Epidemiology and microbiology of nosocomial bloodstream infections: analysis of 482 cases from a retrospective surveillance study[*]

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Abstract: In many traditional Chinese medicine (TCM) hospitals, most patients are elderly with chronic diseases. Nosocomial bloodstream infections (nBSIs) are an important cause of morbidity and mortality. A retrospective surveillance study was performed to examine the epidemiology and microbiology of nBSIs in a TCM hospital from 2009 to 2011. A total of 482 patients with nBSIs were included in the study period. The incidence rate was 5.7/1000 admissions. *Escherichia coli* (25.5%) was the most common Gram-negative and coagulase-negative staphylococcus (CoNS) (14.1%) was the most common Gram-positive organism isolated. One-third of the *E. coli* and *Klebsiella pneumoniae* isolated from the nBSIs were the third-generation cephalosporin-resistant. Half of the *Acinetobacter* species isolates were resistant to imipenem. Of all the CoNS isolates, 90.7% were resistant to methicillin. Carbapenems and glycopeptide were the most frequently used for nBSI therapy. Only about one-third of patients (157/482) received appropriate empirical therapy. Septic shock, hemodialysis, Pitt bacteremia score >4, urinary tract infection, and appropriate empirical therapy were most strongly associated with 28-d mortality. The incidence of nBSIs was low in the TCM hospital but the proportion of nBSIs due to antibiotic-resistant organisms was high. A high Pitt bacteremia score was one of the most important risk factors for mortality in nBSIs. Therefore, the implementation of appropriate empirical therapy is crucial to improve the clinical outcome of nBSIs.

Key words: Nosocomial bloodstream infection, Traditional Chinese medicine hospital, Epidemiology, Microbiology
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1 Introduction

Between 575000 to 677000 episodes of bloodstream infections (BSIs) per year have been reported in North America as the cause of 79000 to 94000 deaths annually. Reports from Europe showed that there were over 1.2 million episodes of BSIs with 157000 deaths per year (Goto and Al-Hasan, 2013). It is difficult to obtain precise estimates of nosocomial bloodstream infections (nBSIs) owing to the limited number of studies from nosocomial infection surveillance systems. Several population-based studies reported that 19.1%, 28%, and 35% of the total episodes of BSI were nosocomial in the USA (Uslan *et al.*, 2007), Canada (Lenz *et al.*, 2012), and Finland (Skogberg *et al.*, 2012), respectively, since the 2000s. Patients who developed nBSIs suffered high morbidity

and mortality risks and had to bear heavy financial costs (Mittmann *et al.*, 2012; Kaye *et al.*, 2014). Many changes have recently occurred in the epidemiology of BSIs, particularly due to the emergence of drug-resistant organisms, which has significantly increased the treatment-failure rate and the risk of adverse outcomes (Lambert *et al.*, 2011). In China, nBSIs accounted for one-third of nosocomial infections, followed by lower respiratory tract and urinary tract infections in the intensive care unit (ICU) (Ding *et al.*, 2009).

Traditional Chinese medicine (TCM) is very popular in China. According to the Health Statistics book of 2012, a total of 2831 TCM hospitals accounted for 12.88% of the hospitals in China (2831/21979) (National Health and Family Planning Commission of the People's Republic of China, 2012). Patients with chronic diseases, including hypertension, diabetes, cancer, hematological malignancies, and other illnesses, often chose TCM hospitals for their treatment. Furthermore, post-operative chemotherapy of malignant tumors, diabetes, and chronic obstructive pulmonary disease patients continued to increase in our hospital for nearly a decade (Jiang *et al.*, 2007). These patients often had a long hospital stay, were elderly, and had underlying diseases, which contributed to a higher risk of suffering from nBSIs. However, studies are limited on nBSIs in TCM hospitals and the epidemiology and microbiology of nBSIs are still unclear in TCM hospitals. Therefore, a retrospective survey was performed to evaluate the epidemiological features of nBSIs in a tertiary TCM hospital, in order to describe the characteristics of the species distribution and to identify the factors influencing mortality.

2 Materials and methods

2.1 Study design and data collection

We undertook a retrospective surveillance study of nBSIs in the First Affiliated Hospital of Zhejiang Chinese Medical University in China, from January 2009 to December 2011. The First Affiliated Hospital of Zhejiang Chinese Medical University is a 1200-bed TCM hospital. The nBSI was diagnosed if one or more cultures of the sampled blood yielded a pathogenic organism, at least 48 h after admission. If the bloodstream isolate was a potential skin contaminant (e.g., coagulase-negative staphylococcus (CoNS), *Corynebacterium*, *Bacillus*, or *Propionibacterium*), two or more separate blood culture sets were required for the diagnosis (Weinstein *et al.*, 1983).

The data were obtained from the electronic medical records without any additional tests performed for the purpose of this study. The data collected for each patient included demographic information, predisposing clinical conditions, underlying diseases, microbiological data, as well as the antimicrobial treatment information and the susceptibilities of the causative pathogens.

2.2 Variables and definitions

The main clinical outcome was measured by a 28-d mortality rate. Predisposing clinical conditions included diabetes, neutropenia, septic shock, chemotherapy, parenteral nutrition, hemodialysis, and the usage of invasive devices. Based on the standard definition, septic shock is a medical condition that occurs as a result of severe infection and sepsis (Bone *et al.*, 1992). Underlying diseases included malignancies, neurological dysfunctions, cardiovascular malfunctions, gastroenterological diseases, respiratory dysfunctions, and renal diseases. The acute severity of the illness was retrospectively assessed on the day before the diagnosis of nBSIs using the Pitt bacteremia score. This is a validated index, based on mental status, need for ventilation and vital signs, which has been used in previous studies (Hilf *et al.*, 1989; Lim *et al.*, 2014). Source of infection was determined from clinical and microbiological data and using CDC/NHSN criteria (Horan *et al.*, 2008).

Detailed information was recorded on the antimicrobial drug treatments during the period from 3 d prior to the collection of the first positive blood culture up to 7 d after it. Empirical antibiotic therapy was considered appropriate when an antibiotic, that had *in vitro* activity against the causative organism, was given during the first 48 h. If the isolates were resistant or if the dose or the route of administration was insufficient, treatment was considered to be inappropriate (Pedersen *et al.*, 2003; Schonheyder and Sogaard, 2010; Lim *et al.*, 2014).

The Ethics Committee of our hospital approved the procedures, and the data collected from this study were kept confidential.

2.3 Microbiological test

One or double blood specimens were collected from each patient at different sites within 5 min. The identification of blood isolates was carried out according to routine methods by the staff of the microbiology laboratory in our hospital. Antibiotic susceptibility testing was performed using the modified broth microdilution method. Minimum inhibitory concentration (MIC) breakpoints and quality control protocols were used according to the standards established by the Clinical and Laboratory Standards Institute (2007). Antibiotic susceptibility data was analyzed with WHONET 5.6 software.

2.4 Statistical analysis

The results were expressed as the mean±standard deviation (SD) for continuous variables, or as a proportion of the total number of patients or isolates for categorical variables. Univariate analysis was used to examine the association between predictor variables and the risk of mortality at 28 d. Variables that were statistically significant in the univariate analysis were then included in a multiple logistic regression analysis to eliminate potential confounding factors. For source of infection, central line associated blood stream infection (CLABSI) was used as the baseline category when performing regression analysis, as in the previous study of Melzer and Welch (2013). This was chosen because CLABSIs are well defined and are associated with a large number of BSIs. *P* values of <0.05 were considered to be statistically significant. The SPSS 16.0 for Windows software package (Version 16.0) was used for this analysis.

3 Results

3.1 Study population and patient characteristics

During the three-year study period, there were 482 significant nBSI episodes. The incidence rate of nBSIs was 5.7/1000 hospital admissions. Patient characteristics and distribution of nBSIs are shown in Table 1.

3.2 Microbiological features

The poly-microbial accounted for 27 out of 482 episodes (5.6%). Of all the nBSI isolates,

Table 1　Patient characteristics of the 482 patients with nBSIs

Parameter	Value[*]
Patient demographics	
Age (year)	62.96±21.4
Male	267 (55.4%)
nBSI distribution	
ICU	127 (26.3%)
Hematology	108 (22.4%)
Oncology	80 (16.6%)
Others	167 (34.6%)
Underlying disease	
Solid tumor	124 (25.7%)
Hematological malignancy	104 (21.6%)
Gastroenterology	53 (11.0%)
Neurologic	43 (8.9%)
Respiratory	36 (7.5%)
Cardiovascular	29 (6.0%)
Renal	16 (3.3%)
Invasive operation	
Central venous catheter	382 (79.3%)
Urinary catheter	229 (47.5%)
Ventilator	126 (26.1%)
Surgery	87 (18.0%)
Organism	
Gram-negative	298 (61.8%)
Gram-positive	162 (33.6%)
Fungi	22 (4.6%)
10-d antimicrobial drug	479 (99.4%)
Appropriate empirical therapy	157 (32.6%)
28-d mortality	81 (16.8%)

[*] Values are expressed as number of patients (percentage), except age (mean±SD)

Gram-negative organisms were the cause of approximately three-fifths (61.8%); Gram-positive organisms accounted for 33.6%; and, fungi accounted for only 4.6%. *Escherichia coli* (25.5%) was the principal organism responsible for nBSIs, followed by CoNS (14.1%) and *Klebsiella pneumoniae* (11.2%). When analyzed by the clinical department, the following patterns emerged: *E. coli*, *K. pneumoniae*, and *S. aureus* were the top three isolated pathogens for the general wards, except for the ICU, where CoNS (29, 22.8%) and *Acinetobacter* spp. (17, 13.4%) were more frequently isolated (Table 2).

Table 2 Distribution of the most frequently isolated pathogens causing nBSIs and number of deaths caused by nBSIs in different clinical departments

Pathogen	No. of patients (No. of deaths)[*]				
	ICU (*n*=127)	Hematology (*n*=108)	Oncology (*n*=80)	Others (*n*=167)	Total (*n*=482)
CoNS	29 (7)	8 (1)	6 (0)	25 (0)	68 (8)
E. coli	13 (2)	29 (5)	30 (4)	51 (2)	123 (13)
A. baumannii	17 (14)	2 (2)	0 (0)	3 (1)	22 (17)
S. aureus	16 (3)	8 (1)	11 (0)	18 (1)	53 (5)
K. pneumoniae	14 (3)	16 (7)	8 (3)	16 (2)	54 (15)
P. aeruginosa	3 (1)	13 (4)	1 (0)	4 (2)	21 (7)
E. faecium	8 (4)	7 (3)	4 (0)	5 (1)	24 (8)

[*] Number of the most common pathogens associated with death in nBSI patients

3.3 Antimicrobial susceptibility

Antimicrobial resistance levels for the most common organisms causing nBSIs are shown in Tables 3 and 4. Methicillin resistance was detected in 60.0% of the 30 *S. aureus* and 90.7% of the 54 CoNS isolates (Table 3). Resistance to the third-generation cephalosporins was found in 38.6% of the 105 *E. coli* and 35.5% of the 31 *K. pneumoniae* isolates in nBSI patients (Table 4). Extended-spectrum β-lactamase (ESBL)-positive *E. coli* and *K. pneumoniae* accounted for 79.8% and 57.1% of isolates, respectively. Imipenem resistance was only detected in 6.1% of the 114 *E. coli* and 6.5% of the 31 *K. pneumoniae* isolates. However, resistance to imipenem was observed in 50.0% of *Acinetobacter* spp. isolates.

3.4 Antimicrobial drugs

A total of 479 patients (99.4%) used antibiotics during the period from 3 d before the collection of the first positive blood culture to 7 d after it. Of those, 85.2% used antibiotics before blood specimen collection. Only about one-third of patients (157/482) received appropriate empirical therapy (Table 1). Carbapenems were the antimicrobial drugs that were the most frequently given (*n*=208; 43.2%), followed by glycopeptides (*n*=128; 26.6%) and cefoperazone-sulbactam (*n*=123; 25.5%), as shown in Fig. 1.

3.5 Clinical outcomes and risk factors for the 28-d mortality

The overall 28-d mortality rate in all the patients with nBSIs was 16.8% (81/482). The top three pathogens associated with the fatalities included *Acinetobacter* spp., *Enterococcus faecium*, and *Pseudomonas aeruginosa*, with mortality rates of 77.3% (17/22), 33.3% (8/24), and 29.2% (7/24), respectively.

Table 3 Rates of antimicrobial resistance among Gram-positive bacteria most frequently isolated from patients with nBSIs

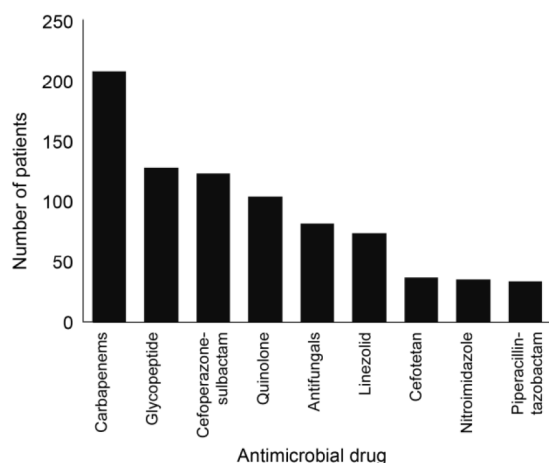| Antimicrobial drug	n_{ri}/n_{it} (% resistant)		
	S. aureus (*n*=53)	CoNS (*n*=68)	*Enterococcus* (*n*=35)
Ampicillin			12/18 (66.7%)
Ampicillin-sulbactam	8/19 (42.1%)	16/28 (57.1%)	
Cefazolin	9/18 (50.0%)	17/28 (60.7%)	
Ciprofloxacin	12/22 (54.5%)	25/34 (73.5%)	
Clindamycin	12/35 (34.3%)	22/57 (38.6%)	
Co-trimoxazole	7/25 (28.0%)	14/44 (31.8%)	
Erythromycin	20/35 (57.1%)	47/57 (82.5%)	25/28 (89.3%)
Gentamicin	16/37 (43.2%)	34/61 (55.7%)	
Levofloxacin	24/34 (70.6%)	43/59 (72.9%)	22/30 (73.3%)
Linezolid	3/35 (8.57%)	4/58 (6.9%)	1/28 (3.6%)
Methicillin	18/30 (60.0%)	49/54 (90.7%)	
Nitrofurantoin	1/38 (2.6%)	2/61 (3.3%)	5/27 (18.5%)
Penicillin	35/35 (100)	56/57 (98.2%)	8/26 (30.8%)
Tetracycline	3/23 (13.0%)	8/19 (42.1%)	12/28 (42.9%)
Vancomycin	0/35 (0%)	0/60 (0%)	0/28 (0%)

n_{ri}: number of resistant isolates; n_{it}: number of isolates tested

Although the prevalence rates of CoNS and *E. coli* isolates were the highest in ICU and general wards respectively, the corresponding mortality was not the highest. The pathogen that was most frequently associated with fatality in the ICU was *Acinetobacter* spp. (82.3%, 14/17), while in hematology and oncology it was *K. pneumoniae* (43.8%, 7/16; 37.5%, 3/8) (Table 2).

Table 4 Rates of antimicrobial resistance among Gram-negative bacteria most frequently isolated from patients with nBSIs

Antimicrobial drug	n_{ri}/n_{it} (% resistant)		
	E. coli (*n*=123)	*Acinetobacter* spp. (*n*=22)	*K. pneumonia* (*n*=54)
Ampicillin-sulbactam	78/103 (75.7%)	8/11 (72.7%)	22/32 (68.8%)
Amikacin	12/105 (11.4%)	1/9 (11.1%)	1/31 (3.2%)
Aztreonam	63/105 (60.0%)	7/9 (77.8%)	15/30 (50.0%)
Cefepime	21/105 (20.0%)	6/9 (66.7%)	7/31 (22.6%)
Cefotetan	30/96 (31.3%)	6/25 (24.0%)	
Ceftazidime	33/105 (31.4%)	6/9 (66.7%)	10/31 (32.3%)
Ceftriaxone	48/105 (45.8%)		12/31 (38.7%)
Ciprofloxacin	46/102 (45.1%)	7/11 (63.6%)	23/38 (60.5%)
Co-trimoxazole	48/107 (44.9%)	1/9 (11.1%)	16/31 (51.6%)
ESBL-positive	87/109 (79.8%)		24/42 (57.1%)
Gentamicin	49/107 (45.8%)	1/9 (11.1%)	16/44 (36.4%)
Imipenem	7/114 (6.1%)	4/8 (50.0%)	2/31 (6.5%)
Levofloxacin	53/110 (48.2%)	10/17 (58.8%)	26/44 (59.1%)

n_{ri}: number of resistant isolates; n_{it}: number of isolates tested

Fig. 1 Most frequent use of antimicrobial drugs
The most frequent antimicrobial drug treatments during the period from 3 d prior to the collection of the first positive blood culture up to 7 d after it

Univariate analyses of 28-d mortality are presented in Table 5. A number of variables were statistically significantly associated with 28-d mortality, including septic shock, central venous catheter, urinary catheter, ventilator, hemodialysis, parenteral nutrition, appropriate empirical therapy, Pitt bacteremia score, and source of infection. The results of multiple logistic regression analysis are presented in Table 6. After adjustment for potential confounding factors, we found that septic shock (odds ratio (OR)= 2.77, *P*=0.01), hemodialysis (OR=3.29, *P*=0.012), Pitt bacteremia score >4 (OR=12.88, *P*<0.001), and urinary tract infection (OR=11.12, *P*<0.001) were strongly associated with 28-d mortality from nBSIs, while appropriate empirical therapy was a protective factor for 28-d mortality (OR=0.23, *P*=0.001).

4 Discussion

Hospital surveillance studies on nosocomial infections could be useful to discover specific issues related to species distribution and resistance patterns of the pathogens causing nBSIs. It is essential to evaluate the etiologic agents and clinical symptoms together to make sure that the surveillance data are reliable. Therefore, we performed a clinically oriented surveillance by collecting the data on the defined infections rather than solely evaluating the culture results in this study.

The incidence of nBSIs in this study was 5.7/1000 hospital admissions, which was not as high as expected and close to the incidence levels of the US with 6.0/1000 admissions (Wisplinghoff *et al*., 2004). Other studies reported that the incidence of nBSIs was 11.6 to 15.5 episodes per 1000 admissions in Thailand (Hortiwakul *et al*., 2012) and 16.0 to 31.2 episodes per 1000 admissions in Europe (Rodríguez-Créixems *et al*., 2008). The relatively low incidence rate in this study might be explained by following reasons. One

Table 5 Univariate analysis of 28-d mortality in nBSIs

Risk factor	Adjusted odds ratio (95% CI)	*P* value
Septic shock	4.34 (2.63–7.14)	<0.001
Central venous catheter	3.19 (1.42–7.17)	0.005
Urinary catheter	3.92 (2.30–6.70)	<0.001
Ventilator	1.87 (1.13–3.10)	0.015
Diabetes	0.92 (0.50–1.66)	0.771
Surgery	0.67 (0.34–1.33)	0.254
Hemodialysis	3.07 (1.70–5.56)	<0.001
Chemotherapy	0.62 (0.35–1.08)	0.093
Neutropenia	1.35 (0.73–2.48)	0.340
Parenteral nutrition	2.08 (1.27–3.40)	0.004
Appropriate empirical therapy	0.27 (0.14–0.54)	<0.001
Pitt bacteremia score		
0–1	1	
2–4	2.39 (1.15–4.98)	0.020
>4	14.14 (7.55–26.46)	<0.001
Source of infection		
Central venous catheter	1	
Abdominal infection	0.43 (0.22–0.85)	0.015
Urinary tract infection	7.96 (3.11–20.33)	<0.001
Pulmonary infection	0.25 (0.09–0.73)	0.012
Others/unknown	1.21 (0.62–2.38)	0.575

Table 6 Multivariate logistic regression analysis of 28-d mortality in nBSIs

Risk factor	Adjusted odds ratio (95% CI)	*P* value
Septic shock	2.77 (1.27–6.02)	0.010
Central venous catheter	2.37 (0.71–7.92)	0.161
Urinary catheter	1.75 (0.79–3.87)	0.167
Ventilator	0.77 (0.23–2.52)	0.664
Hemodialysis	3.29 (1.30–8.34)	0.012
Parenteral nutrition	1.44 (0.72–2.87)	0.300
Appropriate empirical therapy	0.23 (0.10–0.56)	0.001
Pitt bacteremia score		
0–1	1	
2–4	0.45 (0.11–1.82)	0.261
>4	12.88 (5.58–29.70)	<0.001
Source of infection		
Central venous catheter	1	
Abdominal infection	1.07 (0.47–2.45)	0.872
Urinary tract infection	11.12 (2.97–41.71)	<0.001
Pulmonary infection	0.29 (0.08–1.02)	0.053
Others or unknown	2.47 (0.87–7.05)	0.090

probable reason might be the low number and incorrect timing of blood cultures, which may have a significant effect on diagnostic of BSIs (Rampini *et al.*, 2011; Schmitz *et al.*, 2013). Another reason might be the small proportion of surgical and critically ill patients in our hospital. Many studies showed that these patients had a significantly higher incidence of nBSIs (Ding *et al.*, 2009; Trethon *et al.*, 2012). The incidence of nBSIs was up to 34.25/1000 in the cardiac surgery ICUs (Trethon *et al.*, 2012).

E. coli (25.5%), CoNS (14.1%), and *K. pneumoniae* (11.2%) were the top three bacteria isolated in this study. The patterns of bacterial distribution in this study were consistent with those reported in a teaching hospital in Beijing (Lu *et al.*, 2013) and the nationwide surveillance research of China (Wei *et al.*, 2012). In the present study, antibiotic resistance within the group of Gram-negative bacteria was worrisome, especially in the case of *Acinetobacter* spp. with a rate as high as 50% for resistance to imipenem. Imipenem-resistant *Acinetobacter* spp. mainly occurred in ICU. Since resistance to imipenem was usually associated with multidrug resistance, very few antibacterials remain potent (Ye *et al.*, 2010). This could explain why patients with *Acinetobacter* spp. infection had the highest mortality rate (82.3%, 14/17).

As for the use of antibiotics, almost every patient was treated with broad-spectrum antibiotics. About 85.2% of them used the antibiotics before blood specimen collection, which was much higher than the 20% reported by a multi-center study and included the 1100 ICU patients with nBSIs (Tabah *et al.*, 2012). However, compared with that study, the most frequent use of antibiotics for treating BSIs was the same; they were carbapenems and glycopeptides. Moreover, only one-third of patients (157/482) received appropriate empirical therapy in our hospital, which is much lower than those in other hospitals (Townell *et al.*, 2014).

In the present study, septic shock, hemodialysis, Pitt bacteremia score >4, and source from urinary tract infection were shown to be the most common risk factors for the 28-d mortality of nBSI. The Pitt bacteremia score is a marker of severity of illness in patients with nBSIs and patients with scores >4 are considered to be critically ill. In line with the results of previous studies (Neuner *et al.*, 2011; Retamar *et al.*, 2011; Melzer and Welch, 2013), in our hospital the Pitt bacteremia score was strongly correlated with 28-d mortality. Compared with CLABSI, we demonstrated a significant association between urinary tract

source of BSI and death at 28 d. This result has also been validated in a multi-center study in the UK (Melzer and Welch, 2013). However, appropriate empirical therapy can protect patients from mortality at 28 d. The mortality rate was reduced by approximately 4-fold in patients receiving appropriate empirical therapy compared to those without (OR=0.23, *P*=0.001). As shown in other studies, appropriate empirical antibiotic treatment has been known to be the most effective treatment for BSIs (Sogaard *et al.*, 2011) and inappropriate empirical antibiotic therapy has been one of the most important risk factors for mortality in nBSIs (Tabah *et al.*, 2012). Therefore, how to improve the empirical use of antibiotics in the early period of BSIs in order to reduce the 28-d mortality in our hospital should be elaborated in future studies.

In conclusion, the incidence of nBSIs was low in the TCM hospital but the proportion of nBSIs due to antibiotic-resistant organisms requires more attention. Efficient control methods are needed to decrease antibiotic drug resistance and to ensure patients receive effective treatment. A high Pitt bacteremia score was identified as one of the most important risk factors for mortality in nBSIs. Adequate empirical therapy is independently associated with decreased mortality in patients with nBSIs. Therefore, programs to improve the quality of empirical therapy in patients with suspected nBSIs and optimization of definitive therapy should be implemented.

Compliance with ethics guidelines

Jian-nong WU, Tie-er GAN, Yue-xian ZHU, Jun-min CAO, Cong-hua JI, Yi-hua WU, and Bin LV declare that they have no conflict of interest.

This article does not contain any studies with human or animal subjects performed by any of the authors.

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中文概要

题　目：医院获得性血流感染的流行病学和病原学特征分
　　　　析：482 例感染病例的回顾性调查
目　的：分析某三级中医院医院获得性血流感染（nBSIs）
　　　　的流行病学和病原学特征，探索影响 28 天病死
　　　　率的相关危险因素。
创新点：纳入 2009~2011 年所有确诊的血流感染病例，而
　　　　非只依靠血培养结果做判定。收集包括患者的基
　　　　础性疾病、侵入性操作等感染相关危险因素、标
　　　　本送检及抗菌药物使用情况等全面的临床资料，
　　　　分析了 nBSIs 的发生率、病区分布、人群分布、
　　　　病原体分布、细菌耐药性及病死率，并对影响死
　　　　亡的危险因素进行了多因素分析。
方　法：采用回顾性调查的方法，从病历资料中获得预先
　　　　设置好的相关信息。病原体的分离鉴定和药敏检
　　　　测由医院微生物实验室专职人员完成。使用
　　　　WHONET5.6 软件对药敏结果进行分析。采用
　　　　SPSS 16.0 对所有数据进行统计分析，死亡危险因
　　　　素判定先用单因素分析，再用多因素 Logistic 回
　　　　归分析。
结　论：某三级中医院 nBSIs 的发生率为 5.7/1000 入院人
　　　　数，大肠埃希菌和凝固酶阴性的葡萄球菌（CoNS）
　　　　是检出最多的两种细菌。约有 1/3 的肠杆菌对第
　　　　三代头孢菌素耐药（表 4），90.7%的 CoNS 对甲
　　　　氧西林耐药（表 3）。碳青霉烯类和糖肽类是用
　　　　于治疗 nBSIs 使用最广泛的两类抗生素（图 1）。
　　　　感染性休克、血液透析、Pitt 菌血症得分>4 和尿
　　　　路感染是 28 天死亡的危险因素，而合理的经验
　　　　性用药可以明显改善预后（表 6）。
关键词：医院获得性血流感染；中医院；流行病学；
　　　　病原学