTIC program of 2007 demonstrated that 74.1% of isolates were susceptible to meropenem and 78.9% were susceptible to imipenem in Europe, compared with much lower susceptibilities of 51.3% and 52.0% in several Asian countries in the SENTRY program of 2006-2007 (16,17). The emergence of carbapenem-resistant *Acinetobacter* has been described as the sentinel event of antimicrobial resistance. In this study, more than 85% resistance rate was observed in *Acinetobacter* against carbapenems resulting in the isolates rate of multidrug-resistant *Acinetobacter* increased year by year. The results were similar with the Chinese Meropenem Surveillance Study (CMSS), which took place from 2003 to 2008, defined a serious carbapenem resistance problem in *Acinetobacter*. The major mechanism of carbapenem resistance

in *Acinetobacter* is production of OXA β-lactamases, primarily OXA-23, OXA-66 and OXA-58 (13).

No vancomycin-resistant isolate of *Staphylococcus aureus* was found in this 5-year study. Decreasing trend in resistance to clindamycin against *Staphylococcus aureus* was observed. This may related to strengthen the clindamycin-induced experimental in our hospital.

Although antimicrobial agents are an important therapeutic weapon in infectious disease (18), the selective pressure, which may lead to antibiotics resistance, was imposed at the same time. In general, new resistances would be detected soon after introduction of new antimicrobial agents. To cope with resistant bacteria, new antibiotics must be developed, however, it became increasingly difficult to develop new ones (19). To prolong the effectiveness of currently available antimicrobial agents, it is essential to know the pathogen distribution and their antibiotic resistance patterns (20). The pathogen profile and their antibiotic resistance patterns was identified by the present study, it would be help the clinicians to facilitate decision-making.

Our investigation showed that Gram-negative bacteria were the predominant pathogens and that antimicrobial resistance is severe in our hospital, which may be related to illegitimate antibiotic use. The treatment of patients with bacterial LRTI is, therefore, becoming more complicated. In particular, the emergence of resistance to commonly prescribed antimicrobial agent by respiratory tract pathogens has compounded the problem. These results highlight the need for systematic interventions to ensure more consistent application of recommended guidelines for antimicrobial use, especially for the second/third generation cephalosporin and carbapenem. The researchers from our hospital found that the total annual consumption of carbapenem has markedly increased. It increased 192 times in 2009 compared with 2001. The consumption of imipenem/cilastatin, meropenem, and total carbapenem is associated with *Acinetobacter* resistance to piperacillin-tazobactam, ceftazidime, cefepime, amikacin, and levofloxacin (21). The good news is our hospital had formulated the related policy that only the specified senior doctors have the prescription right of above antibiotics.

This 5-year study demonstrated that antimicrobial resistance of pathogens isolated from lower respiratory tracts has become a serious problem with some antibiotics, the hospitals and related government departments should strengthen management of the use of some antibiotics in order to enhance the effectiveness of medication.

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