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Original Article

High prevalence rate of multidrug resistance among nosocomial pathogens in the respiratory care center of a tertiary hospital

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Background and purpose: There is an increasing need for respiratory care centers (RCCs) for patients who require prolonged mechanical ventilation after intensive care unit (ICU) stay. Nosocomial infections occur at a high rate in ICUs, but there have been few studies of nosocomial infections in RCCs in Taiwan.

Methods: The infection rates, sources, and pathogens of nosocomial infections in the RCC of a tertiary hospital were retrospectively analyzed from January 2001 to December 2002. Nosocomial infections were defined in accordance with the recommendations of the Centers for Disease Control in the United States.

Results: There were 398 nosocomial infections in 265 patients (1.5 episodes for each patient). The incidence density of nosocomial infection was 27.3%. The mean age ± standard deviation of patients was 74.5 ± 12.8 years. The mean duration of infection from the day of patient transfer to the RCC was 13 days (range, 2-78 days). Urinary tract infection was most common (53.8%), followed by bloodstream infection (31.2%), skin and soft tissue infection (6.0%), and lower respiratory tract infection (5.5%). 481 strains of microorganisms were isolated, 12.8% of which were *Staphylococcus aureus* (all methicillin-resistant), 11.1% were *Klebsiella pneumoniae* (69.1% of which were the extended spectrum β-lactamase [ESBL] phenotype), and 10.6% were *Escherichia coli* (31.4% of which were the ESBL phenotype).

Conclusion: The infection incidence density in the RCC was similar to previous findings for ICUs during the same period. However, there were differences in the distribution of sites and pathogens. Multiple drug resistance rates were high.

Key words: Cross infection; Drug resistance, microbial; Respiratory care units

Introduction

Due to advances in medical treatment, the life span of the population is increasing. According to data from the National Health Insurance (NHI) of Taiwan in 1997, the cost of mechanical ventilation was NT$7.1 billion, comprising 3% of the total NHI budget [1]. In 1984, the Office of Technology Assessment estimated that the total national hospital expenditure was US$136 billion; of this, US$13 to 15 billion was spent in adult intensive care units (ICUs) [2]. Half of the ventilator-dependent patients are cared for in ICUs and have long hospital stays. These patients can be described as chronically critically ill and are costly to hospitals, both in terms of actual dollars spent and in terms of care burden for nurses and physicians. A previous study found that the cost of 3% of ICU patients who receive mechanical ventilation was 38% of all medical fees for the ICU [3]. In Taiwan, according to the NHI policy, patients who need ventilator support for more than 21 days must be transferred to a respiratory care center (RCC) if their clinical condition is sufficiently stable but they cannot be weaned from the ventilator.

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The main purpose of the RCC is to reduce ICU overcrowding, as well as to reduce the high cost of the ICU by increasing the efficiency of care for patients with similar needs in a single location. Ventilator-dependent patients have prolonged ICU stays and have placement of multiple devices such as a Foley catheter, endotracheal tube, nasogastric tube, and other intravenous catheters. In addition, these patients typically have an extensive history of antibiotic use for severe infections. The incidence of nosocomial infections in ICUs is very high but comparatively few studies have investigated the characteristics of RCC infections. This retrospective study analyzed the rates, sources, and organisms causing nosocomial infections in the new RCC (opened in September 2000) of a tertiary hospital.

Methods

This retrospective study investigated the characteristics of nosocomial infections in an RCC. Patients who met the criteria for nosocomial infection (1988, 1992) defined by the Centers for Disease Control in the United States [4,5] from January 1, 2001 to December 31, 2002 were enrolled. Infection control nurses reviewed the patients' medical records to collect the following information: demographic data, admission date, date of infection, date of transfer to a general ward, discharge date, source of infection, causative organism, risk factors, prognostic factors, and death. The use of a Foley catheter, intravascular catheter (e.g., central venous pressure line, artery line, double lumen catheter, Hickman catheter, port-A catheter), and drain were recorded.

Specifically for *Acinetobacter baumannii*, multidrug resistance was defined as being resistant to all available antibiotics in Taiwan during the study period, including third- or fourth-generation cephalosporins, aminoglycosides, fluoroquinolones, and carbapenems. Parenteral colistin and tigecycline preparations were not available at that time.

Results

Nosocomial infection rate

There were 666 RCC admissions for 14,571 patient days. 265 patients had 398 episodes of nosocomial infection, resulting in a mean infection incidence density of 27.3% and a monthly infection incidence density of 15.7% to 38.9% during the study period. Patients had a mean of 1.5 episodes of nosocomial infection. 170 patients had only 1 infectious episode and 95 patients had multiple infectious episodes. The mean age was 74.5 years (range, 18-99 years), and 51.3% were men and 48.7% were women. Of the patients, 81.7% were transferred from a medical department in the hospital.

The mean ± standard deviation (SD) duration of hospital stay before transfer to the RCC was 40.4 ± 28.9 days while that in the RCC was 32.4 ± 14.1 days. Nosocomial infection developed a median of 13 days after transfer to the RCC (range, 2-78 days). Underlying diseases associated with nosocomial infections in the RCC included hypertension (n = 197; 49.5%), diabetes mellitus (n = 145; 36.4%), pulmonary disease (n = 93; 23.4%), cardiovascular disease (n = 78; 19.6%), gastrointestinal disease (n = 31; 7.8%), and malignancy (n = 30; 7.5%).

Distribution of nosocomial infections by site

The distribution of infection sites of nosocomial infections was as follows: 214 urinary tract infections (UTIs; 53.8%); 124 bloodstream infections (BSIs; 31.2%); 24 skin and soft tissue infections (SSTIs; 6.0%); 22 lower respiratory tract infections (LRTIs; 5.5%), all of which were pneumonia; 5 surgical site infections (SSIs; 1.3%); and 6 others (1.5%).

Microbiological data

481 pathogens were obtained from 398 episodes of nosocomial infection. Gram-negative organisms were the most common (60.7%), followed by Gram-positive organisms (24.9%) and fungi (14.4%). Monomicrobial infections accounted for 65.1% of episodes, followed by polymicrobial infections (25.1%) and culture-negative infections (9.8%).

The most common organism isolated was *Staphylococcus aureus,* followed by *Klebsiella pneumoniae, Escherichia coli*, *Pseudomonas aeruginosa*, *Candida albicans,* and *A. baumannii* (Table 1). All *S. aureus* isolates were resistant to methicillin. Of 55 *K. pneumoniae* isolates, 38 (69.1%) were of the extended-spectrum β-lactamase (ESBL)–producing phenotype, while 16 of 51 *E. coli* isolates (31.4%) had the ESBL-producing phenotype. In 2001, none of the *A. baumannii* isolates were multidrug resistant (MDR) but 50% of isolates in 2002 were MDR.

The distribution of pathogens according to the types of nosocomial infections is shown in Table 1. For UTI, the most common pathogens were *E. coli*, *C. albicans*, and *K. pneumoniae*. For BSI, the most common pathogens were *S. aureus* followed by

Table 1. Distribution of pathogens and types of nosocomial infections in a respiratory care center in Taiwan.

Pathogen	Urinary tract infection	Blood-stream infection	Skin and soft tissue infection	Lower respiratory tract infection	Ear, nose, or throat infection	Gastro-intestinal system infection	Surgical site infection	Other	Total
Gram-negative organisms									
Klebsiella pneumoniae	31 (11.6)	17 (11.5)	3 (10.7)			1 (14.3)	1 (6.7)	2 (28.6)	55 (11.4)
Escherichia cloacae	23 (8.6)	3 (2.0)	4 (14.3)					30 (6.2)	
Escherichia coli	39 (14.6)	8 (5.4)	2 (7.1)			1 (14.3)	1 (6.7)		51 (10.6)
Citrobacter freundii	2 (0.7)	1 (0.7)							3 (0.6)
Proteus mirabilis	9 (3.4)	2 (1.4)	1 (3.6)						12 (2.5)
Pseudomonas aeruginosa	22 (8.2)	12 (8.1)	3 (10.7)	2 (25)		1 (14.3)	2 (13.3)	1 (14.3)	43 (8.9)
Acinetobacter baumannii	23 (8.6)	9 (6.1)		4 (50)			1 (6.7)	1 (14.3)	38 (7.9)
Gram-positive organisms									
Staphylococcus aureus	16 (6.0)	30 (20.3)	8 (28.6)				3 (20.0)	3 (42.9)	60 (12.5)
Coagulase-negative staphylococci		26 (17.6)	1 (3.6)						27 (5.6)
Enterococcus spp.	20 (7.5)	10 (6.8)	1 (3.6)			1 (14.3)			32 (6.7)
Yeasts									
Candida albicans	34 (12.7)	4 (2.7)	2 (7.1)						40 (8.3)
Other *Candida* spp.	28 (10.5)		1 (3.6)						29 (6.1)
Others	20 (7.5)	26 (17.6)	2 (7.1)	2 (25)	1 (100)	3 (42.9)	7 (46.7)		61 (12.7)
Total	267 (100)	148 (100)	28 (100)	8 (100)	1 (100)	7 (100)	15 (100)	7 (100)	481 (100)

coagulase-negative staphylococci. For SSTI, *S. aureus* was the most common pathogen.

Discussion

During the 2-year study period, the incidence density of nosocomial infections in this RCC was 27.3%. The monthly incidence density ranged from 15.7% to 38.8%. As this is the first report of nosocomial infections in an RCC in Taiwan, it makes comparison with other results difficult. The nosocomial incidence density in ICUs in the studies of Jarvis et al [6] of 23.7% and Legras et al [7] of 20% were similar to that in this study of 25.4% during 2001 to 2002. Age, prolonged duration of hospital stay, occult infection, severity of disease, Foley catheter insertion, central venous catheterization, and mechanical ventilation use are risk factors for nosocomial infections in ICU patients [8-11]. In the RCC, besides these risk factors, most patients have had more than 21 days of ICU stay with extensive antibiotic treatment before transfer to the RCC, so high rates of nosocomial infections caused by resistant pathogens could be expected.

In this study, the most common site of nosocomial infection was UTI (53.8%), followed by BSI (31.2%), SSTI (6.0%), LRTI (5.5%), and SSI (1.3%) [Table 1]. These figures are higher than those reported for UTI (range, 17.7-31.0%) in previous epidemiological studies in ICUs, and lower for BSI (range, 7.3-19.0%) and LRTI (range, 27.0-46.9%) [10-12]. These variations may be due to the differences in the epidemiological characteristics of nosocomial infections in RCCs and ICUs.

In this study, 96% of patients who developed UTI had Foley catheter insertion. Foley catheter use has been well recognized to be associated with UTI. Attention to aseptic technique, avoidance of unnecessary insertion and early removal of Foley catheter are important factors for prevention of UTI [13]. In this study, 71.9% of BSI occurred in patients with a central venous catheter. Sherertz found that BSI occurred at 2 to 30 times higher rates when a central venous catheter was used and 90% of BSI in ICU patients were associated with a central venous catheter [14]. The implementation of multiple infection control measures in central venous catheterization is essential to prevent BSI [14]. Endotracheal tube intubation and ventilator use are risk factors for RTI. Ventilator-dependent patients had 3 to 21 times the risk of developing RTI than non-ventilator–dependent patients [15,16].

Analysis of pathogen distribution at different infection sites showed that *E. coli*, *C. albicans,* and *K. pneumoniae* were more common in UTI. By contrast,

S. aureus and coagulase-negative staphylococci were the most common pathogens in BSI. *S. aureus* was also a common pathogen in SSTI. However, differences between the proportions of nosocomial pathogens in this study and previous studies of nosocomial infections in the ICU may be attributable to variant epidemiology between the different countries' hospitals and even between individual units [6,7,10,11,17].

Among the nosocomial pathogens isolated, Gram-negative bacteria were more prevalent than Gram-positive bacteria and fungi. The most common organism was *S. aureus*, followed by *K. pneumoniae* and *E. coli*. High levels of antibiotic resistance were found in this study. All *S. aureus* isolates were methicillin resistant, 69.1% of *K. pneumoniae* isolates and 31.4% of *E. coli* isolates were ESBL producers, and 50% of *A. baumannii* isolates in 2002 were MDR. As in the ICU, prolonged stay and use of broad-spectrum antibiotics are high risk factors for nosocomial infection and the emergence of drug-resistant strains [18-20].

In conclusion, this study found that nosocomial infections in the RCC were as prevalent as those reported in ICUs. However, there were variations in the pathogen distribution of different nosocomial infections. MDR pathogens were common. Therefore, implementation of infection control programs and continuous monitoring of resistance profiles in RCC nosocomial isolates are necessary to reduce the emergence of nosocomial infections and antibiotic resistance.

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