

# Analysis of pathogenic bacteria and risk factors of neonatal ventilator-associated pneumonia

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World Journal of Biology Pharmacy and Health Sciences, 2024, 19(03), 124–129

Publication history: Received on 16 June 2024; revised on 05 August 2024; accepted on 07 August 2024

Article DOI: <https://doi.org/10.30574/wjbphs.2024.19.3.0477>

## Abstract

**Objective:** To study the pathogenic bacteria and risk factors of neonatal ventilator-associated pneumonia in order to provide a feasible basis for clinical intervention.

**Methods:** Selection object of study from our hospital in October 2019 to December 2020 neonatal intensive care unit 100 cases treated by mechanical ventilation more than 48 h of children, for all children with the summary of the clinical data, study the incidence of neonatal ventilator associated pneumonia, investigation of neonatal ventilator associated pneumonia pathogen at the same time, And summarize the related risk factors.

**Results:** Among the 100 children with mechanical ventilation for more than 48 hours, 20 (20.00%) of them developed ventilator-associated pneumonia. 27 strains of pathogenic bacteria were isolated from 20 children. Through analysis and summary, it can be concluded that the pathogens of neonatal ventilator associated pneumonia were mainly Gram-negative bacteria, 19 strains in total, accounting for 70.37%. In addition, there were 7 strains of Gram-positive bacteria, accounting for 25.92%, and 1 strain of fungus, accounting for 3.70%. *Klebsiella pneumoniae* was the main gram-negative bacteria, with 14 strains, accounting for 51.85%. The risk factors of neonatal ventilator-associated pneumonia were summarized, which were mainly related to delivery mode, length of hospital stay, duration of mechanical ventilation, gestational age, birth weight, number of intubation, 1min Apgar score after birth, and the presence of primary pulmonary diseases. Logistic Regression analysis showed that Intubation more than 2 times was an independent risk factor for neonatal ventilator-associated pneumonia. 0.05, the difference was statistically significant.

**Conclusion:** The pathogenic bacteria leading to ventilator associated pneumonia in newborn infants are mainly Gram-negative bacteria, and the main manifestation is *Klebsiella pneumoniae*. The risk factors leading to ventilator associated pneumonia in newborn infants are manifested in multiple aspects, which require clinical measures for comprehensive intervention, which can effectively ensure the safety of newborn infants.

**Keywords:** Neonatal ventilator; Associated pneumonia; Pathogenic bacteria; Analysis risk factors

## 1. Introduction

As one of the main measures to rescue respiratory failure in critically ill neonates, mechanical ventilation has been widely used in NICU. But it has been accompanied by an increase in ventilator-associated pneumonia (VAP), a common complication in patients on mechanical ventilation. VAP refers to the pulmonary infection that occurs after mechanical ventilation  $\geq 48$  h and has been proved by etiology. VAP is one of the common types of hospital-acquired pneumonia [1]. Ventilator associated pneumonia is a common complication of mechanical ventilation in neonates, with an incidence

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of about 20% in neonatal care units. Ventilator-associated pneumonia is also one of the important causes of nosocomial infectious death of neonates with severe neonates, which can prolong the duration of mechanical ventilation and hospital stay, and increase the cost of treatment [2-3]. This study retrospectively analyzed the clinical data, sputum culture and drug sensitivity results of VAP patients undergoing mechanical ventilation treatment in our NICU to summarize the possible risk factors for the occurrence of neonatal VAP, pathogenic bacterial infection characteristics and bacterial resistance, so as to provide a scientific basis for the empirical antibiotic treatment.

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## 2. Material and methods

**Inclusion and exclusion criteria** Inclusion criteria: (1) hospitalization within 24 h after birth; (2) Meet the diagnostic criteria of ventilator-associated pneumonia [4-5]; (3) Endotracheal intubation was performed after admission, ventilator assisted ventilation and mechanical ventilation time was > 48 h; (4) The families of the children agree to participate in this study. Exclusion criteria: (1) children who abandoned treatment or died during mechanical ventilation; (2) Children with infection of other organ systems.

For general data, 100 neonates who received mechanical ventilation treatment in the First Affiliated Hospital of Bengbu Medical College from October 2019 to December 2020 were selected. The neonates were divided into observation group (n = 20) and control group (n = 80) according to the occurrence of ventilator-associated pneumonia. There was no significant difference between the two groups in sex, delivery mode and single and twin fetuses ( $P < 0.05$ ), which was comparable. See table 1.

The diagnostic criteria of ventilator associated pneumonia were based on the relevant diagnostic criteria in the "Guidelines for the Diagnosis, Prevention and Treatment of Ventilators Associated Pneumonia (2013)" [6] formulated by the Chinese Society of Critical Medicine of the Chinese Medical Association: (1) the onset of Ventilators after 48 h of use; (2) Chest X - ray examination after ventilator use showed invasion of the lung or new inflammatory lesions; (3) pulmonary consolidation signs and/or pulmonary auscultation can be heard and wet rales, and one of the following conditions is satisfied: ① white blood cell count  $> 10 \times 10^9 / L$  or  $< 4 \times 10^9 / L$ , with or without left nuclear shift; ② Fever, body temperature  $> 37.5 \text{ }^\circ\text{C}$ , a large number of purulent secretions appear in the respiratory tract; (3) New pathogenic bacteria were isolated from bronchial secretions after onset.

**Data collection Methods** Clinical data of all children were collected, including gestational age, sex, birth weight, delivery method (necrotomy, natural delivery), length of mechanical ventilation, length of hospital stay, number of intubation, 1min Apgar score, and maternal age.

**Statistical methods** SPSS 25.0 statistical software package was used for data processing. Measurement data were expressed as ( $\bar{x} \pm s$ ) and t test was used. The statistical data were tested by  $\chi^2$  test. The influencing factors of neonatal ventilator-associated pneumonia were analyzed by multivariate logistic regression analysis.  $P < 0.05$  was considered statistically significant.

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## 3. Results

### 3.1. Pathogenic bacteria analysis

In this paper, 20 cases (20.00%) of 100 children with mechanical ventilation for more than 48 hours developed ventilators associated pneumonia. 27 strains of pathogenic bacteria were isolated from 20 children. Through analysis and summary, it can be concluded that the pathogens of neonatal ventilator associated pneumonia were mainly Gram-negative bacteria, 19 strains in total, accounting for 70.37%. In addition, there were 7 strains of Gram-positive bacteria, accounting for 25.92%, and 1 strain of fungus, accounting for 3.70%. *Klebsiella pneumoniae* was the main gram-negative bacteria, with 14 strains, accounting for 51.85%.

### 3.2. Risk factor analysis

Multivariate logistic regression analysis showed that the number of intubation more than 2 times was an independent risk factor for neonatal ventilator-associated pneumonia. 0.05, the difference was statistically significant. See Table 2 for details.

**Table 1** Comparison of related factors between the observation group and the control group

Correlative factor	Number of examples	Control group	VAP Group	$\chi^2$	P
Sex					
Male		49	15	1.313	0.252
Female		31	5		
Delivery mode					
Normal childbirth		21	5	0.013	0.909
Delivery		59	15		
Single/ multiple births					
Single birth		62	16	0.058	0.809
Multiple births		18	4		
Mechanical ventilation time					
<3		23	1	21.148	0.000
3~7		42	10		
>7		15	9		
Length of stay					
<2		40	4	8.268	0.016
2~4		30	9		
>4		10	7		
Gestational age					
<28		2	4	8.752	0.013
28~37		41	9		
>37		37	7		
Birth weight					
<1000		2	2	6.131	0.047
1000~2500		36	13		
>2500		42	5		
Pluof times					
1		50	7	6.640	0.036
1~3		27	10		
>3		3	3		
1min Apgar score					
<7		7	5	4.160	0.125
4~7		25	6		
>7		48	9		
Maternal age					
<25		20	4	3.656	0.161

25~35		39	9		
>35		11	7		

**Table 2** Analysis of independent risk factors for the occurrence of ventilator-associated pneumonia in neonates

Factor	B	SE	Wald	P	OR( 95%CI )
Mechanical ventilation time	0.837	0.617	1.840	0.175	(0.689~7.742)
Length of stay ; LOS	1.285	0.705	3.319	0.069	(0.907~14.397)
Gestational age	0.504	0.582	0.750	0.386	(0.529~5.177)
Birth weight	1.019	0.613	2.760	0.097	(0.833~9.219)
Pluof times	1.204	0.594	4.106	0.043	(1.040~10.691)
constant	-3.484	0.778	20.044	0.000	

#### 4. Discussion

Domestic studies have shown that the occurrence of neonatal ventilator associated pneumonia is related to a variety of factors [7-8]. The results of this study showed that the number of intubation more than 2 times was a risk factor for neonatal ventilator-associated pneumonia, which was consistent with the results of relevant studies [9-11]. However, in this study, birth weight and gestational age were not risk factors for neonatal ventilator-associated pneumonia, and clinical attention should be paid to the possibility that the number of intubations was insufficient. The incidence of VAP in newborns is much higher than that in adults due to the immature immune system, incomplete skin and mucosal barrier to pathogens, and low complement level. During endotracheal intubation, the upper respiratory tract is directly injured, and the function of temperature and humidification and filtration is damaged, airway ciliary movement and cough reflex are weakened, and sputum deposition is difficult to discharge. Intubation and sputum aspiration damage the airway mucosa and weaken the body's defense mechanism. Multiple intubation causes more obvious airway mucosal injury and higher chance of infection. Clinically, it is necessary to avoid tube blockage and catheterization as well as repeated intubation to reduce the occurrence of VAP [12].

The results of this study showed that the pathogens of neonatal VAP were mainly Gram-negative bacilli (70.37%), which was consistent with literature reports [13 ~ 16]. The top five were *Klebsiella pneumoniae*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Maltophilia oligomonas*, and *Acinetobacter baumannii*, and the infection rate of ESBL-producing negative bacteria was high. The drug sensitivity data in this group showed that Gram-negative bacilli were extensively resistant to cephalosporin antibiotics. The first few antibiotics with sensitivity were imipenem, cilastatin, meropenem and piperacillin tazobactam, while the number of bacteria resistant to cefoperazone sulbactam and cefepime increased, which was closely related to the abuse of antibiotics. Ciprofloxacin is a quinolone drug with a wide antibacterial spectrum, but this drug can cause damage to the cartilage tissue of young animals, so it is not suitable for use in newborns. However, due to its ototoxicity and nephrotoxicity, amikacin is not used as a first-line drug in clinical application. Both vancomycin and linezolid were sensitive to gram-positive cocci. It should be noted that carbapenem antibiotics, such as imipenem and meropenem, have a wide antibacterial spectrum in recent years, and their application in the neonatal field has been gradually increased in recent years, and their drug sensitivity has been significantly decreased, which needs to be paid high attention to by clinicians. In order to prevent the occurrence of bacterial resistance, clinicians should strictly grasp the indications when selecting antimicrobial agents, and prevent the prophylactic application of antibiotics in children without signs of infection before exposure to the computer, in order to prevent bacterial flora disorder, leading to drug-resistant strains and double infections. As the extension of breathing machine ventilation time, patients should be closely observed pneumonia related clinical signs and the change of airway secretions, so that early detection, diagnosis and give treatment in time, once the doubt co-infection is timely selection of antibiotics based on the characteristics of the common pathogenic bacteria care unit, and promptly leave sputum specimens were bacterial culture, In order to avoid aggravating the phenomenon of pathogen resistance and improve the cure rate of VAP.

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## 5. Conclusion

The pathogenic bacteria leading to ventilator associated pneumonia in newborn infants are mainly Gram-negative bacteria, and the main manifestation is *Klebsiella pneumoniae*. The risk factors leading to ventilator associated pneumonia in newborn infants are manifested in multiple aspects, which require clinical measures for comprehensive intervention, which can effectively ensure the safety of newborn infants.

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## Compliance with ethical standards.

### *Acknowledgments*

I am very thankful to my supervisor Chen Li and Wu yu meng gao ke and Sadia Hassan.

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

### *Statement of ethical approval*

This manuscript is in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of The First Affiliated Hospital of Bengbu Medical University.

### *Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

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