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ORIGINAL PAPER

Active Screening of Multi-Drug Resistant Bacteria Effectively Prevent and Control the Potential Infections

Yuguo Ren · Guoliang Ma · Lin Peng · Yufeng Ren · Fengmei Zhang

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Abstract Our objective is to determine if actively screen the multi-drug resistant bacteria (MDRB) infection in intensive care unit (ICU) to prevent, control, and decrease the infection rate and transmission of MDRB. The patients admitted in ICU of one hospital in 2013 were analyzed. The throat swab, blood, defecation, and urine of patients were actively collected for bacteria cultures to screen *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Escherichia coli*, *Staphylococcus aureus*, and *Acinetobacter baumannii* in patients. All patients received screening of MDRB infection and colonization within 2 days and after 2 days of admission, the results showed that there were 418 infectious bacterial strains in total and *P. aeruginosa* was the main bacterium. The asymptomatic infection rates of *P. aeruginosa*, *K. pneumonia*, *E. coli*, *S. aureus*, and *A. baumannii* were 39.02, 24.74, 44.00, 29.17, and 33.33 %, respectively; the symptomatic infection rates were 60.98, 75.26, 56.00, 70.83, and 66.67 %. 59.70 % patients received antibiotics treatment, 27.45 % patients received trachea cannula, 32.95 % patients received mechanism ventilation, 2.27 % patients received arterial cannula or venous cannula and 4.00 % patients received indwelling urinary catheters. The main MDRB in ICU is *P. aeruginosa*. The active screening of MDRB infection and colonization can provide the opportunity to take the life-saving measure against MDRB and treat patients. This can decrease the infection risk and the nosocomial transmission of MDRB.

Keywords Active screening · Multi-drug-resistance · *Pseudomonas aeruginosa* · Effectiveness evaluation

Introduction

Patients colonized with multi-drug resistant bacteria (MDRB) are the bacteria reservoirs in hospitals, which can potentially ignite the explosion of life-threatening infection outbreaks. The outbreaks and prevalence of MDRB have become a social problem [1–4]. Due to the decreased immunity, long hospitalization, and severe complications, patients in ICU are more susceptible to infections [5–9]. To protect patients' health and improve medical safety, it is necessary to actively screen the MDRB in ICU, and analyze the infection and colonization status of MDRB to prevent and control the transmission of MDRB. Necessary preventive measures should be taken to decrease the risk of infection in patients.

Materials and Methods

General Data

204 patients in the ICUs (respiratory ICU, emergency ICU, neurological ICU) of one hospital in 2012 were selected. The clinical data and microbial statuses were recorded.

Yuguo Ren and Guoliang Ma have contributed equally to this study, should be considered as co-first authors.

Y. Ren · G. Ma · L. Peng
Department of Medical Laboratory, Laiwu City People's Hospital, Laiwu, China

Y. Ren
Department of Internal Medicine, Fangxia Hospital of Laicheng District, Laiwu, China

F. Zhang (✉)
Department of Endocrinology, Laiwu City People's Hospital, 1 Xuehu Street, Laicheng district, Laiwu 271100, Shangdong, China
e-mail: drzhangfengmei@163.com

Table 1 The top five pathogens and their distribution (%)

Pathogen	The number of screened out strains	Component ratio (%)
Pseudomonas aeruginosa	123	29.43
Klebsiella pneumoniae	97	23.21
Escherichia coli	75	17.94
Staphylococcus aureus	72	17.22
Acinetobacter baumannii	51	12.20
In total	418	100.00

Table 2 MDRB infection and colonization status

Pathogen	The number of screened out strains	Colonization rate (%)	Infection rate (%)
Pseudomonas aeruginosa	123	48 (39.02)	75 (60.98)
Klebsiella pneumoniae	97	24 (24.74)	73 (75.26)
Escherichia coli	75	33 (44.00)	42 (56.00)
Staphylococcus aureus	72	21 (29.17)	51 (70.83)
Acinetobacter baumannii	51	17 (33.33)	34 (66.67)
In total	418	143 (34.21)	275 (65.79)

Research Method

Patient samples were periodically collected and assayed for the data of the patients. The infection status of MDRB was evaluated according to the "Hospital infection diagnostic criteria" published in 2001 by Public Health Department. The results of bacteria infection were analyzed with the general data, clinical symptoms, and laboratory reports of bacteria.

Sample Collection and Submission

Throat swab, blood, defecation, and urine within 2 days and after 2 days of admission were screened, cultured and analyzed.

Identification of Bacteria

The corresponding chromogenic culture media were used to screen *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Escherichia coli*, *Staphylococcus aureus,* and *Acinetobacter baumannii*. Meanwhile, supplementary tests of oxidase, catalase, and gram stain microscopic examination were performed for verification. All the chromogenic culture media and reagents were purchased from bioMérieux, Inc.

Results

The Top Five Pathogens and Their Distribution

In the samples of 204 patients, 418 MDRB strains were screened out, 218 strains of which were from pharyngeal intubations, 57 strains from blood, 128 strains from defecation, or urine and 15 strains from the other samples. *Pseudomonas aeruginosa* was the main bacterium, which took up 29.43 % of the total, *K. pneumoniae* 23.21 %, *E. coli* 17.94 %, *S. aureus* 17.22 %, and *A. baumannii* 12.20 % (Table 1).

Table 3 The data of MDRB by active screening culture after 2 days

Pathogen	Number of patients	Colonization rate (%)	Infection rate (%)
Pseudomonas aeruginosa	25	5 (20.00)	20 (80.00)
Klebsiella pneumoniae	2	2 (100.00)	0
Escherichia coli	8	0	8 (100.00)
Staphylococcus aureus	4	0	4 (100.00)
Acinetobacter baumannii	3	1 (33.33)	2 (66.67)

The Infection and Colonization Status of MDRB

In active screening of MDRB in 204 patients, 418 MDRB were isolated, and *P. aeruginosa* was the main infectious bacteria strain (Table 2).

The Active Screening of MDRB Within 2 Days and After 2 Days of Admission in ICU

In active screening of 164 patients within 2 days of admission in ICU, 324 MDRB strains were screened out. 107 (33.02 %) of the strains were carried from the other wards of the hospital, 83 (25.62 %) from the other hospitals, the rest 134 (41.36 %) from the communities. In active screening of 32 patients at 2 days after admission, 32 MDRB strains were screened out (Table 3).

The Relevant Factors of Infection

The lower respiratory tract was the primary infection site. Urinary tract, blood, and soft tissues were secondary. The

urinary tract related infection rate was 0.66 ‰; the vessel catheter related infection rate was 6.25 ‰; the ventilator-associated pneumonia-related infection rate was 3.91 ‰.

Discussion

As the most important department to rescue critical patients, ICU is also the most vulnerable place for infection outbreak and prevalence [10, 11]. As the conditions of most patients are severe, the body function is poor, the immunity is decreased, and the length of stay is long, they become the main targets of MDRB infection [12–15]. According to related survey, the infection rate in ICU patients was 10 times that in other wards, especially the patients who received antibiotics treatment before admission have higher infection risk [16–18]. MDRB colonized patients is the huge bacteria reservoir within hospitals, which can cause the explosion of potentially life-threatening infection in hospital. At present, the occurrence and prevalence have become a social issue [19–23]. In one study, the active screening of MDRB in ICU showed that active screening could timely detect MDRB, so that doctors could take proper measures, which decreased the nosocomial infection of MDRB [24]; In another report, the active screening of MDRB in infants in ICU showed that age, invasive operation, premature delivery could affect the colonization, and infection of MDRB, however, there was no correlation with gender [25].

In this study, we conducted active screening in ICU, and the respiratory ICU was the main infection place for MDRB. The urinary cannula-related infection rate was 0.66 ‰, the vessel catheter-related infection rate was 6.25 ‰, and the ventilator-associated pneumonia-related infection rate was 3.91 ‰. Vessel catheters are easy to cause infections. In the isolated samples from 204 patients, 418 MDRB strains were screened out, 218 strains of which were from pharyngeal intubations, 57 from blood, 128 from defecation or urine and 15 from the other sources. *Pseudomonas aeruginosa* was the primary bacterium, which took up 29.43 % of the total, klebsiella pneumonia 23.21 %, *E. coli* 17.94 %, *S. aureus* 17.22 %, and *A. baumannii* 12.20. The asymptomatic infection rates of *P. aeruginosa*, klebsiella pneumonia, *E. coli*, *S. aureus*, and *A. baumannii* were 39.02, 24.74, 44.00, 29.17, and 33.33 %, respectively. The symptomatic infection rates were 60.98, 75.26, 56.00, 70.83, and 66.67 %. In active screening of 164 patients within 2 days of admission in ICU, 324 MDRB strains were screened out, 107 (33.02 %) of which were carried from other wards of the hospital, 83 (25.62 %) from other hospitals, the remaining 134 (41.36 %) from the communities. In active screening of 36 patients at 2 days after admission, 32 MDRB strains were screened out.

In conclusion, the active screening and culture of MDRB in patients has important value for the controlling and prevention of MDRB infection. It helps with the understanding of MDRB infection and colonization, the applications of active measures for disinfection and isolation, and proper antibiotics in patients in need can decrease the transmission of MDRB and decrease the infection risk of patients.

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