

REPORT

Distribution and clinical characteristics of pathogenic bacteria causing catheter-related bloodstream infections

Hong-mei LI

Hospital Infection Management Department, Xinxiang Central Hospital, Xinxiang City, Henan Province, China

Abstract: This paper on analysis pathogenic bacterial distribution of central veins Catheter-related Blood-Stream Infection (CRBSI) and clinical features of different infection. Ninety-one patients with CRBSI were selected, to analyze and research for etiological distribution, clinical characteristics, inflammatory markers and prognosis. Among the 91 cases, 31 cases were infected by *Candida*, accounting for 34.1%; 31 cases were infected by Gram-negative bacilli, accounting for 34.1%; 29 cases were infected by Gram-positive cocci, accounting for 31.8%. The CRBSI clinical features of *Candida* and Gram-negative bacilli high fever and chills, and Gram-positive coccal moderate fever, chills. The pathogens CRBSI inflammatory markers in these 3 groups all were increased, but, the CRBSI inflammatory reaction of *Candida* and Gram-negative bacilli were more severe, the CRBSI fatality rate by *Candida* was high ($P<0.05$). *Candida*, Gram-negative bacilli and Gram-positive cocci were all the CRBSI common pathogenic bacterium. It shall pay attention to etiology research, at the same time, it shall take empiric therapy to decrease CRBSI fatality rate based on clinical features.

Keywords: Gram-negative bacteria infection, Gram-positive bacterial infection, *Candida*, CRBSI.

INTRODUCTION

Recent years, the increase in invasive operation acrosses the incidence of catheter-related bloodstream infection (CRBSI) hanging, therefore, CRBSI become the main hospital infection. Literature had reported that the most common CSBSI pathogenic bacteria belong to coagulase negative *Staphylococcus*, especially the *Staphylococcus epidermidis*, followed as the *Staphylococcus aureus*, *Candida* spp, *Enterococcus*, *Enter* bacterium and *Acinetobacter* (Tarpatzi *et al.*, 2012 and Manian, 2009). However, there was rare reports on CRBSI clinical characteristics induced by different bacterial genres. This study has retrospectively analyzed the data of the 91 CRBSI patients.

MATERIAL AND METHODS

General material

From February 2011 to October 2012, 91 cases were diagnosed as CRBSI in Xinxiang Central Hospital. CRBSI clinical patient diagnosis standards, reference of prevention and treatment of intravascular catheter related infections guide (2007) was consulted. 55 cases of males, 36 cases of females, aged 18-89 years old, average being 63 years. Among these patients, 47 cases belonged to surgical department, 32 cases from ICU, 5 cases from comprehensive internal medical department, 6 cases from renal medical department and 1 case from oncology department.

Method

This study recorded patients' age, basic diseases, indwelling time of central venous catheter, antimicrobial drug intake history, clinical manifestation, etiology, peripheral blood in leukocyte count, C-reactive protein (CRP), pro-calcitonin (PCT) and prognosis. Bacterial cultivation was adopted the sterile broth tube qualitative method. Bacterial identification was done by VITEK automatic bacteria identification system or API method. CRP detection was done by immune turbidimetry, using Siemens BN-II automatic protein analyzer. PCT detection was done by the immune chemiluminescence method (French Merieux Minivifks automated microplate ELISA analyzer).

STATISTICAL ANALYSIS

All the data were processed by SPSS 13.0 software. Measurement data was marked as average fig. \pm standard deviation ($\bar{x} \pm s$), comparison between groups was analyzed by single factor variance, the comparison between two groups was tested by q , count data were tested by χ^2 , $P<0.05$ was for the statistically significant difference.

RESULTS

Distribution of central venous catheter pathogen

Among 91 cases of CRBSI pathogens, 31 strains of *Candida*, accounting for 34.1%, of which mainly were *Candida parapsilosis* and *Candida albicans*. There were 31

*Corresponding author: e-mail: zmeditlm@163.com

strains of Gram-negative bacterial (G^+ bacillus), accounting for 34.1%, of which mainly were *Escherichia coli* and *Klebsiella pneumoniae*. There were 29 strains of Gram-positive bacterial (G^+ bacillus), accounting for 31.8%, of which mainly was staphylococcus epidermidis; seen as table 1.

Clinical feature of CRBSI caused by 3 types of pathogens

The 91 cases of patients with CRBSI were mainly from general surgery and general ICU, distribution department details are shown in table 2. When patients were diagnosed with CRBSI, the difference of the indwelling catheter days of these 3 groups and leucocyte profile differences did not show statistical significance ($P>0.05$); In the Candida group, the ratio of vein high nutrition and broad-spectrum antibiotics were higher than Gram-negative bacilli and the Gram-positive cocci group ($P<0.05$); The patients' temperature and CRP of Candida group and Gram-negative bacilli group were higher than in Gram-positive cocci group ($P<0.05$); The highest incidence frequency of chills during fever was Candida group, following by Gram-negative bacilli group, and Gram-positive cocci; the PCT of Gram-negative bacilli group was the highest, while, the PCT in Candida group and Gram-positive cocci had no obvious differences. Among 91 cases of patients, 12 had died, accounting 13.2%. Candida group was at top, as shown in table 3.

DISCUSSION

As reported in foreign literature, the main pathogenic bacteria which caused CRBSI were Gram-positive cocci, such as Staphylococcus epidermidis, Staphylococcus aureus and Enterococcus; followed by Gram-negative bacteria, such as *Escherichia coli*, *Enterobacter cloacae*, *Acinetobacter*, *Pseudomonas aeruginosa* and *Candida albicans*. The constituent ratio of CRBSI pathologic bacteria in Xinxiang Central Hospital was Candida, Gram-negative bacilli and Gram-positive cocci, which indicated Candida and Gram-negative negative bacilli being the main pathogenic bacteria of CRBSI. The distribution of CRBSI department indicated general surgery department and ICU being the key monitoring departments.

Within 10 days after catheter placement, the CRBSI pathogenic bacteria mainly were from local skin, most belonged to staphylococcus epidermidis, Staphylococcus aureus, which could spread along with the tube into tube tip; 10 days of catheter placement, the CRBSI pathogenic bacteria mainly were from pipe joint, having contamination by medical staff during the operation, then caused cavity engraftment and CRBSI, the pathogenic bacteria were mainly Gram-negative bacilli, *Gandida albicans* and *Candida glabrata* (Cairo, 2007). Among the 3 groups of this study, the infection occurrence time

between the 3 groups had no significant difference, all were infected after 10 days, which indicated the potential pathogens could not be judged based on the time of catheter placement.

It was reported that, intravenous high nutritional value and application of broad-spectrum antibiotics were the risk factors of fungus CRBS (Olaechea *et al.*, 2011). The application ratio of vein high nutrition and broad spectrum antibiotics in CRBSI Candida group were higher than the CRBSI caused by bacteria, which was consistent with literature reports. At the same time, the ratio of tumor patients of Candida and Gram-negative bacterial CRBSI group was higher than that in Gram-positive bacteria CRBSI group, which indicated tumor patient were more inclined to develop the complication of Candida and Gram-negative CRBSI.

The patients' temperature in Gram-positive bacterial CRBSI group was moderate fever, while the patients' temperature in Candida and Gram-negative bacterial CRBSI group were higher than that in Gram-positive bacterial CRBSI group. It indicated the systemic inflammatory reflection in Candida and Gram-negative bacterial CRBSI group could be more severe, which may be associated with the pathogen attack. In Gram-negative bacterial CRBSI group, the dominating ratio of *Escherichia coli*, *Klebsiella pneumoniae* and Candida had strong pathogenicity. In Gram-positive bacterial CRBSI group, the coagulase negative staphylococci were in a dominant advantage and with low pathogenicity. It may be the reason for the difference on clinical features.

The leukocyte count was still the common index used for measuring the diagnostic profile of bacterial infection. In this study, the leukocyte count of the CRBSI in the 3 groups had increased, without statistically significant differences. Therefore, it could not estimate the possible pathogens based on leukocyte count. CRP concentration helped to evaluate the degree of infection and its progression. The literature reported that the CRP of less than 50mg/L was due to the relatively low inflammatory reaction, CRP of more than 100 mg/L was due to severe reaction (Clare *et al.*, 2008). In this study, the CRP concentrations were significantly higher than 50 mg/L, the average of CRBSI level in Candida and Gram-negative bacterial group was higher than 95mg/L, of which was higher than that of CRBSI in Gram-positive bacterial group. But the CRP level of Candida and Gram-negative bacteria had no significant difference. This indicated the CRBSI of Candida and Gram-negative bacteria could cause more severe inflammatory reaction.

PCT is mainly secreted by thyroid C cells under the stimulus of bacterial endotoxins and inflammatory cytokines. As to reports for CRBSI caused by Gram-negative bacteria, the PCT increase was higher than

Table 1: The Distribution of Pathogens in CRBSI

Pathogens	Strain (%)	Pathogens	Strain (%)
<i>Candida</i>	31 (34.1)	<i>Acinetobacter lwoffii</i>	1 (1.1)
<i>Candida parapsilosis</i>	11 (12.1)	<i>Achromobacter xylosoxidans</i>	1 (1.1)
<i>Candida albicans</i>	10 (11.0)	<i>Enterobacter cloacae</i>	1 (1.1)
<i>Candida tropicalis</i>	4 (4.4)	<i>Serratia marcescens</i>	1 (1.1)
<i>Candida glabrata</i>	3 (3.3)	Gram-positive coccus	29 (31.8)
<i>Candida lusitanae</i>	1 (1.1)	<i>Staphylococcus aureus</i>	13 (14.3)
<i>Candida guilliermondii</i>	1 (1.1)	<i>Staphylococcus aureus</i>	5 (5.5)
<i>Candida famate</i>	1 (1.1)	<i>Staphylococcus hominis</i>	4 (4.4)
Gram-negative bacilli	31 (34.1)	<i>Enterococcus faecalis</i>	2 (2.2)
<i>Escherichia coli</i>	10 (11.0)	<i>Enterococcus faecium</i>	2 (2.2)
<i>Klebsiellar pneumonia</i>	7 (7.7)	<i>Hemolytic enterococcus</i>	1 (1.1)
<i>Pseudomonas aeruginosa</i>	4 (4.4)	<i>Staptococcus lentus</i>	1 (1.1)
<i>Acinetobacter baumannii</i>	3 (3.3)	<i>Staphylococcus saprophyticus</i>	1 (1.1)
<i>Stenotrophomonas maltophilia</i>	3 (3.3)		

Table 2: The distribution of clinical departments in 3 groups of patients

Group	Quantity	General Surgery Department	ICU	Renal Medical Department	General Internal Medical Department	Anorectal Surgery Department	Oncology Department
Candida	31	18	11	0	2	0	0
Gram-negative bacillus	31	12	10	0	2	6	1
Gram-positive cocci	29	11	11	6	1	0	0

Table 3: Comparison of clinical features among 3 groups

Group	N	Catheter Set Days (days)	Intravenous high nutritional value	Broad spectrum antibiotics application	Tumor	Temperature (□)
Candida	31	16.1±9.2	15 (48.4)	16 (51.6)	16 (51.6)	39.3±0.5
G-negative Bacillus	31	17.2±8.0	4 (12.9) ^a	8 (25.8) ^a	19 (61.3)	39.1±0.4
G-positive Cocci	29	19.0±8.8	5 (17.2) ^a	6 (20.7) ^a	1 (3.4) ^{ab}	38.8±0.7 ^{ab}
F or χ^2		0.829	11.879 [*]	7.574 [*]	23.822 ^{**}	7.319 ^{**}
Group	N	Chills	WBC ($\times 10^9/L$)	CRP (mg/L)	PCT ($\mu g/L$)	Deaths
Candida	31	24 (77.4)	13.2±6.3	97.9±34.1	1.41±1.28	8(25.8)
Gram-negative Bacillus	31	16 (51.6) ^a	12.4±6.3	116.2±50.8	2.21±1.69 ^a	2 (6.4) ^a
Gram-positive Cocci	29	4 (13.8) ^{ab}	10.3±5.5	70.1±35.8 ^{ab}	1.14±0.99 ^b	2 (6.9) ^a
F or χ^2 value		24.489 ^{**}	1.527	9.52 ^{**}	4.822 [*]	6.543 [*]

* $P < 0.05$, ** $P < 0.01$; ^a for comparison with Candida group, $P < 0.05$, compared with Gram-negative bacillus group, $P < 0.05$; Data format in the table was $\bar{x} \pm s$ or %

Gram-positive bacteria and fungi infected individuals, therefore, PCT concentration has the differential diagnostic significance for different strains of bloodstream infections (Brodzka *et al.*, 2012). In this study, the PCT concentration of CRBSI Gram-negative bacterial group was higher than that of Gram-positive bacteria group and Candida group, which was consistent with reports. While, the PCT concentration of different bacteria is needed for further research on genus differential diagnosis value.

Documents were reported that the CRBSI fatality rate induced by coagulase negative staphylococci was lower than that by non-coagulase negative staphylococci, of which, the candidemia was on top (Xing *et al.*, 2007). In this study, the CRBSI case fatality rate of Candida was also to be the highest, followed by Gram-positive bacterial group, the Gram-negative bacteria group was on a low level. Therefore, the laboratory should strengthen the examination and identification of fungi in bloodstream infections and clinical doctors should give priority attention to this problem. In this study, among 29 cases of

patients with CRBSI in Gram-positive coccal group, 19 cases belonged to coagulase negative staphylococci, while only 2 cases were infected by *Staphylococcus aureus*. Therefore, the mortality difference in coagulase negative *Staphylococcus* and coagulase negative *Staphylococcus* needs further investigation.

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