Yu-qi et al., Trop Med Surg 2013, 1:7
DOI: 10.4172/2329-9088.1000155

Tropical Medicine & Surgery

Review Article Open Access

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

WU Yu-qi[1]*, SHAN Hong-wei[2], YU Min[1], QIAN Min[1], ZHANG Xin-Li[1], LÜ Xiao-Ling[1], CHEN Qun-xia[3] and YANG Xin-yi[2]

[1]*Critical Care Medicine, The People's Hospital of Three Gorge University, The First People's Hospital, China*
[2]*Department of Emergency, Shanghai Changzheng Hospital, Second Military Medical University, China*
[3]*Department of Pediatrics, Jinshan Maternal and Child Health Care Hospital, China*

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}: 95% Confidence Interview; 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 became 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) who had hospital infections caused by *Pseudomonas aeruginosa* (43 case), *Klebsiella pneumonia* (43 case) and *Anietobacter baumanniil* (60 case), 35 cases as the control suffered from hospital infections caused by Escherichia coli, case-control study was conducted.

Diagnosis standard

According to hospital infections with the diagnosis standard established by National Ministry of Health, China, 2001.

Contents of the investigation and method

We adopt the method of retrospective case-control study. To fill blank with the factor in the table established.

Statistical analysis

To collect and arrange materials from their medical inpatients, set up data storage system and give a description of analysis. The data were analyzed by using the SPSS. The variables found to be predictors of hospital infections based on unvaried analysis were subjected to multivariable logistic regression analysis in order to identify a subset of variables for predicting infection. A p-value <0.05 was considered statistically significant.

The standard to exclude

The patients of automatic discharge were eliminated; the patients who can be separated by pathogenic bacteria without the infection symptom were eliminated too.

Results

The morbidity rate of hospital infections

On January 2002-December 2006, EICU received the 1950 patients; among in 1950 cases we investigated 146 ones as case who had hospital infections caused by *Pseudomonas aeruginosa* (43 case), *Klebsiella pneumonia* (43 case) and *Anietobacter baumanniil* (60 case). The morbidity rate was 2.94%, 2.94%, 3.07%. Female 61 cases, Male 85 cases.

Risk factors for hospital infections

Unvaried analysis of risk factors for hospital infections caused

***Corresponding author:** WU Yu-qi, The People's Hospital of Three Gorge University, The First People's Hospital, Yichang 443002, Hubei, China, Tel: 15871663872; E-mail: wu926@163.com

Received May 28, 2013; **Accepted** November 19, 2013; **Published** November 21, 2013

Citation: Yu-qi W, Hong-wei S, Min Y, Min Q, Xin-Li Z, et al. (2013) Case Control Study for Hospital Infections Caused by Gram-Negative Bacilli in Emergency Intensive Care Unit. Trop Med Surg 1: 155. doi:10.4172/2329-9088.1000155

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

Variable		Control (35)	Case (43)	χ^2	P-value
Age (y)		51.4 ± 20.79	53.56 ± 18.85	*t=-0.461*	*0.646*
Treatment duration (d)		36.96	41.57	*Z=-0.895*	*0.371*
Time to initial hospital infection (d)		38.74	40.12	*Z=-0.267*	*0.790*
Mechanical ventilation time (d)		27.16	49.55	*Z=-4.679*	*0.000*
Length of stay (d)		31.37	46.13	*Z=-2.860*	*0.004*
Stay in ICU (d)		31.33	46.15	*Z=-2.875*	*0.004*
Gender (%)	female	12 (34.28)	24 (55.81)	0.026	0.872
	male	23 (65.71)	19 (44.18)	—	—
Age (%)	>60	13 (37.14)	15 (34.88)	0.797	0.671
	30-60	14 (40)	21 (48.83)	—	—
	0-30	8 (22.85)	7 (16.27)	—	—
Hypoalbuminemia (%)	yes	11 (31.42)	17 (39.53)	0.551	0.458
	no	24 (68.57)	26 (60.46)	—	—
Hepatic impairment (%)	yes	22 (62.85)	27 (62.79)	0.257	0.612
	no	13 (37.14)	16 (37.20)	—	—
H_2 blocker (%)	yes	24 (68.57)	35 (81.39)	1.722	0.189
	no	11 (31.24)	8 (18.60)	—	—
Hyperglycemia requiring insulin (%)	yes	9 (25.71)	17 (39.53)	1.658	0.198
	no	26(74.28)	26 (60.46)	—	—
Multiple operations (%)	yes	7 (20)	14 (32.55)	1.547	0.214
	no	28 (80)	29 (67.44)	—	—
Repeat blood transfusions (%)	yes	25 (71.42)	35 (81.39)	1.080	0.299
	no	10 (28.57)	8 (18.60)	—	—
Hypertension (%)	yes	9 (25.71)	14 (32.55)	0.435	0.510
	no	26 (74.28)	29 (67.44)	—	—
Total parenteral nutrition (%)	yes	23 (65.71)	28 (65.11)	0.003	0.956
	no	12 (34.28)	15 (34.88)	—	—
Cardiopulmonary resuscitation (%)	yes	10 (28.57)	10 (23.25)	0.286	0.593
	no	25 (71.42)	33 (76.74)	—	—
Urinary catheter (%)	yes	30 (85.71)	39 (90.69)	1.046	0.306
	no	5 (14.28)	4 (9.30)		
Length of stay (%)	>60d	6 (17.14)	15 (34.88)	9.5	0.009
	30-60d	10 (28.57)	19 (44.18)	—	—
	0-30d	19 (54.28)	9 (20.93)	—	—
Repeat endotracheal intubations (%)	yes	3 (8.57)	12 (27.9)	4.644	0.031
	no	32 (91.42)	31 (72.09)	—	—
Tracheotomy (%)	yes	18 (51.42)	37 (86.04)	11.121	0.001
	no	17 (48.57)	5 (11.62)	—	—
Corticosteroid use (%)	yes	12 (34.28)	31 (72.09)	11.149	0.001
	no	23 (65.71)	12 (27.90)	—	—
Coma (%)	yes	7 (20)	20 (46.51)	5.992	0.014
	no	28 (80)	23 (43.49)	—	—
Mechanical ventilation (%)	>3 weeks	3 (8.57)	15 (34.88)	24.605	0.000
	1-2 weeks	5 (14.28)	19 (44.18)	—	—
	<1 week	27 (77.14)	9 (20.93)	—	—
Intra-abdominal operation (%)	yes	22 (62.85)	11 (25.58)	10.984	0.001
	no	13 (37.14)	32 (74.41)	—	—

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)	χ^2	P-value
Age (y)		53.74 ± 21.26	48.44 ± 20.13	t=1.155	0.252
Time to initial hospital infection (d)		38.59	40.24	Z=-0.322	0.747
Treatment duration (d)		40.06	39.05	Z=-0.196	0.845
Mechanical ventilation time (d)		30.43	46.88	Z=-3.554	0.000
Length of stay (d)		32.61	45.10	Z=-2.423	0.015
Stay in ICU (d)		33.29	44.56	Z=-2.187	0.029
Gender (%)	female	10 (28.57)	12 (27.9)	0.004	0.948
	male	25 (71.42)	31 (72.09)	—	—
Age (%)	>60Y	14 (40)	11 (25.58)	1.866	0.393
	30-60Y	14 (40)	22 (51.16)	—	—
	0-30Y	7 (20)	10 (23.25)	—	—
Hypoalbuminemia (%)	yes	11 (31.42)	21 (48.83)	2.417	0.120
	no	24 (68.57)	22 (51.16)	—	—
Repeat endotracheal intubation (%)	yes	4 (11.42)	8 (18.60)	0.763	0.382
	no	31 (88.57)	35 (81.39)	—	—
Hepatic impairment (%)	yes	18 (51.42)	31 (72.09)	3.528	0.06
	no	17 (48.57)	12 (27.90)		
Nasogastric tube (%)	yes	30 (85.71)	37 (86.04)	1.253	0.534
	no	5(14.28)	6 (13.95)	—	—
Thoracic or abdominal drainage (%)	yes	24 (68.57)	25 (58.13)	0.899	0.343
	no	11 (31.42)	18 (41.86)	—	—
Corticosteroid use (%)	yes	14 (40)	24 (55.81)	1.931	0.165
	no	21 (60)	19 (44.18)	—	—
H_2 blocker(%)	yes	26 (74.28)	33 (76.74)	0.063	0.801
	no	9 (27.71)	20 (46.51)	—	—
Multiple operations (%)	yes	6 (17.14)	8 (18.60)	0.028	0.867
	no	29 (82.85)	35 (81.39)	—	—
Repeat blood transfusions (%)	yes	26 (74.26)	33 (76.74)	0.063	0.801
	no	9 (25.71)	10 (23.25)	—	—
Hypertension (%)	yes	11 (31.42)	6 (13.95)	3.457	0.063
	no	24 (68.57)	37 (86.04)	—	—
Total parenteral nutrition (%)	yes	24 (68.57)	25 (58.13)	0.899	0.343
	no	11 (31.42)	18 (41.86)	—	—
Tracheotomy (%)	yes	19 (54.28)	34 (79.07)	5.442	0.020
	no	16 (45.71)	9 (20.93)	—	—
Coma (%)	yes	7 (20)	23 (53.49)	9.142	0.002
	no	28 (80)	20 (46.50)	—	—
Intra-abdominal operation (%)	yes	24 (68.57)	10 (23.25)	16.114	0.000
	no	11 (31.42)	33 (76.74)	—	—
Mechanical ventilation (%)	>3 weeks	2 (5.714)	11 (25.58)	12.905	0.002
	1-2 weeks	6 (17.14)	16 (37.20)	—	—
	<1 week	27 (77.14)	16 (37.20)	—	—
Length of stay 0-10d (%)	yes	4 (11.42)	3 (7.00)	0.458	0.494
	no	31 (88.57)	40 (93)	—	—
Length of stay 11-20d (%)	yes	7 (20)	3 (7.00)	2.928	0.087
	no	28 (80)	40 (93)	—	—
Length of stay 21-30d (%)	yes	8 (22.85)	5 (11.62)	1.752	0.186
	no	27 (77.14)	38(81.39)	—	—
Length of stay >31d (%)	yes	16 (45.71)	32 (74.41)	6.717	0.010
	no	19 (54.28)	11 (25.58)	—	—

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

operation, Mechanical ventilation, Length of stay>31d; Risk factors of *Anietobacter baumanniil* 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 caused by gram-negative bacilli (Table 4).

Variable		Control (35)	Case (60)	χ^2	P-value
Age (y)		51.4 ± 20.79	52.48 ± 20.38	t=-0.228	0.820
Length of stay (d)		45.09	49.28	Z=-0.787	0.431
Time to initial hospital infection (d)		48.77	47.55	Z=-0.209	0.835
Mechanical ventilation time (d)		38.84	53.34	Z=-2.556	0.011
Gender female (%)	yes	12 (34.28)	25 (41.67)	0.937	0.333
	no	23 (65.71)	35 (58.33)	—	—
Age (%)	>60Y	13 (37.14)	22 (36.67)	0.356	0.837
	30-60Y	14 (40)	27 (45)	—	—
	0-30Y	8 (22.85)	11 (18.33)	—	—
Length of stay (%)	>60d	6 (17.14)	16 (26.67)	1.128	0.569
	30-60d	10 (28.57)	15 (25)	—	—
	0-30d	19 (54.28)	29 (48.33)	—	—
Hypoalbuminemia (%)	yes	11 (31.42)	24 (40)	0.698	0.403
	no	24 (68.57)	36 (60)	—	—
Repeat endotracheal intubations (%)	yes	3 (8.57)	10 (16.67)	1.226	0.268
	no	32 (74.41)	50 (83.33)	—	—
Hepatic impairment (%)	yes	20 (57.14)	33 (55)	0.041	0.839
	no	15 (34.88)	27 (45)	—	—
Tracheotomy (%)	yes	18 (51.42)	39 (65)	1.696	0.193
	no	17 (48.57)	21 (35)	—	—
H_2 blocker (%)	yes	24 (68.57)	46 (76.66)	0.747	0.387
	no	11 (31.42)	14 (23.33)	—	—
Hyperglycemia requiring insulin (%)	yes	9 (25.71)	19 (31.67)	0.377	0.539
	no	26 (74.26)	41 (68.33)	—	—
Multiple operations (%)	yes	7 (20)	7 (11.67)	1.222	0.269
	no	28 (80)	53 (88.33)	—	—
Repeat blood transfusions (%)	yes	25 (71.42)	45 (75)	0.145	0.703
	no	10 (28.57)	15 (25)	—	—
Hypertension (%)	yes	9 (25.71)	15 (25)	0.006	0.938
	no	26 (74.26)	45 (75)	—	
Total parenteral nutrition (%)	yes	23 (65.71)	35 (58.33)	0.506	0.477
	no	12 (34.28)	25 (41.66)	—	—
Cardiopulmonary resuscitation (%)	yes	10 (28.57)	16 (26.67)	0.04	0.841
	no	25 (71.42)	44 (73.33)	—	—
Urinary catheter (%)	yes	30 (85.71)	54 (90)	0.397	0.529
	no	5 (14.26)	6 (10)	—	—
Intra-abdominal operation (%)	yes	22 (62.85)	21 (35)	6.924	0.009
	no	13 (37.14)	39 (65)	—	—
Mechanical ventilation (%)	>3 weeks	3 (8.57)	19 (31.67)	10.014	0.007
	1-2 weeks	5 (14.28)	14 (23.33)	—	—
	<1 week	27 (77.14)	27 (45)	—.	—.
Corticosteroid use (%)	yes	12 (34.28)	37 (61.67)	6.636	0.010
	no	23 (65.71)	23 (38.33)	—	—
Coma (%)	yes	7 (20)	24 (40)	4.022	0.045
	no	28 (80)	36 (60)	—	—
Thoracic or abdominal drainage (%)	yes	23 (65.71)	27 (45)	3.305	0.051
	no	12 (34.28)	33 (55)	—	—

Table 3: Univariate Analysis of the Risk Factors for the Hospital Infections Caused By *Anietobaxter baumanniil*, as Opposed to *Escherichia coli*.

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
Anietobacter baumanniil's Mechanical ventilation	0.917	0.373	0.014	22.502	1.203-5.203

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

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).

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 shows 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 *Anietobacter baumanniil* 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 *Anietobacter baumanniil* [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

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 effecter 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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