Case Control Study for Hospital Infections Caused by Gram-Negative Bacilli in Emergency Intensive Care Unit

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Abstract

Objective: A case study was performed in EICU to evaluate the potential patient factors associated with hospital infections caused by gram-negative bacilli in EICU.

Methods: We adopted the method of retrospective case-control study and multivariable logistic regression analysis.

Results: Unvaried analysis revealed an association between numerous patient factors and multivariate analysis revealed four factors to be associated independently with hospital infections caused by gram-negative bacilli: Mechanical ventilation, Corticoid use, Length of stay, Coma.

Conclusion: We must have the comprehensive preventive measures to deal with the risk factor of hospital infections in EICU.

Keywords: Hospital infections; Risk factor; Case cohort study

Abbreviations: CI: 95% Confidence Interval; EICU: Emergency Intensive Care Unit; OR: Odds Ratio

Introduction

Almost all hospitals face the problem of the hospital infections. To find out the risk factors and preventive methods of hospital infections in Emergency Intensive Care Unit (EICU), it has become the important method to understand the incidence and affecting factor of hospital infections and provide the basis for the preventing. Many investigations were conducted at home and abroad, but the domestic method described to study before accurately could not measure the strength of contraction between the factors with the hospital infections. For this purpose, adopted method of retrospective case-control study to be conducted. This study was designed to determine the patient risk factors that would prove useful in designing strategies to limit the spread of gram-negative bacilli. Reduction or elimination of these risk factors should extend the usefulness of antibiotic.

Patients and Methods

Patients In EICU, in the Department of Emergency of Changzhen Hospital, Shanghai, we investigated 146 ones as case (on January 2002-December 2006), 35 cases as the control suffered from "Pseudomonas aeruginosa" (60 case), 21, 2013

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by gram-negative bacilli: Risk factors of *Pseudomonas aeruginosa* are Mechanical ventilation, Mechanical ventilation time, Stay in EICU (d), Corticosteroid use, Coma, Length of stay, Tracheotomy, Repeat endotracheal intubations, Intra-abdominal operation; Risk factors of *Klebsiella pneumoniae* are Mechanical ventilation time (d), Length of stay (d), Stay in EICU (d), Tracheotomy, Coma, Intra-abdominal

### Table 1: Univariate Analysis of the Risk Factors for the Hospital Infections Cause by *Pseudomonas aeruginosa*, as opposed to *Escherichia coli*.

| Variable                      | Control (35) | Case (43) | χ²   | P-value |
|-------------------------------|--------------|-----------|------|---------|
| Age (y)                       | 51.4 ± 20.79 | 53.56 ± 18.85 | Z=-0.461 | 0.646   |
| Treatment duration (d)        | 36.96        | 41.57     | 0.000 | 0.994   |
| Time to initial hospital      | 38.74        | 40.12     | 0.790 | 0.371   |
| Mechanical ventilation time   | 27.16        | 49.55     | 0.000 | 0.994   |
| Length of stay (d)            | 31.37        | 46.13     | 0.004 | 0.994   |
| Stay in ICU (d)               | 31.33        | 46.15     | 0.004 | 0.994   |
| Gender (%)                    | female, 12/34.28 | 24/55.81 | 0.026 | 0.872   |
| Hypoalbuminemia (%)           | yes, 11/34.28 | 17/39.53 | 0.551 | 0.458   |
| H₂ blocker (%)                | yes, 24/68.57 | 35/81.39 | 1.722 | 0.189   |
| Hypoglycemia (%)              | yes, 9/25.71  | 17/39.53 | 1.658 | 0.198   |
| Multiple operations (%)       | yes, 7/20     | 14/32.55 | 1.547 | 0.214   |
| Repeat blood                  | yes, 25/71.42 | 35/81.39 | 1.080 | 0.299   |
| hypertension time (d)         | 36.96        | 41.57     | 0.994 | 0.371   |
| Total parenteral nutrition (%)| yes, 23/65.71 | 28/65.11 | 0.003 | 0.956   |
| Cardiopulmonary resuscitation| yes, 10/28.57 | 10/23.25 | 0.286 | 0.593   |
| Urinary catheter (%)          | yes, 30/85.71 | 39/69.09 | 1.046 | 0.306   |
| Length of stay (%)            | yes, 6/17.14  | 15/34.88 | 9.5   | 0.009   |
| Repeat endotracheal intubations| yes, 3/8.57   | 12/27.9  | 4.644 | 0.031   |
| Tracheotomy (%)               | yes, 18/51.42 | 37/66.04 | 11.121 | 0.001  |
| Coma (%)                      | yes, 17/48.57 | 11/61.97 | 1.062 | 0.306   |
| Mechanical ventilation (%)    | yes, 12/34.28 | 31/72.09 | 11.149 | 0.001  |
| Coma (%)                      | yes, 7/20     | 20/46.51 | 5.992 | 0.014   |
| Mechanical ventilation (%)    | yes, 23/65.71 | 12/27.90 | 0.916 | 0.339   |
| Mechanical ventilation (%)    | yes, 22/62.85 | 11/25.58 | 10.984 | 0.001  |

### Table 2: Univariate Analysis of the Risk Factors for the Hospital Infections Caused by *Klebsiella pneumoniae*, as opposed to *Escherichia coli*.

| Variable                      | Control (35) | Case (43) | χ²   | P-value |
|-------------------------------|--------------|-----------|------|---------|
| Age (y)                       | 53.74 ± 21.28 | 48.44 ± 20.13 | 1=1,155 | 0.252   |
| Time to initial hospital      | 38.59        | 40.24     | 0.322 | 0.747   |
| Mechanical ventilation time   | 40.06        | 39.05     | 0.196 | 0.845   |
| Length of stay (d)            | 30.43        | 46.88     | 3=5.354 | 0.000   |
| Hypoalbuminemia (%)           | yes, 11/34.28 | 21/48.83 | 2.417 | 0.120   |
| Repeat endotracheal intubulation (%) | yes, 4/11.42 | 8/18.60 | 0.763 | 0.382   |
| Hemiparetic (%)               | yes, 18/51.42 | 31/72.09 | 3.528 | 0.06    |
| Hypothalamus (%)              | yes, 30/85.71 | 37/86.04 | 1.253 | 0.534   |
| Total parenteral drainage (%) | yes, 11/34.28 | 18/41.86 | 0.899 | 0.343   |
| Corticosteroid use (%)        | yes, 14/40    | 24/55.81 | 1.931 | 0.165   |
| Repeat blood                  | yes, 6/17.14  | 8/18.60  | 0.028 | 0.867   |
| Repeat blood transfusions (%) | yes, 26/74.28 | 33/76.74 | 0.063 | 0.801   |
| Hypertension (%)              | yes, 24/68.57 | 25/58.13 | 0.899 | 0.343   |
| Total parenteral nutrition (%)| yes, 11/34.28 | 18/41.86 | 0.899 | 0.343   |
| Tracheotomy (%)               | yes, 19/54.28 | 34/79.07 | 5.442 | 0.020   |
| Coma (%)                      | yes, 7/20     | 23/53.49 | 9.142 | 0.002   |
| Mechanical ventilation (%)    | yes, 24/68.57 | 10/23.25 | 16.114 | 0.000   |
| Mechanical ventilation (%)    | yes, 11/34.28 | 33/76.74 | 0.000 | 0.994   |
| Length of stay 0-10d (%)      | yes, 4/11.42  | 3/7.00   | 0.458 | 0.494   |
| Length of stay 11-20d (%)     | yes, 7/20     | 3/7.00   | 0.087 | 0.567   |
| Length of stay 21-30d (%)     | yes, 8/22.85  | 5/11.62  | 1.752 | 0.186   |
| Length of stay >31d (%)       | yes, 16/45.71 | 32/74.41 | 0.717 | 0.406   |

operation, Mechanical ventilation, Length of stay>31d; Risk factors of *Aerobacter baumannii* are Mechanical ventilation time (d), Intra-
abdominal operation, Mechanical ventilation, Corticosteroid use, as opposed to *Escherichia coli*. Gender, Age, Urinary catheter and so on is not the risk factor (Tables 1-3).

**Multivariable logistic regression analysis of risk factors for hospital infections:** Mechanical ventilation, Corticoid use, length of stay, Coma are the independent risk factors for hospital infections.

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**Table 3:** Univariate Analysis of the Risk Factors for the Hospital Infections Caused By *Aerobacter baumannii*, as opposed to *Escherichia coli*.

| Variable                      | Control (35) | Case (60) | χ² | P-value |
|-------------------------------|--------------|-----------|----|---------|
| Age (y)                       | 51.4 ± 20.79 | 52.48 ± 20.38 | 0.028 | 0.820   |
| Length of stay (d)            | 45.09        | 49.28     | 0.787 | 0.317   |
| Time to initial hospital infection (d) | 48.77       | 47.55    | 0.209 | 0.835   |
| Mechanical ventilation time (d) | 38.84       | 53.34    | 2.556 | 0.111   |
| Gender female (%) yes         | 12 (34.28)   | 25 (41.67) | 0.937 | 0.333   |
| Age (%) >60Y                  | 13 (37.14)   | 22 (36.87) | 0.356 | 0.837   |
| Length of stay (%) >60d       | 6 (17.14)    | 16 (26.67) | 1.128 | 0.293   |
| Hypoaalbuminemia (%) yes      | 11 (31.42)   | 24 (40)    | 0.698 | 0.403   |
| Hypoglycemia requiring insulin (%) yes | 9 (25.71)   | 19 (31.67) | 0.377 | 0.539   |
| Multiple operations (%) no    | 26 (74.26)   | 24 (36.67) | 1.226 | 0.293   |
| Repeat endotracheal intubations (%) yes | 3 (8.57)    | 10 (16.67) | 0.288 | 0.871   |
| Hepatic impairment (%) yes    | 20 (57.14)   | 33 (55)    | 0.041 | 0.893   |
| Repeat blood transfusions (%) no | 32 (88.57)  | 27 (45)    | 0.145 | 0.703   |
| Hypertension (%) yes          | 25 (71.42)   | 45 (75)    | 0.006 | 0.938   |
| Total parenteral nutrition (%) yes | 23 (65.71)  | 35 (58.33) | 0.506 | 0.477   |
| Cardiopulmonary resuscitation (%) yes | 10 (28.57) | 16 (26.67) | 0.04 | 0.841   |
| Urinary catheter (%) yes      | 30 (85.71)   | 54 (90)    | 0.397 | 0.529   |
| Intra-abdominal operation (%) yes | 22 (62.85)  | 21 (35)    | 0.924 | 0.333   |
| Mechanical ventilation (%) >3 weeks | 3 (8.57)    | 19 (31.67) | 0.016 | 0.911   |
| Corticosteroid use (%) yes    | 12 (34.28)   | 37 (61.67) | 8.636 | 0.004   |
| Coma (%) yes                  | 7 (20)       | 24 (40)    | 4.022 | 0.045   |
| Thoracic or abdominal drainage (%) no | 23 (65.71)  | 27 (45)    | 3.050 | 0.051   |

**Table 4:** Multivariate Logistic Regression of the Risk Factors for the Hospital Infections Caused by Gram-Negative Bacilli in EICU.

| Risk factor                                           | Regression coefficient | SE | P | OR | CI 95 |
|-------------------------------------------------------|------------------------|----|---|----|------|
| *Pseudomonas aeruginosa's Mechanical ventilation*     | 1.414                  | 0.433 | 0.001 | 4.112 | 1.758-9.618 |
| *Pseudomonas aeruginosa's Corticosteroid use*         | 1.262                  | 0.578 | 0.029 | 3.532 | 1.137-10.976 |
| *klebsiella pneumoniae's Length of stay*              | 0.994                  | 0.457 | 0.029 | 2.702 | 1.404-6.611 |
| *klebsiella pneumoniae's Coma*                        | 1.588                  | 0.770 | 0.039 | 4.894 | 1.081-22.146 |
| *Aerobacter baumannii's Mechanical ventilation*       | 0.917                  | 0.373 | 0.014 | 22.502 | 1.203-5.203 |

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**Discussion**

Recent years have witnessed, Length of stay which the patients had the hospital infections was prolonged, were independently associated with hospital infections [1,2].

The research showed that length of stay of the case was much longer than the control, and length of stay in ICU of the case increase in significantly with literature. The researchers reported that length of stay for a long time is risk factor of the hospital infections infection. Some investigation showed the number of length of stay were prolonged more than one double [1,3]. The lengths of stay are the risk factor for the infection with *klebsiella pneumoniae*, a dramatic increase was observed when the lengths of stay was greater than 31 days. An explanation of those associations might be the fact that the hospital is an ecological niche, where the use of antimicrobial agents tends to create a selective pressure that promotes the emergence of resistant organisms and predisposes to colonization with such organisms [4].

The Mechanical ventilation time of case cause by *Pseudomonas aeruginosa, Klebsiella pneumoniae* and *Aerobacter baumannii* was longer than Control, they were considered statistically significant. Rank-sum test (Z=-4.679, P=0.000; Z=-3.554, P=0.000; Z=-2.556, P=0.011).

There are many kinds of immunity mechanism in human beings, for example, anatomy barriers, Cough reflect, macrophage and leukocyte-mediated cellular immunity and humeral immunity [5]. Mechanical ventilation destroys anatomy barriers of body. It gave the chance, let the pathogenic bacteria invade body, and led to get hospital infection easily. It was observed by the case of the *Pseudomonas aeruginosa* and *Aerobacter baumannii* [5,6]. Noninvasive ventilation (NIV) was as effective as conventional ventilation in improving gas exchange and was associated with fewer serious complications and shorter stays in the intensive care unit. The use of NIV instead of mechanical ventilation is associated with a lower risk of hospital infections, less antibiotic use, shorter length of ICU stay, and lower mortality [7,8].

Corticosteroid use is one of the risk factors of hospital infections, the group of the *Pseudomonas aeruginosa* was observed. Immune factor was damaged or suppressed by Corticosteroid therapy. It effected on caused by gram-negative bacilli (Table 4).

**Site of hospital infections:** The most common position of infection was lower respiratory tract and lung 54.79% (80/146), the second one was the urinary tract 15.06% (22/146), the 3rd one is in the abdomen cavity 8.21% (12/146), the other is in the chest 6.84% (10/146) and blood 6.84% (10/146), the wound 4.10% (6/146) and catheter 4.10% (6/146).

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host’s lymphocytes, monocytes/macrophages and others: Lymphocytes, Reversible lymphopenia, CD4 depletion (>50% reduction) [9] decreased proliferation and migration of lymphocytes [10], Impaired delayed-type hypersensitivity [11] Impaired natural killer cell cytotoxicity [12] Decreased lymphokine production (interleukin-2, TNF-α, interleukin-12, interferon γ) Th1/Th2 deregulation of T-helper cells (decreased Th1 and increased Th2 cytokine production) Impaired phagocyte effector cell function and cellular immune response [13]. Neutrophils: Impaired phagocytosis, degranulation and oxidative burst [10,14]. Reduced cytokine production [15]. Impaired formation of nitric oxide. Defective adherence to endothelium, extravasations, and chemo taxis [14]. Inhibition of apoptosis [15] Monocytes/macrophages, Reversible monocytopenia (>40% reduction), Impaired phagocytosis and oxidative killing, decreased chemo taxis and migration to sites of inflammation, Impaired maturation of monocytes to macrophages [16].

Above all, as opposed to Escherichia coli, the independent risk factors of hospital infections caused by gram-negative bacilli are: Mechanical ventilation, Corticoid use, Length of stay and Coma.

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