



Knowledge, Adherence, and Barriers Related to Ventilator-Associated Pneumonia Prevention Among Critical Care Nurses in Baoshan, the People's Republic of China*

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ที่สัมพันธ์กับการใช้เครื่องช่วยหายใจในพยาบาลวิกฤต
เมืองเป่าซาน สาธารณรัฐประชาชนจีน*

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Abstract

Ventilator-associated pneumonia (VAP) is the most common complication found among patients who use mechanical ventilation as a life support measure. To improve the quality of nursing practice related to VAP prevention, baseline information regarding knowledge, adherence, and barriers related to VAP prevention among critical care nurses should be explored. This descriptive correlational design aimed to explore knowledge, adherence, and barriers to VAP prevention among critical care nurses in Baoshan City, the People's Republic of China. The relationship between knowledge and adherence was also determined. Purposive sampling was used to recruit 142 critical care nurses from six hospitals in Baoshan City, Yunnan province, the People's Republic of China. Measurement tools were composed of 1) the demographic data record form, 2) questionnaires related to knowledge towards prevention of VAP (QKVAP), and 3) the Questionnaire on VAP Prevention Compliance and Barriers (QVAPCB). The Chinese versions of these instruments were used. The internal consistency of the QKVAP using the KR-20 formula was .81, and the Cronbach's alpha coefficients of the QVAPCB adherence and barrier parts were .91 and .87, respectively. Data were analyzed using descriptive statistics and Spearman's rank-order correlation test.

The results of this study were as follows:

1. The majority of participants (81.69%) had knowledge of VAP and VAP prevention at a fair level;
2. The majority of participants (95.07%) perceived adherence to VAP prevention at a sufficient level;
3. Knowledge was positively related to adherence to VAP prevention at a low level ($r = .255, p < .001$);
4. The top three barriers towards VAP prevention perceived by critical care nurses were forgetfulness to perform some evidence-based procedures (90.14%), staff shortages in the unit (82.39%), and noncompliance of patients in performing VAP prevention practice (59.15%).

The study findings provide baseline information regarding critical care nurses' knowledge and adherence, as well as the barriers to complying with VAP prevention. Further research should explore the factors influencing collaboration on and barriers to VAP prevention related to the use of ventilators in each ICU in order to have strategic plans to improve the VAP prevention.

Keywords: Ventilator-associated pneumonia; Knowledge; Adherence; Barrier; Critical care nurses

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บทคัดย่อ

ปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจ เป็นภาวะแทรกซ้อนที่พบบ่อยในผู้ป่วยที่ใช้เครื่องช่วยหายใจเพื่อการช่วยชีวิต การพัฒนาคุณภาพการปฏิบัติพยาบาลเกี่ยวกับการป้องกันปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจ จำเป็นต้องสำรวจข้อมูลพื้นฐานเรื่องความรู้ ความร่วมมือ และอุปสรรคในการป้องกันปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจในพยาบาลวิกฤต การวิจัยเชิงพรรณนาหาความสัมพันธ์นี้ มีวัตถุประสงค์เพื่อศึกษาความรู้ ความร่วมมือ และอุปสรรคในการป้องกันปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจในพยาบาลวิกฤต เมืองเป่าซาน สาธารณรัฐประชาชนจีน และศึกษาความสัมพันธ์ระหว่างความรู้และความร่วมมือในการป้องกันปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจ คัดเลือกกลุ่มตัวอย่างแบบเจาะจงในพยาบาลวิกฤตจำนวน 142 คน จาก 6 โรงพยาบาลในเมืองเป่าซาน มณฑลยูนนาน สาธารณรัฐประชาชนจีน เครื่องมือประเมินประกอบด้วย 1) แบบบันทึกข้อมูลส่วนบุคคล 2) แบบสอบถามความรู้เกี่ยวกับการป้องกันปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจ (QKVAP) และ 3) แบบสอบถามความร่วมมือในการป้องกันปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจและอุปสรรค (QVAPCB) เครื่องมือทั้งหมดเป็นฉบับภาษาจีน ตรวจสอบคุณภาพเครื่องมือ QKVAP โดยใช้การทดสอบความเชื่อมั่น KR20 ได้เท่ากับ .81 และเครื่องมือ QVAPCB ในส่วนความร่วมมือและอุปสรรค หาค่าความเชื่อมั่นโดยหาค่า Cronbach's alpha coefficients ได้เท่ากับ .87 และ .91 ตามลำดับ วิเคราะห์ข้อมูลโดยใช้สถิติบรรยาย และสถิติ Spearman's rank-order correlation

ผลการวิจัย มีดังนี้

1. กลุ่มตัวอย่างส่วนใหญ่ (81.69%) มีความรู้เกี่ยวกับปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจและการป้องกัน อยู่ในระดับปานกลาง
2. กลุ่มตัวอย่างส่วนใหญ่ (95.07%) รับรู้ความร่วมมือในการป้องกันปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจในระดับเพียงพอ
3. ความรู้มีความสัมพันธ์ทางบวกในระดับต่ำกับความร่วมมือในการป้องกันปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจ ($r = .255, p < .001$)
4. อุปสรรคในการป้องกันปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจในพยาบาลวิกฤต 3 อันดับแรก ได้แก่ การลืมทำกิจกรรมตามหลักฐานเชิงประจักษ์ (90.14%), การขาดแคลนเจ้าหน้าที่ในหน่วยงาน (82.39%), และผู้ป่วยไม่ให้ความร่วมมือในกิจกรรมการป้องกันปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจ (59.15%)

ผลการศึกษาี้ แสดงถึงข้อมูลพื้นฐานเกี่ยวกับความรู้ ความร่วมมือ และอุปสรรคในการป้องกันปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจในพยาบาลวิกฤต สำหรับการวิจัยในครั้งต่อไป ควรศึกษาปัจจัยที่มีอิทธิพลต่อความร่วมมือและอุปสรรคในการป้องกันปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจในหอผู้ป่วยวิกฤตแต่ละแห่ง เพื่อใช้ในการวางแผนกลยุทธ์ในการป้องกันปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจให้ดีขึ้น

คำสำคัญ: ปอดอักเสบที่สัมพันธ์กับการใช้เครื่องช่วยหายใจ ความรู้ ความร่วมมือ อุปสรรค พยาบาลวิกฤต

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Background and significance

Although the use of mechanical ventilation (MV) is an important life support measure, prolonged usage of MV induces complications. Ventilator-associated pneumonia (VAP) is the most common complication found among patients with MV (Pham et al., 2017). VAP, a nosocomial infection, is classified within the broader spectrum of hospital-acquired pneumonia (HAP). The Infectious Diseases Society of the American Thoracic Society (IDSA/ATS) guidelines defined HAP as “pneumonia that occurs 48 hours or more after admission and did not appear to be incubating at the time of admission” and VAP as “a type of HAP that develops more than 48 to 72 hours after endotracheal intubation” (Kalil et al., 2016). VAP is one of the most frequent hospital-acquired infections (HAIs) in mechanically ventilated patients (Olivieri et al., 2017), found at a frequency of around 9 to 27% worldwide (Khan et al., 2017). However, no study of the exploration of VAP incidence in Baoshan City, China has been done.

The occurrence of VAP is associated with increased mortality, ICU recovery, and health-related costs (Olivieri et al., 2017). Papazian and colleagues (2020) expounded that all-cause mortality associated with VAP has been reported to be as high as 50%. Compared to those without VAP, length of stay (LOS) in the ICU increased by 5 to 7 days, and LOS in the hospital was two- to three-fold in patients with VAP (Torres et al., 2017). The costs of treating VAP range from \$1,728 to \$10,000 per event in the USA, and the annual total cost of treating VAP is approximately \$46 million (Klompas, 2015).

It was estimated that 55% of VAP could be prevented through the application of evidenced-based recommendations and protocol. Regardless of the existence of guidelines, research has confirmed that the occurrence of VAP is directly related to the inadequacy of experienced nurses who had insufficient knowledge and understanding about the pathophysiology and risk factors regarding the development and prevention strategies of VAP (Timsit et al., 2017). Moreover, effective adherence towards VAP prevention among nurses is vital (Kalyan et al., 2020).

Adherence towards VAP prevention is defined as the process in which a critical care nurse complies with all the processes and recommendations listed in the evidence-based VAP prevention guidelines (Kalyan et al., 2020). Previous studies show that knowledge of, and adherence to, evidence-based guidelines regarding the prevention of VAP would reduce the risk of VAP occurrence and decrease morbidity and mortality for mechanically ventilated patients in ICUs (Ali, 2013; Kalyan et al., 2020).

It is expected that nurses with sufficient knowledge are more likely to adhere to prevention of VAP. Therefore, barriers to implementing evidence-based guidelines for VAP prevention should be explored, and strategies for enhancing VAP prevention guideline adherence should be planned (Jahansefat et al., 2016).

Inconsistent findings on knowledge, adherence, and barriers towards VAP prevention among nurses have been reported worldwide, as well as in China. It can be concluded that nurses' knowledge varied from low to moderate levels, adherence ranged from insufficient to sufficient,



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and barriers were different from place to place (Ali, 2013; Jansson et al., 2018; Shan, 2020; Soni & Mehta, 2018). However, the results from these studies are context-based and have limited application elsewhere.

Baoshan is a city located in western Yunnan province, between the border of Myanmar and the Lancang river (Mekong). The Yunnan Provincial Center for Disease Control and Prevention developed a protocol aligned with China's VAP preventive recommendations to effectively mitigate and decrease the occurrence of VAP (Shi et al., 2019). There are limited studies of the incidence and prevalence of VAP in Baoshan, or even in Yunnan Province (Shi et al., 2019). In addition, no information regarding knowledge, adherence, or barriers towards VAP prevention among nurses in Baoshan city has been reported. To improve the quality of practice related to VAP prevention, the baseline information regarding knowledge, adherence, and barriers in Baoshan should be explored.

Research objectives

1. To examine knowledge, adherence, and barriers related to VAP prevention among critical care nurses in Baoshan City, the People's Republic of China.
2. To study the relationship between knowledge and adherence of VAP prevention among critical care nurses in Baoshan City, the People's Republic of China.

Conceptual framework

The conceptual framework of this study is based on the literature review. VAP is one of the most frequent HAIs in mechanically ventilated patients. Critical care nurses play an important role in preventing VAP as they provide 24-hour bedside care and a safe environment for the patients.

Knowledge is a critical care nurses' understanding of VAP and prevention strategies. Adherence refers to the degree to which a critical care nurse complies with all the processes and recommendations based on the up-to-date guideline. There may be a positive relationship between knowledge and VAP prevention adherence.

Barriers towards the prevention of VAP refers to all those things which can prevent or impact a critical care nurse's compliance with VAP prevention. Baseline information regarding critical care nurses' knowledge as well as their adherence, and the barriers to complying with VAP prevention are vital to be explored. Then, quality care for preventing VAP among mechanically ventilated patients can be made possible through fulfilling critical care nurses' knowledge and overcoming the obstacles to VAP prevention adherence.

Methodology

This descriptive correlational design was done among critical care nurses in 6 hospitals in Baoshan, Yunnan province, People's Republic of China.



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Population and sample

Participants were recruited by the purposive sampling method according to the following criteria: 1) holding a registered nurse license granted by the Ministry of Health and having worked at least 6 months in the intensive care unit (ICU); and 2) agreeing to participate in this study. The target population included 152 people in Baoshan city. Therefore, after having 10 nurses test the tools for reliability, 142 nurses who satisfied the inclusion criteria were recruited.

Research instruments

The instrument is a questionnaire including four parts, as follows:

1. The demographic data record form was developed by the researcher, and included information on participants' age, gender, hospital name, educational level, ICU working experience, position, and education in VAP, as well as their hospital's number of ICU beds, and the nurses-to-patient ratio in their working unit.

2. The original version of the Questionnaire related to Knowledge towards prevention of Ventilator Associated Pneumonia (QKVAP) was developed by Soni and Mehta (2018) and includes knowledge on VAP (possible score: 0-17) and knowledge on prevention of VAP (possible score: 0-17). Each question was scored 1 for correct and 0 for incorrect, with a maximum total score of 34. The knowledge level classification was based on the proportion of correct answers to the total score as follows ($\leq 49\%$ = low level, $50-74.9\%$ = fair level, and $\geq 75\%$ = high level) (Soni & Mehta, 2018).

3. The original version of the Questionnaire of VAP Prevention Compliance and Barriers (QVAPCB) was developed by Aloush and Al Rawaifa (2020). It is composed of 2 sections:

The first section consists of 10 items which measure nurses' adherence to VAP prevention and which use a Likert scale ranging from 4 to 1 (4-always, 3-often, 2-sometimes, and 1-never). Potential scores range from 10 to 40 with higher scores indicating greater adherence. Level of adherence is determined by the proportion of the received score compared to the highest possible score, and this is classified into 3 levels as following: $\geq 75\%$ is sufficient adherence; $50-74.9\%$ is weak adherence; and score proportion $\leq 49\%$ is insufficient adherence (Aloush & Al-Rawaifa, 2020).

The second section of the tool includes 15 items used to assess potential barriers encountered in nursing practice that may limit nurses' compliance with VAP prevention. A Likert scale ranging from 4 to 1 was used (4-strongly agree, 3-agree, 2-disagree, and 1-strongly disagree), and scores ≥ 3 indicated barriers to VAP prevention with higher scores representing the greater barriers. Possible scores ranged from 15 to 60.

All original measurement tools were translated into Chinese using the back translation method (Chapman & Carter, 1979). The quality of the instruments was tested among 10 nurses who had similar characteristics to the participants in the current study. The KR-20 score of the QKVAP was .81, and the Cronbach's alpha coefficients of the QVAPCB adherence and barrier parts were .87 and .91, respectively.



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Ethical considerations

The study was approved by the Research Ethics Committee of the Faculty of Nursing, Chiang Mai University, Thailand with the certificate approval number of 072/2021. Permission for data collection was obtained from each of the six hospitals in Baoshan City. All participants who agreed to participate in this study were required to sign a written consent form, independently, after details of the study were explained and clarification was made. They had the right to participate in or quit from this study at any time without any negative consequence on their benefits or future career. In addition, only a code number was used for data analysis. Voluntariness, privacy, and confidentiality were ensured.

Data collection

Two packages of research documents were distributed to all participants. One package included study information forms and informed consent forms while the other included questionnaires. The study information and purposes were clearly explained to eligible participants. They were asked independently to complete the informed consent within an hour if they agreed to participate in the study. They were invited to a private room and were asked to put the completed documents in separate boxes labeled “the box for consent form” and “the box for questionnaire”, located in front of the unit. The response rate for 142 participants was 100%.

Data analysis

The data was analyzed by statistics software. Only the variable of nurses' knowledge data was normal distributed. Therefore, descriptive statistics and Spearman's rank-order correlation were applied. The significance level was set at 0.05. In addition, the comparison of knowledge and adherence among demographic characteristics was tested by independent t-test and one-way analysis of variance.

Results

Table 1 displays the participants' demographic data. The majority were females ($n = 119$, 83.80%) aged between 21-30 years old ($n = 87$, 61.27%) with a mean age of 30.23 ($SD = 5.46$) years old. Nearly half of them held an associate degree ($n = 70$; 49.30%) and more than half were senior nurses ($n = 89$, 62.68%). Around half of them ($n = 74$, 52.11%) had less than 5 years' experience working in the ICU, but almost all of them had VAP prevention education ($n = 138$, 97.18%). In terms of ICU beds, only a small number of them ($n = 43$, 30.28%) worked in an ICU with more than 12 beds. However, more than half of them ($n = 88$, 61.97%) worked in units where the nurse-to-patient ratio was more than 1:2.



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Table 1 Characteristics of the Subjects Categorized by Frequency, Percentage, Mean, Standard Deviation, and Range (n = 142)

Demographic Characteristics	Frequency (n)	Percentage (%)
Age (years) (Mean = 30.23, SD = 5.46, Range = 21 - 50)		
21-30	87	61.27
31-40	49	34.51
41-50	6	4.22
Gender		
Female	119	83.80
Male	23	16.20
Working Hospital		
Baoshan People's Hospital	43	30.28
Baoshan Second People's Hospital	26	18.31
Tengchong People's Hospital	27	19.01
Longling People's Hospital	16	11.27
Changning People's Hospital	20	14.09
Shidian People's hospital	10	7.04
Educational Level		
Diploma	41	28.87
Associate degree	70	49.30
Bachelor's degree	31	21.83
Master's degree	0	0
Professional Title		
Junior nurse	26	18.31
Senior nurse	89	62.68
Nurse-in-charge	23	16.20
Associate chief nurse	1	0.70
Chief nurse	3	2.11
Working years in ICU (years) (Mean = 6.90, SD = 4.83, Range = 1 - 25)		
1-5	74	52.11
6-10	36	25.35
>10	32	22.54
Education on VAP prevention		
Yes	138	97.18
No	4	2.82



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Table 1 Characteristics of the Subjects Categorized by Frequency, Percentage, Mean, Standard Deviation, and Range (n = 142) (Continue)

Demographic Characteristics	Frequency (n)	Percentage (%)
Nurse-to-patient ratio		
1: ≤ 2	54	38.03
1: > 2	88	61.97
Beds in ICU where the subjects work (Mean = 13.85, SD = 5.81, Range = 6 – 22)		
≤12	99	69.72
>12	43	30.28

Table 2 shows that the mean score of knowledge of VAP (M = 11.26, SD = 2.34), VAP prevention (M = 10.82, SD = 2.01), and overall scores (M = 22.08, SD = 3.31) were at fair levels.

Table 2 Means and Standard Deviations of Overall and Each Dimension of Knowledge in VAP Prevention of the Subjects (n = 142)

Knowledge	M ± SD	Number of subjects		
		Good knowledge (score ≥75%) n (%)	Fair knowledge (score 50-74.9%) n (%)	Poor knowledge (score <50%) n (%)
VAP	11.26 ±2.34	45(31.69)	75(52.82)	22(15.49)
Prevention of VAP	10.82 ± 2.01	33(23.24)	98(69.01)	11(7.75)
Overall	22.08 ± 3.31	21(14.79)	116(81.69)	5(3.52)

As presented in Table 3, the subjects of this study perceived their adherence to VAP prevention at a sufficient level (M = 36.83, SD = 3.23).

Table 3 Perceived Level of Adherence as Determined by Mean, Standard Deviation, and Score Percentage Among the Subjects (n = 142)

Adherence to prevention of VAP	n (%)	Mean	SD	%	Level
Sufficient (score ≥75%)	135 (95.07%)	37.33	2.40	93.32	Sufficient
Weak (score 50-74.9%)	7 (4.93%)	27.29	2.14	68.22	Weak
Insufficient (score <50%)	0 (0%)	0	0	0	Insufficient
Total	142 (100%)	36.83	3.23	92.08	Sufficient



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There was significant higher overall VAP prevention knowledge among males ($t [140] = 2.84$, $p = .005$), and those who worked in settings with beds equal to or less than 12 ($t [131.57] = 3.15$, $p = .020$) or who worked in settings with a nurse-to-patient ratio equal to or less than 2 ($t [140] = 2.88$, $p = .005$) (Table 4). Table 4 reveals a significant difference in VAP prevention adherence among those who had different ICU years of experience ($F [2,139] = 2.910$, $p = .050$). Those who worked in settings with numbers of ICU beds equal to or less than 12 had higher VAP prevention adherence than those whose work settings had more than 12 beds ($t [60.02] = 2.66$, $p = .010$) (Table 4).

The results of this study revealed that there was a low positive correlation between VAP prevention knowledge and adherence ($r = .255$, $p < .001$).

Table 4 Comparison of Knowledge and Adherence Among Demographic Characteristics
($n = 142$)

Characteristic	Knowledge			Mean ± SD	F/t	p	Adherence to VAP Prevention			Mean ± SD	F/t(df)	p
	Good	Fair	Poor				Sufficient	Weak	Insufficient			
Age *												
21-30	15	69	3	22.44 ± 3.47	1.88	.156	85	2	0	37.20 ± 3.05	2.28	.106
31-40	5	42	2	21.35 ± 2.91			46	3	0	36.25 ± 3.04		
41-50	1	5	0	22.83 ± 3.54			4	2	0	34.67 ± 6.06		
Gender**												
Male	10	12	1	23.83 ± 3.64	2.84	.005	22	1	0	37.57 ± 2.64	1.19	.235
Female	11	104	4	21.74 ± 3.15			113	6	0	36.69 ± 3.32		
ICU years of experience*												
1-5	14	58	2	22.09 ± 3.61	0.07	.937	72	2	0	37.36 ± 3.07	2.91	.050
6-10	36	28	3	22.19 ± 3.34			35	1	0	36.69 ± 2.91		
>10	2	30	0	21.91 ± 2.56			28	4	0	35.75 ± 3.71		
Education on VAP**												
Yes	21	112	5	22.25 ± 2.22	-	.916	131	7	0	38.50 ± 1.91	-1.05	.296
					0.11							
No	0	4	0	22.07 ± 3.34			4	0	0	36.78 ± 3.25		
Number of ICU beds**												
≤12	20	74	5	22.54 ± 3.65	3.15	.020	97	2	0	37.36 ± 2.72	2.66	.010
>12	1	42	0	21.02 ± 2.03			38	5	0	35.60 ± 3.95		
Nurse-to-patient ratio **												
1: ≤2	14	38	2	23.07 ± 3.55	2.88	.005	52	2	0	37.09 ± 3.39	0.76	.452
1: >2	7	78	3	21.47 ± 3.01			83	5	0	36.67 ± 3.14		

Note: * tested by one way ANOVA; ** tested by independent t-test

Table 5 shows that among 142 subjects, almost all of them (128, 90.14%) reported “forgetfulness to perform some evidence-based procedure may increase the risk of VAP” as their barrier towards VAP prevention with an average of 2.91 (SD = 0.46) whereas 117 participants (82.39%) reported “staff shortage in unit” as the barrier with an average of 2.91 (SD = 0.61). The



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barrier related to the patient, “patients do not cooperate when perform some procedures to decrease VAP,” was perceived as the third most common barrier by more than half of participants (84, 59.15%).

Table 5 The Barriers Towards VAP Prevention Among the Subjects (N = 142)

Item	Mean	SD	Agree n(%)	Strongly agree n(%)
Forgetfulness to perform some evidence-based procedures may increase the risk of VAP	2.91	0.46	123(86.62)	5(3.52)
Staff shortage in unit	2.91	0.61	101(71.12)	16(11.27)
Uncooperative patients	2.55	0.65	81(57.04)	3(2.11)

Discussion

Knowledge about VAP prevention among critical care nurses

The findings showed that the mean score of VAP, VAP prevention, and overall knowledge scores among critical care nurses in Baoshan City, the People's Republic of China were at a fair level, which was consistent with the findings of previous studies (Kalyan et al., 2020; Shan, 2020). However, the findings were inconsistent with another study (Soni & Mehta, 2018) which reported the opposite findings. It is possible that the different characteristics of participants in different cultures lead to different findings.

In this current study, most participants were novice nurses who had ICU experience of 1 to 5 years. In order to provide the best care for ICU patients, VAP education and training is necessary (Timsit et al., 2017). This current study reported that more than 97% of the participants had VAP training which supports another previous study (Shan, 2020). However, knowledge regarding VAP and VAP prevention among the participants was not at a fair level, possibly because they did not have sufficient background or experiences in caring for ICU patients (Jahansefat et al., 2016).

Male subjects had statistically significant good levels of VAP and VAP prevention knowledge higher than females, as presented in Table 4. Pan et al. (2017) reported that male nurses had more vigor and absorption, so they had higher levels of energy and more concentration on their work than that of females who had more household responsibilities. However, only 23 males (16.20%) participated in this study.

The majority of participants (61.97%) in this study worked in high-workload units where the nurse-to-patient ratio was 1: >2. This study revealed that nurses who had high workloads had lower mean scores of knowledge than nurses whose workload was low (those who worked in unit with a nurse-to-patient ratio of 1: ≤2). Additionally, in this study, the number of nurses who worked in an ICU with equal to or less than 12 beds had statistically significantly higher knowledge of VAP prevention scores compared to others. Hugonnet and colleagues (2007) confirmed that nurses with high workloads had less time to maintain and update their clinical knowledge.



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Therefore, subjects in this study had fair levels of VAP and VAP prevention knowledge which was consistent with the results of a prior study by Soni and Mehta (2018).

Adherence to VAP prevention among critical care nurses

The results of this study demonstrate that critical care nurses in Baoshan hospitals perceive adherence to VAP prevention at a sufficient level (Table 4). This is congruent with the results of prior Chinese studies done by Zhang and colleagues (2020) and Zhijing and colleagues (2019) which found that VAP prevention adherence was 70% and 80%, respectively. However, the present results are inconsistent with some results of prior studies, including Aloush and colleagues (2020) in Jordan, Bankanie et al. (2021), and Jansson and colleagues (2018) in Finland. The findings of this study could be explained through factors including nurses' years of experience in the ICU, their professional positions, Chinese standards for nursing care, and numbers of ICU beds in different units.

In this study, the majority of participants had less than 10 years of ICU experience, held professional positions as junior or senior nurses (115, 80.99%), and fewer years working in an ICU. Nurses with less experience in the ICU had higher adherence scores, with statistical significance, than those with more than 10 years of working experience in the ICU (Table 4) which relates with a previous study reporting that nurses with less ICU experience usually actively maintained high professional interest, whereas the higher-experienced ICU nurses might feel frustrated and negative about the risks, responsibilities and super-intensive nursing workload (Zhang et al., 2020). Additionally, the younger nurses were assigned to do VAP prevention direct nursing care more often than the senior staff. This was consistent with Jansson and colleagues (2018) who found that less experienced nurses reported significantly higher adherence to VAP prevention than those with more ICU experience.

Nevertheless, nursing interventions in Chinese standard nursing care were similar to those in VAP prevention intervention (Shi et al., 2019). According to hospital policies, these procedures were considered as an integral component of standard basic nursing care. All Chinese nurses have major obligations to apply such interventions in their daily nursing practices. In China, in order to graduate, nursing students have to practice to be skillful. Although the participants in this study had a fair level of knowledge, they still had high adherence to VAP prevention.

Significantly higher VAP prevention score adherence was observed among nurses in ICUs with fewer beds (≤ 12 beds) compared with those whose units had more beds (> 12 beds). In line with Aloush and Rawajfa (2020), critical care nurses in ICUs with fewer beds had higher compliance with VAP prevention guidelines. Numbers of ICU beds reflect on nurses' workload, and nurses working in units with fewer beds and one patient at a time follow VAP prevention guidelines better than those in units with more beds who have to take care of two or more patients (Aloush & Rawajfa, 2020).



Relationship between knowledge and adherence to VAP prevention among critical care nurses

In this study, there was a positively significant weak relationship between knowledge and adherence to VAP prevention among critical care nurses in Baoshan City indicating that when they have more knowledge of VAP and VAP prevention, critical care nurses are more likely to adhere to VAP prevention. This finding is inconsistent with Bankanie and colleagues (2021) who reported no significant relationship between knowledge and compliance to VAP prevention. Jansson and colleagues (2018) reported that, despite the fact that knowledge is still the most important component in the adoption of evidence-based guidelines for VAP prevention, other factors such as a limited number of personnel and a lack of managerial support might have an impact on compliance. There might be other factors like availability of updated VAP prevention guidelines, enforcement of VAP prevention policy, and obligation to regularly perform standard nursing care that influenced the adherence rather than knowledge.

Barriers towards the prevention of VAP prevention among critical care nurses

The main barriers towards the prevention of VAP prevention among critical care nurses in this study were “forgetfulness to perform some evidence-based procedure may increase the risk of VAP” and “staff shortage in the unit”. These findings support previous studies (Jansson et al., 2018; Soni & Mehta, 2018) and should be shared with nurses working in ICUs, for both novices and senior nurses, in order to remind them of the usefulness of applying evidence-based practice for all nurses to have better quality of care for ICU patients during staff shortages in units (Al-Sayaghi, 2021).

The top third barrier found in this study was “patients don't cooperate when performing some procedures to decrease VAP”. In terms of workload, critical care nurses have less time to deal with individual nursing procedures. Moreover, there are some painful and uncomfortable VAP prevention procedures, such as the aspiration of subglottic secretions, which facilitate early mobilization, such as repositioning every two hours (Shi et al., 2019). Reminding ICU patients to cooperate with all difficult procedures is, therefore, a way to manage and reduce their pain and difficulty (Hsieh & Tuite, 2006).

Conclusions and Implications

The study findings provide a foundation regarding knowledge, adherence, and barriers to VAP prevention among nurses in Baoshan. This information will raise nurses' awareness of VAP prevention. Administrative teams can apply or design appropriate strategies to improve the quality of care for ICU patients.

Recommendations

To improve knowledge about and adherence to VAP prevention in ICUs, the relationships between knowledge, adherence to VAP prevention among nurses in individual settings, and other



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relevant confounders should be further explored in order to review their relationships in other clinical settings to expand to include more information of involved variables and benefits for caring for ICU patients.

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