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ARTICLE

Clinical Analysis of Hospital-acquired Bloodstream Infection in the Elderly

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ABSTRACT

Objective: This study was designed to get epidemiological characteristics, etiology characteristics, prognosis assessment and prognostic factors of hospital-acquired bloodstream infection (HABSI) in the elderly in Chinese PLA General Hospital and aimed at providing a reference for HABSI in the elderly on clinical diagnosis and treatment to improve the prognosis. **Methods:** The clinical data and pathology data of 210 cases of the elderly patients with HABSI from 2009 to 2012 in geriatric wards were retrospectively analyzed. Compare the clinical assessment effects of APACHE-II score, SAPS-II score and SOFA score to HABSI prognosis in the elderly by plotting the receiver operating characteristic curve. Use univariate and multivariate logistic regression analysis to get prognostic factors of HABSI in the elderly. **Results:** Univariate analysis of mortality: Day 1 apache -> 18 II score, lung infection, invasive ventilation, chronic hepatic insufficiency, chronic renal insufficiency, substantive organ malignant tumor, deep venipuncture, indwelling gastric tube indwelling ureter, complicated with shock and acquired bloodstream infections in the elderly patients with 7 days survival state association is significant. Day-1 SOFA score>7, chronic liver dysfunction, chronic renal insufficiency, concurrent shock, hemodialysis and 28-day survival status of patients with acquired bloodstream infection in elderly hospitals were significantly associated. Multivariate unconditioned logistic regression analysis related to death: Day-1APACHE-II score>18, parenchymal malignant tumors, and concurrent shock are independent risk factors for 7-day death in elderly patients with acquired bloodstream infection. Day-1 SOFA score>7, chronic renal insufficiency, and concurrent shock are independent risk factors for 28-day mortality in elderly patients with acquired bloodstream infection. **Conclusion:** The incidence of acquired bloodstream infections in the elderly was 1.37%. The 7-day and 28-day mortality rates were 8.10% and 22.38%, respectively. Concurrent shock is 26.7%. The 28-day mortality rate of concurrent shock patients was 48.21%. The best outcome score for the 7-day prognosis of elderly patients with acquired bloodstream infection was the Day-1APACHE-II score, followed by the Day-1 SOFA score. The best score for the 28-day prognostic assessment was the Day-1 SOFA score.

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1. Introduction

With the increase of tumor incidence, organ transplantation and aging of population, the number of people with low immunity and immunosuppression is increasing. At the same time, various invasive diagnosis and treatment techniques are gradually developed in clinical practice, and the incidence of bloodstream infection is gradually increased. Bloodstream infection is a serious systemic infectious disease. It not only has a high incidence rate, but also has a high mortality rate and high treatment costs. Bloodstream infection is one of the most serious and thorny problems in infectious diseases [1-3].

It is estimated that approximately 250,000 Americans suffer from hospital-acquired bloodstream infections each year [4]. The incidence of hospital-acquired bloodstream infections is 0.6% [5], which is one of the most common hospital-acquired infections. It accounts for about one-tenth of hospital-acquired infections. The incidence rate is high, the hospital stay is long, and the mortality rate is high. It ranks second among the causes of death associated with hospital-acquired infections, second only to hospital-acquired pneumonia [1-3, 6]. Nosocomial acquired bloodstream infection greatly increases the mortality of patients. Bueno-cavanillas et al. thought that it increased the case fatality rate by 3.13 times [7]. Catheter-related bloodstream infection is the most common type of hospital-acquired bloodstream infection. The case fatality rate of catheter-related bloodstream infection reported abroad is 12% ~ 25% [8, 9]. In the United States, catheter-related bloodstream infections can reach up to 28,000 deaths per year and cost $2.3 billion annually [5]. In China, Yang Zuyao et al. [10] conducted a meta-analysis of domestic related literature published from 1990 to August 2008 and found that the mortality rate of bloodstream infection was 28.7%. According to the epidemiological survey on the causes of death in the United States conducted by the centers for disease control and prevention (CDC), compared with the survey results in 1980, sepsis among the causes of death in patients of all ages rose to the top 10 [11].

2. Materials and Methods

2.1 Research Object

All patients with blood stream infection in geriatric ward of our hospital from January 2009 to December 2012 were taken as research objects.

Inclusion criteria: 1) conform to the diagnostic criteria for hospital-acquired bloodstream infections (referring to China's 2001 Ministry of Health Hospital Infection Diagnostic Criteria); 2) ≥65 years old; 3) The medical history is complete.

Diagnostic criteria for bloodstream infections: Diagnostic Criteria for Nosocomial Infections of the Ministry of Health of China in 2001 (Trial)

Clinical diagnosis: Fever >38 °C or hypothermia <36 °C. Chills may accompany and combine one of the following: 1) Have an invasive portal or migratory lesions; 2) Systemic poisoning symptoms without obvious infection focus; 3) There were rash or bleeding spots, enlarged liver and spleen, and increased neutrophilic granulocytes in the blood, accompanied by left nuclear shift, and no other reasons could be explained; 4) The systolic blood pressure is lower than 12 kPa (90 mmHg), or the original systolic pressure drops more than 5.3 kPa (40 mmHg) [12].

Pathogenic diagnosis: One of the following two criteria is met: (1) Pathogenic microorganisms were isolated from blood culture; (2) The antigenic substance of the pathogen is detected in the blood.

Strain identification and drug sensitivity method: Bacteria were identified using the French BioMérieux VITEK2-Compact microbiological automatic appraisal. The fungi were identified by a VITEK2-Compact microbiological automatic identification instrument combined with manual methods. Drug sensitivity method: The K-B method or the MIC method was used for the pathogenic drug sensitivity test.

2.2 Research Method

The medical records are retrieved and consulted, and the data is recorded using an Excel spreadsheet. The details are as follows:

(1) General condition of the patient: Name, inpatient department, hospital number, ID number, gender, age, weight, height, time of bloodstream infection, time of admission, time of leaving the hospital, etc.;

(2) When bloodstream infection occurs, patients are complicated with major basic diseases and invasive medical procedures:

(3) Cardiovascular diseases: Hypertension, coronary atherosclerotic heart disease, arrhythmia, cardiac insufficiency, etc.;

(4) Respiratory diseases: COPD, chronic bronchitis, emphysema, bronchiectasis, pulmonary interstitial fibrosis, etc.;

(5) Digestive system diseases: liver cirrhosis, hepatitis, chronic liver dysfunction, biliary system diseases, etc.;

(6) Endocrine system diseases: diabetes, hyperthyroidism, etc.;

(7) Urinary system diseases: acute renal insufficiency, chronic renal insufficiency, etc.;

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(8) Neurological diseases: previous cerebral infarction, Parkinson's disease, Alzheimer's disease, sequelae of stroke, vertebrobasilar insufficiency, etc.

(9) Tumor: hematological tumor, parenchymal malignant tumor, etc.;

(10) Others: indwelling gastric tube, indwelling catheter, deep vein catheterization, admission to ICU, invasive ventilation, hemodialysis, combined antibiotics before infection.

(11) Pathogen species, infection pathway, primary tumor, migratory foci, drug susceptibility results, etc.

(12) Vital signs and laboratory tests:

A. Recording time: the worst value of blood flow infection 24 hours (Day-1) and bloodstream infection 24 hours (Day1);

B. Record items: body temperature, blood pressure, respiration, pulse, eye reaction, speech response, exercise response, chronic health status, application of mechanical ventilation, application of vasoactive drugs, biochemistry, blood routine, etc.;

C. Outcome of treatment: survival status within 28 days in patients with bloodstream infection.

2.3 Data Sorting

The Excel2007 table is used to organize the data, the quantitative data is recorded in real values, and the qualitative data is assigned. For example, "1" is used for invasive ventilation, and "0" is used for non-invasive ventilation.

According to the acute physiology and chronic health status score (APACHE-II score), simplified acute physiology score (SAPS-II score), sequential organ failure evaluation score (SOFA score), Day-1 and Day1 scores were calculated for the enrolled patients.

2.4 Statistical treatment

Excel 2007 form was used to establish the database. SPSS 17.0 statistical software was used to process the data. The two quantitative data were compared using the t test. The two qualitative data were compared using the χ^2 test. To evaluate the effect of the three scoring systems on the prognosis, a receiver operating characteristic curve (ROC curve) was drawn. Death related factors were analyzed. Univariate analysis was performed using enter method and univariate logistic regression. Multivariate analysis was performed using the Forward:LR method for multivariate unconditional logistic regression analysis. P values, OR values, and 95% confidence intervals for OR values were calculated. A two-sided test was used. $P < 0.05$ indicates that the results are statistically significant.

3. Results

3.1 General Clinical Data

From January 2009 to December 2012, a total of 527 positive blood culture specimens were collected in the geriatric ward of our hospital. After the exclusion of false positive cases, a total of 210 patients with nosocomial acquired bloodstream infection were enrolled. The mean age of the patients was 87.1 6.7 years (65 ~ 104 years), with 198 males (94.3%) and 12 females (5.7%). General clinical data are shown in Table 1.

Table 1. General clinical data

Item	Hospital acquired bloodstream infection
Age	87.1±6.7
Gender	
Male(%)	198(94.3)
Female(%)	12(5.7)
Average maximum temperature (°C)	38.9±0.8
Fever type	
Enecia(%)	104(49.5)
Hyperthermia(%)	72(34.3)
Irregular fever(%)	22(10.5)
low-grade fever(%)	11(5.2)
Hypothermia (≤35°C)(%)	1(0.5)
Chill	
Yes(%)	122(58.1)
No(%)	88(41.9)
Shock(%)	
Yes(%)	56(26.7)
No(%)	154(73.7)
C-reactive protein (mg/dL)	6.75±6.47
White blood cells (10^9/L)	11.43±6.01
Neutrophil percentage	0.81±0.10

Note: The highest body temperature, C-reactive protein, white blood cell, and neutrophil percentage were the highest values for 24 hours of infection.

Among the most enrolled patients, the most common underlying diseases were: 161 cases (76.67%) of cardiovascular diseases, 123 cases (58.57%) of cerebrovascular diseases, and 109 cases (51.90%) of pulmonary infections, 95 cases (45.24%) of parenchymal malignant tumors, 85 cases (40.48%) of chronic renal insufficiency, 74 cases (35.24%) of COPD, 74 cases (35.24%) of diabetes, 27 cases (12.86%) of chronic bronchitis, 27 cases (12.86%) of chronic liver insufficiency and 12 cases (5.71%) of hematological tumors. Invasive medical operations and others: 165 cases (78.57%) of deep venous indwelling

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catheter, 139 cases (66.19%) of indwelling gastric tube, 125 cases (59.52%) of indwelling catheter, 100 cases (47.62%) of invasive ventilation, 21 cases (10.00%) of thoracoperitoneal catheterization, and 14 cases (6.67%) of hemodialysis and 27 cases (12.86%) of ICU.

3.2 Clinical Outcome

The cumulative mortality rates of patients with acquired blood flow in elderly at 7 days, 14 days, 21 days, and 28 days are shown in Table 2.

Table 2. Cumulative mortality in elderly patients with acquired bloodstream infection

Time	Cumulative mortality
7 days	8.10(17/210)
14 days	11.90(25/210)
21 days	18.10(38/210)
28 days	22.38(47/210)

The overall cumulative mortality of the elderly patients with acquired bloodstream infection increased gradually with time within 28 days after infection, which showed a basically linear distribution. This suggests that the mortality rates at week 1, 2, 3, and 4 are essentially the same. In addition, the 28-day mortality from shock was 48.21% (27/56).

3.3 Comparison of the value of three system scores for prognosis evaluation

Bloodstream infection was observed for 7 days and 28 days. The survival status of patients was divided into survival group and death group. The APACHE-II score, the SAPS-II score, and the score of the SOFA scoring system in Day-1 and Day1 were compared to the prognostic value of the above observation endpoint. When the area under the ROC curve is equal to 0.5, it is meaningless. When the area under the ROC curve is 0.5 ~ 0.7, the evaluation effect is general. When the area under the ROC curve is 0.7 ~ 0.9, the evaluation effect is good. When the area under the ROC curve is greater than 0.9, the evaluation effect is excellent. For infectious diseases, the higher the sensitivity, the higher the value of clinical diagnosis and treatment, and the stronger the practicality of prognosis assessment. The higher the specificity, the higher the accuracy of clinical diagnosis. The death was set to 1 and the survival was set to 0. The ROC curves of the above scores at 7 days and 28 days are shown in Figure 1 and Figure 2, respectively. The 95% confidence intervals for the AUC, standard error, P value, and area under each curve for each curve are shown in Table 3.

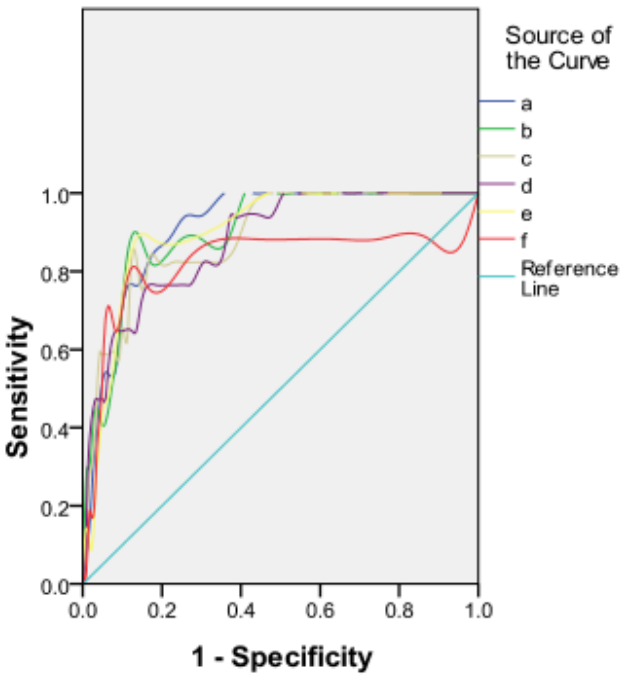

Figure 1. ROC curve

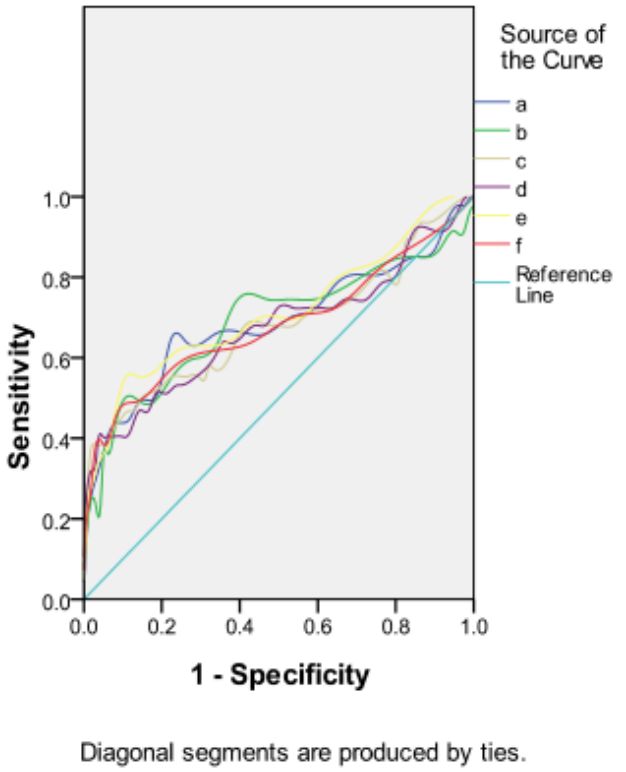

Figure 2. ROC curve

Note: a, b, c, d, e, and f represent Day-1 APACHE-II score, Day1APACHE-II score, Day-1 SAPS-II score, Day1 SAPS-II score, Day-1 SOFA score and Day1 SOFA score, respectively.

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Table 3. Area under the ROC curve for APACHE-II score, SAPS-II score, and SOFA score

Time	Score	AUC	Standard error	P	95% CI
7 days	Day-1APACHE-II	0.910	0.026	0.000	0.859~0.960
	Day1APACHE-II	0.900	0.032	0.000	0.837~0.963
	Day-1SAPS-II	0.887	0.037	0.000	0.814~0.960
	Day1SAPS-II	0.878	0.039	0.000	0.802~0.954
	Day-1SOFA	0.903	0.030	0.000	0.843~0.962
	Day1SOFA	0.821	0.074	0.000	0.676~0.967
28 days	Day-1APACHE-II	0.687	0.053	0.000	0.584~0.790
	Day1APACHE-II	0.687	0.052	0.000	0.584~0.789
	Day-1SAPS-II	0.680	0.052	0.000	0.578~0.782
	Day1SAPS-II	0.675	0.052	0.000	0.572~0.777
	Day-1SOFA	0.713	0.049	0.000	0.616~0.809
	Day1SOFA	0.681	0.053	0.000	0.578~0.784

3.4 Univariate Analysis of Death-related Factors

Bloodstream infections were observed for 7 and 28 days. The Day-1APACHE-II score >18 was included in the observational endpoint for 7 days of risk factors. The Day-1 SOFA score > 7 was included in the observation endpoint for 28 days of risk factors. The effects of exposure and non-exposure to risk factors on the observed endpoint survival status were compared. χ^2 test was performed. Risk factors with $P < 0.05$ were selected. Risk factors were analyzed by enter method with single factor logistic regression. P, OR and OR 95% CI were calculated and the results are shown in Table 4.

3.5 Multivariate analysis of death-related factors

The blood flow was infected for 7 days and 28 days as the end point of observation. The patient's survival status was taken as the dependent variable (death = 1, survival = 0). Factors with $P < 0.05$ at each observation endpoint in table 4 were taken as independent variables. The model was established by using forward:LR multi-factor non-conditional logistic regression analysis method (the introduction probability was 0.05, and the rejection probability was 0.10). The results showed that Day-1APACHE-II score>18, parenchymal malignant tumors, and concurrent shock were independent risk factors for 7-day death in elderly patients with acquired bloodstream infection. Day-1 SOFA score>7, chronic renal insufficiency, and concurrent shock are independent risk factors for 28-day death in elderly patients with acquired bloodstream infection. The specific results are shown in Table 5.

Table 5. Comparison of cognitive function between diabetic group and control group

Time	Risk factor	Partial regression coefficient	Standard error	P	OR	OR95% CI
7 days	Day-1APACHE-II score>18	3.917	1.171	0.001	50.265	5.062~499.095
	Parenchymal malignant tumor	2.091	0.788	0.008	8.096	1.728~37.924
	Concurrent shock	4.218	1.147	0.000	67.912	7.177~642.632
	Constant term	-8.976				

Table 4. Statistical results of single factors related to death in elderly patients with acquired bloodstream infection

Time	Risk factor	Partial regression coefficient	Standard error	P	OR	OR95% CI
7 days	Day-1APACHE-II score>18	3.642	1.043	0.000	38.175	4.945~294.175
	Lung infection	2.067	0.766	0.007	7.898	1.759~35.477
	Invasive ventilation	1.376	0.590	0.020	3.960	1.246~12.581
	Chronic hepatic insufficiency	1.497	0.558	0.007	4.468	1.498~13.328
	Chronic renal insufficiency	2.579	0.768	0.001	13.179	2.928~59.317
	Malignant tumors of parenchymal organs	1.081	0.529	0.041	2.948	1.046~8.039
	Venous catheterization	1.769	0.703	0.012	5.866	1.478~23.281
	Indwelling gastric tube	2.231	1.042	0.032	9.311	1.209~71.708
	Indwelling catheter	2.512	1.041	0.016	12.330	1.603~94.849
	Concurrent shock	4.114	1.046	0.000	61.200	7.878~475.418
28 days	Day-1SOFA score >7	2.020	0.370	0.000	7.536	3.651~15.555
	Chronic hepatic insufficiency	1.219	0.430	0.005	3.383	1.455~7.865
	Chronic renal insufficiency	1.243	0.346	0.000	3.465	1.759~6.825
	Concurrent shock	1.833	0.359	0.000	6.238	3.086~12.611
	Hemodialysis	1.680	0.569	0.003	5.368	1.760~16.370

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28 days	Day-1SOFA score >7	2.269	0.872	0.009	9.667	1.749~53.422
	Concurrent shock	3.590	1.085	0.001	36.224	4.322~303.605
	Chronic renal insufficiency	1.706	0.894	0.056	5.506	0.955~31.728
	Constant term	-7.055				

4. Discussion

Risk factors for bloodstream infections include the patient's underlying disease, medical factors, microbiological factors, and environmental factors. Medical factors mainly include intravascular catheters, indwelling catheters, endoscopic procedures, and abdominal infection drainage tubes [13]. In addition, a multicenter study in the Netherlands also found that long stay in ICU before intravenous catheterization, intravenous catheterization and infusion of intravenous nutrient solution can increase the incidence of catheter-related bloodstream infection, and intravenous catheterization and infusion of antibiotics can reduce the incidence [14]. Other studies have shown that the greatest risk factors for catheter-related bloodstream infection are neutropenia caused by intravenous infusion of nutrient solution and chemotherapy [15-17].

Because this study was a retrospective study, it was difficult to find a matched control group, and statistical analysis of risk factors for bloodstream infection in elderly patients was not completed. Therefore, only the basic diseases of patients and factors such as indwelling ducts were preliminarily counted. Cardiac dysfunction, pulmonary infection, chronic hepatic insufficiency, chronic renal insufficiency, hematological malignancies, diabetes, parenchymal malignancies, indwelling gastric tube, indwelling catheter, hemodialysis are included as risk factors for bloodstream infection. The results showed that 98.57% patients were combined with risk factors, and 80.48% patients were combined with three or more risk factors. This is one of the reasons for the high incidence of acquired bloodstream infections in the elderly.

Early assessment of the prognosis of bloodstream infection is always the direction of clinical workers. It is helpful for clinicians to determine the treatment scope and intensity, rationally use medical resources, improve the quality of medical care, improve the prognosis of patients, and reduce the fatality rate. This study made a statistical analysis of the APACHE-II score, SAPS-II score, and SOFA score for the prognosis of elderly patients with acquired bloodstream infection. Acquired bloodstream infections in the elderly patients with 7 and 28 days of the Day - 1 APACHE -II score, Day1 APACHE -II score, Day 1 SAPS II score, Day1SAPS II score, Day 1 SOFA score, Day1 SOFA score differences were compared. The results showed that P was less than 0.001 and the difference was significant. Therefore, the Day-1 APACHE-II score is the best for the 7-day prognosis of elderly patients with acquired bloodstream infection. The Day-1 SOFA score was the best for 28-day prognosis in elderly patients with acquired bloodstream infection.

5. Conclusion

The incidence of acquired bloodstream infections in the elderly was 1.37%. The 7-day and 28-day mortality rates were 8.10% and 22.38%, respectively. Concurrent shock is 26.7%. The 28-day mortality rate of concurrent shock patients was 48.21%. The best outcome score for the 7-day prognosis of elderly patients with acquired bloodstream infection was the Day-1APACHE-II score, followed by the Day-1 SOFA score. The best score for the 28-day prognostic assessment was the Day-1 SOFA score. Univariate analysis of mortality: Day 1 apache -> 18 II score, lung infection, invasive ventilation, chronic hepatic insufficiency, chronic renal insufficiency, substantive organ malignant tumor, deep venipuncture, indwelling gastric tube indwelling ureter, complicated with shock and acquired bloodstream infections in the elderly patients with 7 days survival state association is significant. Day-1 SOFA score>7, chronic liver dysfunction, chronic renal insufficiency, concurrent shock, hemodialysis and 28-day survival status of patients with acquired bloodstream infection in elderly hospitals were significantly associated. Multivariate unconditioned logistic regression analysis related to death: Day-1APACHE-II score>18, parenchymal malignant tumors, and concurrent shock are independent risk factors for 7-day death in elderly patients with acquired bloodstream infection. Day-1 SOFA score>7, chronic renal insufficiency, and concurrent shock are independent risk factors for 28-day mortality in elderly patients with acquired bloodstream infection.

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