

ORIGINAL ARTICLE

Knowledge of intensive care unit nurses about medical device-related pressure injury and analysis of influencing factors

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Abstract

To investigate ICU nurses' knowledge level with regard to device-related pressure injuries in northern, central, and southern China and analyse its influencing factors. A total of 261 ICU nurses participated in this cross-sectional survey. A convenience sampling method was used to select ICU nurses as respondents from one hospital in each of the six cities of Taiyuan, Wuhan, Xianning, Guangzhou, Foshan, and Huizhou. Data were collected using the MDRPI Knowledge Questionnaire. The questionnaire was developed by the investigators based on a summary of evidence of MDRPI, which has been reviewed and validated by experts. The obtained data were analysed using SPSS software. The average rate of the correct response about MDRPI was 60.54% (15.74 ± 2.90). The lowest percentage of correct responses was on the "concept and staging" dimension rated 28% (0.56 ± 0.67). The "skin assessment" dimension rated 39.2% (1.57 ± 0.84). Multiple linear regression analysis showed that the factors influencing the MDRPI knowledge of ICU nurses included hospital grade, the highest educational attainment, whether or not they had wound care certification, when they last attended MDRPI training or lectures, and whether or not they had attended MDRPI training or lectures. The level of knowledge of nurses about MDRPI was insufficient. Training of ICU nurses on MDRPI should be emphasised at the institutional level. MDRPI training contents should be based on clinical evidence and updated timely. There is a need to focus on the training of wound care certification and education.

KEYWORDS

ICU, knowledge, medical device-related pressure injury, nurse

Key Messages

- based on summarised evidence, this study developed a device-related pressure injury knowledge questionnaire and investigated the current status of nurses' knowledge level with regard to device-related pressure injury in northern, central, and southern China
- nurses have a relatively insufficient knowledge of MDRPI

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- nurse administrators should focus on MDRPI training, update content according to guidelines and should focus on wound care certification and education

1 | INTRODUCTION

Medical device-related pressure injury (MDRPI) was initially classified as pressure injury by the National Pressure Injury Advisory Panel (NPIAP), Pressure Ulcer Advisory Panel (PUAP) in 2016, and defined it as pressure injuries caused by medical devices for the diagnosis or treatment of a certain disease. The shape of the damaged part is consistent with the shape of the medical device.¹ In a recent Meta-analysis based on 17 cross-sectional studies and 12 cohort studies, Jackson et al reported that pooled incidence and prevalence of MDRPI were 12% (95% CI: 8-18) and 10% (95% CI: 6-16), respectively.² In a Meta-analysis reported by Cao et al, the incidence of MDRPI in adult inpatients was 10.3% [95% CI: 6.4%-14.2%] and the prevalence was 6.1% [95% CI: 5.0%-7.1%].³ Indeed, MDRPIs cause complications such as pain, increase risks in infection, lead to an increase in morbidity and mortality, prolong the length of hospital stay, and increase treatment costs.⁴⁻⁸

The incidence of MDRPI was higher in intensive care unit (ICU) patients than in those admitted to other departments. For example, Coyer et al reported that ICU patients were 3.8 times more likely than non-intensive care patients to develop a pressure injury whilst in hospital (RR 2.7-5.4, 95% CI).⁹ An exploratory descriptive study revealed that the overall incidence of MDRPI was 27.9% (50/179) with the majority (68%, 34/50) occurring in ICU.¹⁰ Previous studies have pointed out that the prevention of MDRPI requires nurses' education, and intensified monitoring at a local level.¹⁰ Wang et al found that the lack of awareness of MDRPI prevention among ICU nurses is an important factor for the increased MDRPI in ICU patients.¹¹

To date, few studies have focused on the knowledge level of MDRPI among ICU nurses. In two studies performed in the ICU nurses in Turkey, Dalli and Sönmez et al collected the data with the self-designed MDRPI Knowledge Questionnaire and demonstrated that the average percent knowledge score of ICU nurses on MDRPI was 68.4% and 61.4%, respectively.^{12,13} Surveys of the MDRPI knowledge level of ICU nurses in four different provinces in China found that there was an ordinary lack of MDRPI knowledge among ICU nurses.¹⁴⁻¹⁸ These findings motivated us to investigate ICU nurse' knowledge about MDRPI and the influencing factors.

In previous studies, questionnaires for ICU nurses' knowledge of MDRPI were developed merely based on

the literature review. However, there is a high possibility of inadequate literature review and a lack of rigorous quality evaluation for this method. Besides, the current surveys on the MDRPI knowledge of ICU nurses conducted in China are mostly single-centered as the questionnaire is performed on the ICU nurses in a single region, which yields to relatively limited sampling scope and a lack of representativeness. In this study, we developed an MDRPI knowledge questionnaire based on the summary of evidence of MDRPI. The aim of this study was to investigate ICU nurses' knowledge about MDRPI and its influencing factors, which may help to understand the level of MDRPI knowledge of ICU nurses in North, South and Central China, and to provide a basis for further construction of MDRPI knowledge training.

2 | MATERIALS AND METHODS

2.1 | Subjects and study design

This study was designed as a descriptive and cross-sectional survey. From September 2021 to December 2021, ICU nurses were selected as study subjects from Taiyuan (North China), Wuhan (Central China), Xianning (Central China), Guangzhou (South China), Foshan (South China), and Huizhou (South China) using convenience sampling. Inclusion criteria were as follows: nurses working in ICUs; those obtaining a nursing practice certificate issued by the ministry of health of China; and voluntarily participated in this study. Nurses who were not on duty during the survey due to vacation and external training were excluded from this study.

2.2 | Determination of sample size

The sample size for the survey was calculated according to the previous description, with the sample size fixed by 10 times the number of items.¹⁹ As the questionnaire had 26 items, the sample size was finally set to be 286 after an expansion of 10% considering the lack of sample response rate. Therefore, a total of 286 questionnaires were distributed in this study, and 283 were returned. Here, 21 invalid questionnaires were excluded, and 261 valid questionnaires were finally used, with an effective rate of 91.3%.

2.3 | Data collection

The data were collected using the Nurse Information Form, which included questions regarding the socio-demographic information such as age, gender, the highest educational attainment, hospital degree, hospital type, ICU type, work experience, title. In addition, MDRPI-related characteristics were also collected, including whether participants had received training on MDRPI, the last time they attended any MDRPI training or workshops, whether they had ever searched for MDRPI information online, the last time they read any MDRPI-related literature, and whether they had wound care certification.

2.4 | MDRPI knowledge questionnaire

In this study, a self-designed MDRPI knowledge questionnaire was based on the summary of evidence of MDRPI.²⁰ The questionnaire was distributed to the participants, after taking the recommendations of 15 nursing experts into consideration. Appropriate modification was given to the questionnaire based on the expert's opinion, until consensus. Finally, 6 dimensions and 26 items were set for the questionnaire. The answers to the items were "correct," "wrong" and "do not know," with "correct" being assigned a score of 1, "wrong" and "I don't know" being assigned a score of 0. Some of the items were designed to be reverse scored, for a total of 26 points. A pre-test was applied to 20 nurses who possessed the same characteristics and qualifications as the nurses in the sample to which the questionnaire would be applied in order to evaluate the comprehensibility of the statements in the measurement tool. Five of the 15 experts did the content validity evaluation for the questionnaire. The content validity index of each item (I-CVI) was 0.85-1.00, and that for the whole scale (S-CVI) was 0.92. In order to test the invariance of the data collection form over time, the test-retest internal consistency was examined, the test-retest reliability was 0.77 and the Kuder-Richardson coefficient (KR₂₀ = 0.72, >0.70) was found to be sufficient. These results indicated that the internal consistency of the items in question was quite high.

2.5 | Statistical analysis

Statistical analysis was performed using SPSS 26.0 software. The measurement data were described using the mean \pm SD. Categorical variables were summarised by frequency and percentage. The comparison between the two groups was done using *t* test. One-way ANOVA was used for comparison between multiple groups. Multiple

TABLE 1 Socio-demographic information and MDRPI-related characteristics of the participants

category	N (%) or M \pm SD
Socio-demographic and professional characteristics	
Age (years)	30.62 \pm 5.90
Gender	
Female	229 (87.7%)
Male	32 (12.3%)
Highest educational attainment	
Associate degree	52 (19.9%)
Bachelor's degree	199 (76.2%)
Postgraduate degree or above	10 (3.8%)
Hospital degree	
Tertiary hospital	223 (85.4%)
Second hospital	38 (14.6%)
Hospital type	
General hospital	211 (80.8%)
Specialised hospital	50 (19.2%)
ICU type	
General ICU	79 (30.3%)
Specialised ICU	182 (69.7%)
Work experience (years)	6.91 \pm 5.59
Title	
Nurse	64 (24.5%)
Senior nurse	123 (47.1%)
Supervisor nurse	66 (25.3%)
Co-chief nurse	8 (3.1%)
MDRPI-related characteristics	
Did you receive training on MDRPI?	
Yes	238 (91.2%)
No	23 (8.8%)
Have you attended any MDRPI training or workshops in the last year?	
Yes	116 (44.4%)
No	145 (55.6%)
Have you ever searched for MDRPI information online?	
Yes	198 (75.9%)
No	63 (24.1%)
Have you read any MDRPI-related literature in the last year?	
Yes	133 (51%)
No	128 (49%)
Are you certified as a wound therapist?	
Yes	11 (4.2%)
No	250 (95.8%)

linear regression analysis was carried out. $P < 0.05$ indicated that the difference was statistically significant.

TABLE 2 Theme scores of the overall questionnaire

Themes	Accuracy (%)	Score (M ± SD)	Max. Score
Concept and staging	28	0.56 ± 0.67	2
Risk assessment	73	2.19 ± 0.63	3
Selection and suitability of medical devices	68.6	5.49 ± 1.11	8
Application of dressings	59.0	3.54 ± 0.85	6
Skin assessment	39.2	1.57 ± 0.84	4
Skin care	79.7	2.39 ± 0.68	3
Total	60.5	15.74 ± 2.90	26

Abbreviations: M, mean; SD, standard deviation.

3 | RESULTS

3.1 | Socio-demographic information and MDRPI-related characteristics of the participants

Table 1 showed the socio-demographic and MDRPI-related characteristics of the participants. The mean age of the 261 ICU nurses was 30.62 ± 5.90 years. Among them, 32 (12.3%) were male and 229 (87.7%) were female. There were 52 (19.9%) nurses with Associate degree, 199 (76.2%) with bachelor's degrees, and 10 (3.8%) with postgraduate degree. The majority of nurses (223, 85.4%) participating in this questionnaire worked in tertiary hospitals, while the rest (38, 14.6%) worked in second hospitals. A total of 211 (80.8%) nurses were from general hospitals and 50 (19.2%) nurses from specialised hospitals. Among these nurses, 79 (30.3%) nurses worked in the general ICU and 182 (69.7%) in the specialised ICU. The average work experience was 6.91 ± 5.59 years.

For the professional title, 64 (24.5%) nurses were preliminary, and the rest were senior nurses (123, 47.1%), supervisor nurses (66, 25.3%), and co-chief nurses (8, 3.1%). Of the participants, 238 (91.2%) nurses had attended MDRPI-related training. About 44.4% of the participants had attended MDRPI-related training or lecture within the last year. About 75.9% of the participants had searched for information about MDRPI on the Internet. Among the participants, only a small proportion of the nurses (11, 4.2%) had wound care certifications.

3.2 | The knowledge level of ICU nurses about MDRPI

The average rate of correct response about MDRPIs was 60.5% (15.74 ± 2.90). The rate of each theme was shown in Table 2. Of the six themes, the highest percentage of correct responses was on “skin care” with a rate of 79.7%

(2.39 ± 0.68), while that of the “concept and staging” was the lowest, with a rate of 28% (0.56 ± 0.67).

Then, we determined the responses for each item. Three items with the lowest rate were as follows: “Medical device should be tightly fixed to avoid displacement (9.6%)” categorised to “Selection and suitability of medical devices” theme; “Hydrosol dressings are superior to foam dressings in the prevention of MDRPIs (11.1%),” which was categorised into the dimension of “application of prophylactic dressings”; “To avoid the occurrence of MDRPIs, the skin under and around the medical device should be checked at least once a day (14.9),” belonging the dimension of “skin assessment” (Table 3).

3.3 | The relationship between nurses' demographic characteristics and nurse knowledge score of MDRPI

The differences in knowledge scores were statistically significant among the participants grouped according to age ($P = 0.038$), the highest educational attainment ($P = 0.000$), hospital degree ($P = 0.000$), and ICU type ($P = 0.033$) (Table 4). Whether nurse had received training on MDRPI ($P = 0.000$), when they last attended any MDRPI training or workshops ($P = 0.008$), whether they had ever searched for MDRPI information online ($P = 0.025$), and whether they had wound care certifications ($P = 0.000$) significantly affected their scores (Table 5).

3.4 | Multiple linear regression analysis for nurse knowledge scores of MDRPI and nurses' socio-demographic, and MDRPI-related characteristics

In this section, multiple regression analysis was performed based on the independent variables screened after

TABLE 3 Knowledge of ICU nurses about MDRPI

Items	Accuracy (%)
Concept and staging	
1. MDRPIs are pressure injuries caused by medical devices instead of non-medical devices (eg, mobile phones, pens, etc.). ^a	35.2
2. International pressure injury classification stages (eg, Stage I, Stage II) are used to categorise MDRPI that develop on the mucous membranes. ^a	20.3
Risk assessment	
3. All patients using medical devices are at risk of developing MDRPIs.	88.5
4. Critical patients, newborns, and the elderly are the high-risk groups for MDRPIs.	98.1
5. Risk assessment for MDRPIs should be completed for each patient within 12 hours of admission. ^a	32.6
Selection and suitability of medical devices	
6. The selection of medical devices should follow the manufacturer's recommendations.	37.2
7. The appropriate medical device with the right size should be chosen for the patient to avoid MDRPIs.	97.3
8. Medical device should be tightly fixed to avoid displacement. ^a	9.6
9. For patients requiring mechanical ventilation, a softer tracheal tube may reduce the incidence of MDRPIs.	87.7
10. For patients with cervical spine injuries, a neck brace needs to be worn until healing occurs. ^a	60.2
11. Alternating oxygen administration with a face mask and nasal plugs, while ensuring safety, can reduce nasal and facial pressure injuries during oxygen therapy in neonates, children, and adults.	88.9
12. The bridging method or elevated platform bridging method is used to fix the pipeline to reduce the occurrence of pressure damage.	98.9
13. The indwelling urinary catheter should be placed under the patient's leg. ^a	69.7
Application of dressings	
14. A foam dressing placed between the non-invasive ventilation mask and the skin can reduce pressure.	93.1
15. The device needs to be moved daily to assess the skin, and prophylactic dressings are selected that can be moved repeatedly and removed without damaging the skin.	83.5
16. If the prophylactic dressing is broken, displaced, loose, or too wet, the dressing should be replaced and the skin reassessed.	76.2
17. Multi-layer prophylactic dressings are more effective in reducing pressure and should be placed under medical-device to prevent the occurrence of MDRPIs. ^a	53.3
18. Prophylactic placement of a hydrocolloid dressing on the skin at the site of pressure caused by the tracheotomy tube fixation belt reduces the incidence of MDRPIs.	89.7
19. Hydrosol dressings are superior to foam dressings in the prevention of MDRPIs. ^a	11.1
Skin assessment	
20. A comprehensive skin assessment should be performed and documented for each patient within 12 hours of admission. ^a	25.7
21. Patients at risk for skin injury should be evaluated daily and closely monitored for skin or mucosal compression, especially skin at the bony augmentation site, and skin or mucosa in contact with and around medical devices.	96.9
22. To avoid the occurrence of MDRPIs, the skin under and around the medical device should be checked at least once a day. ^a	14.9
23. For patients with generalised edema, the skin under and around the medical device should be checked twice daily to avoid MDRPIs. ^a	19.2
Skin care	
24. The skin under the medical device should be maintained clean and dry.	89.7
25. Alkaline skin cleanser can be used to wash the skin. ^a	57.5
26. It is important that skin at risk of pressure damage should not be massaged or vigorously scrubbed.	92.0

^aShows incorrect statement.

TABLE 4 The relationship between nurses' demographic variables and knowledge of MDRPI

Demographic variables	Frequency, N (%)	Scores (M ± SD)	t/F-values	P-values
Age (years)				
<25	57 (21.8)	15.49 ± 2.75	2.854	0.038*
26-30	85 (32.6)	15.53 ± 3.42		
31-35	66 (25.3)	16.62 ± 2.44		
>35	53 (20.3)	15.26 ± 2.51		
Gender				
Male	32 (12.3)	16.41 ± 3.94	1.050	0.301
Female	229 (87.7)	15.65 ± 2.72		
Highest educational attainment				
Associate degree	52 (19.9)	15.12 ± 2.22	20.407	0.000*
Bachelor's degree	199 (76.2)	15.64 ± 2.81		
Postgraduate or above	10 (3.8)	21 ± 2.79		
Hospital degree				
Second-class hospital	38 (14.6)	12.87 ± 3.04	−6.436	0.000*
Tertiary hospital	223 (85.4)	16.23 ± 2.58		
Hospital type				
General hospital	211 (80.8)	15.84 ± 3.06	1.393	0.167
Specialised hospital	50 (19.2)	15.34 ± 2.05		
ICU type				
General ICU	79 (30.3)	15.16 ± 2.71	−2.138	0.033*
Specialised ICU	182 (69.7)	15.99 ± 2.95		
Work experience (years)				
<5	112 (42.9)	15.9 ± 3.08	0.795	0.529
6-10	98 (37.5)	15.54 ± 2.91		
11-15	35 (13.4)	15.83 ± 2.37		
16-20	9 (3.4)	16.67 ± 3.16		
>20	7 (2.7)	14.43 ± 1.51		
Title				
Nurse	64 (24.5)	15.41 ± 2.30	0.431	0.731
Senior nurse	123 (47.1)	15.83 ± 3.30		
Supervisor nurse	66 (25.3)	15.85 ± 2.63		
Co-chief nurse	8 (3.1)	16.25 ± 3.01		

* $P < 0.05$.

univariate analysis, including age, the highest educational attainment, hospital degree, ICU type, attended training on MDRPI or not, time for the last attended training or workshops on MDRPI, whether they had searched information about MDRPI online, and whether they had wound care certifications. The criteria for assigning values to each variable were shown in Table 6. There were significant relationships between the total score and the participants' hospital degree ($P = 0.000$), the highest education attainment ($P = 0.007$), whether the participants had wound care certifications

($P = 0.001$), the last time the participants attended an MDRPI training or workshops ($P = 0.038$), and whether the participants have received training on MDRPI ($P = 0.004$) (Table 7).

3.5 | Ethical statements

This survey has been approved by the institutional review board of Huizhou Health Sciences Polytechnic. The purpose and significance of the survey have been explained

TABLE 5 MDRPI-related characteristics correlation with knowledge scores of ICU nurses

MDRPI-related characteristics	Frequency, N (%)	Scores (M \pm SD)	t/F-values	P-values
Did you receive training on MDRPI?				
Yes	238 (91.2)	16.06 \pm 2.66	6.116	0.000*
No	23 (8.8)	12.43 \pm 3.24		
The last time participants attended any MDRPI training or workshops (years).				
<1	117 (44.8)	16.44 \pm 2.83	3.500	0.008*
1-2	59 (22.6)	15.41 \pm 3.59		
2-3	32 (12.3)	15.28 \pm 2.64		
>3	30 (11.5)	14.83 \pm 1.74		
Never	23 (8.8)	14.87 \pm 2.10		
Have you ever searched for MDRPI information online?				
Yes	198 (75.9)	15.97 \pm 2.88	2.253	0.025*
No	63 (24.1)	15.03 \pm 2.86		
The last time participants read any MDRPI-related literature.				
<1	133 (51)	16.05 \pm 2.63	1.022	0.397
1-2	44 (16.9)	15.47 \pm 3.58		
2-3	32 (12.3)	15.72 \pm 3.31		
>4	31 (11.9)	15.45 \pm 3.02		
Never	21 (8)	14.85 \pm 1.96		
Are you certified as a wound therapist?				
Yes	11 (4.2)	19.91 \pm 3.36	5.095	0.000*
No	250 (95.8)	15.56 \pm 2.74		

* $P < 0.05$.

to the respondents. The principle of voluntary participation and confidentiality of information has been followed.

4 | DISCUSSION

This study investigated ICU nurses' knowledge of MDRPI. The MDRPI knowledge questionnaire was adapted from the evidence summary of MDRPI prevention. The participants were enrolled from six hospitals in Taiyuan, Wuhan, Xianning, Guangzhou, Foshan, and Huizhou cities of China. The results of this study indicated that the nurses' knowledge of MDRPIs was insufficient. The average rate of correct response about MDRPI was 60.54% (15.74 \pm 2.90), and the results of this study were similar to those of previous reports.^{12,13,16} However, our results differed from the findings of Zhang,¹⁴ who derived 82.87% (149.14 \pm 24.62) score of MDRPI knowledge among ICU nurses. This may be related to the fact that different tools for survey, items and scoring methods were utilised.

The lowest percentage of correct responses was on the "Concept and staging" dimension with a rate of 28%,

which was consistent with the results of Sönmez et al.¹³ The "staging" dimension in Sönmez's study scored 41.6%, both Sönmez's study and the present study showed that ICU nurses lacked knowledge of staging of MDRPI. Item 2 "International pressure injury classification stages (eg, Stage I, Stage II) are used to categorize medical device-related pressure injuries that develop on the mucous membranes" in the "Concept and staging" theme of this study is approximately the same as that of previous studies,^{12,13} and the results are consistent. The rate of item 2 in the "Concept and staging" theme was 20.3%, compared with 7.37% for Erbay Dalli et al.¹² and 57.7% for Sönmez et al.,¹³ suggesting that nurses lack knowledge of stage on a mucous membrane. Because mucosal injuries develop more rapidly than skin injuries, more systematic daily assessment of high-risk areas (eg, nose and lips) to reduce or mitigate mucosal injuries.²¹ In summary, the results suggest that there is still a need to enhance the training of nurses in their ability to assess the staging of mucosal pressure injuries.

The rate of the "Skin assessment" dimension in this study was only 39.2%, compared to 83.6% for Erbay Dalli et al.,¹² indicating that the ICU nurses lacked knowledge of the MDRPI related to skin assessment. We compared

some descriptions by Erbay Dalli and Sönmez et al to analogous expressions in our study. In the “Skin assessment” them, the rate of item 22 “To avoid the occurrence of MDRPIs, the skin under and around the medical device should be checked at least once a day” was only 14.9%. The description of item 22 is consistent with the item of Erbay Dalli et al¹² and Sönmez et al.¹³ The rate of the item was 86.9% in the study of Erbay Dalli et al¹² and 52.1% in the study of Sönmez et al.¹³ The lower correct rate of this item in this study compared to previous studies may be due to the lack of knowledge of the MDRPI skin assessment among our participants. We considered

TABLE 6 The criteria for assigning values to each variable

Variables	Scoring
Age (years)	1 = ≤ 25, 2 = 26-30, 3 = 31-35, 4 = ≥ 36
Highest educational attainment	1 = Secondary technical education, 2 = Junior college, 3 = Undergraduate, 4 = Postgraduate or above
Hospital degree	1 = Level 2 grade B, 2 = Level 2 grade A, 3 = Level 3 grade B, 4 = Level 3 grade A
ICU type	1 = General ICU, 2 = Specialised ICU
Did you receive training on MDRPI?	1 = Yes, 2 = No
The last time participants attended any MDRPI training or workshops (years)	1 = < 1, 2 = 1-2, 3 = 2-3, 4 = >4, 5 = Never
Have you ever searched for MDRPI information online?	1 = Yes, 2 = No
Are you certified as a wound therapist?	1 = Yes, 2 = No

item 23 “For patients with generalized edema, the skin under and around the medical device should be checked twice daily to avoid MDRPIs” in our study analogous to that of Erbay Dalli and Sönmez et al.^{12,13} However, the rate of item 23 in this study was only 19.2%, compared to 82.8% in the study by Erbay Dalli et al¹² and 94.6% in the study by Sönmez et al.¹³ The possible reason for the inconsistency of this item with the results of previous studies is that this study was a reverse scoring item. Erbay Dalli and Sönmez et al designed a positive scoring item, which was easier to score.^{12,13} On the other hand, it indicated that nurses lack knowledge of skin assessment in special patients using medical devices. Previous studies have shown that skin assessment is a prerequisite for guiding nurses to take preventive measures.²² Nursing administrators should increase the frequency of training nurses in skin assessment knowledge, especially for patients using medical devices and high-risk patients.

It is noteworthy that the item 8 “Medical instruments should be tightly fixed to avoid displacement” is the same as the item of Sönmez et al.¹³ However, the rate of item 8 in this study was only 9.6%, which is much lower than the rate of 49.3% reported by Sönmez et al.¹³ This may be due to the fact that it is based on the knowledge from 2019 guidelines²³ and the training is not up to date on the content of device fixation in China. Nurses who are unaware that improperly fixed medical devices can cause additional stress are likely to contribute to the occurrence of MDRPI. When organising MDRPI training, nursing administrators should update the training content according to the latest guidelines. The rate of item 19 “Hydrosol dressings are superior to foam dressings in the prevention of MDRPIs” was only 11.1%, suggesting that ICU nurses lack knowledge in the selection of prophylactic dressings. Nursing administrators should strengthen nurses’ knowledge about prophylactic dressings in future training, especially how to select dressings and the timing of dressing application.

TABLE 7 Multivariate linear regression analysis

Variables	Unstandardized B	SE	Standardised Coefficients beta	t-values	P-values
Constants	16.631	2.765		6.014	0.000
Hospital degree	1.170	0.270	0.285	4.341	0.000
Highest educational attainment	0.942	0.347	0.150	2.712	0.007
Whether the participants had wound care certification	-2.704	0.813	-0.188	-3.324	0.001
The last time the participants attended an MDRPI training or workshops	-0.248	0.119	-0.115	-2.087	0.038
Whether the participants have received training on MDRPI	-1.911	0.667	-0.187	-2.867	0.004

Note: $R^2 = 0.308$, adjusted $R^2 = 0.286$, $F = 14.001$, P -value = 0.000.

This study found that the factors influencing MDRPI prevention knowledge included: hospital level, the highest educational attainment, whether or not they have wound care certifications, whether or not they had attended MDRPI training or lectures, and when they had last attended MDRPI training or lectures. ICU nurses in tertiary hospitals have higher MDRPI knowledge scores than in secondary hospitals, which has also been reported by Zhang and Wei et al.^{14,16} The results indicated that tertiary hospitals have more educational resources to carry out MDRPI training, suggesting that nursing administrators in secondary hospitals should pay attention to the training of ICU nurses in MDRPI and build a medical consortium with tertiary hospitals to carry out MDRPI training together. ICU nurses with graduate degrees had higher MDRPI knowledge scores than undergraduates and Associate degrees, and the results of this study were consistent with Dalli's findings.¹² Nurses with graduate degrees are provided with more opportunities for training and are more capable of independent learning. Besides, nurses with graduate degrees are more adept at searching the literature from various sources to update their knowledge about MDRPI. Therefore, nursing administrators should create incentives to encourage nurses to upgrade their education. Nurses who attended MDRPI training had higher MDRPI knowledge scores than ICU nurses who did not receive training. This result is consistent with the findings of Sönmez et al.¹³ MDRPI training can improve ICU nurses' knowledge of MDRPI, suggesting that nursing administrators should develop a training program for MDRPI at the institutional level, normalise and standardise MDRPI, and ensure that ICU nurses have received MDRPI training. Nurses with less than 1 year of training had higher MDRPI knowledge scores than nurses with more than 1 year of training. The reason for this is that the knowledge questionnaire for this study was adapted based on the MDRPI evidence summary. The guidelines for sources of evidence were updated for release in 2019 and published in the China Interpretation Edition in 2020. Nurses with less than 1 year of training had their knowledge updated in a timely manner. Therefore, training content should be kept up to date. Nurses with a wound care certification had a much higher MDRPI knowledge score than nurses without a wound care certification. This result is consistent with the findings of Zulkowski et al.²⁴ Possible reasons for this are that nurses with a wound care certification have attended more training on pressure injuries, have read books and guidelines related to pressure injuries, and are more active in updating information related to pressure injuries.²¹ This result suggests that nursing administrators need to train wound specialist nurses with a wound care certification to perform wound care.

5 | CONCLUSIONS

The level of MDRPI knowledge of ICU nurses needs to be improved. Factors influencing MDRPI knowledge include hospital level, the highest educational attainment, whether they had wound care certifications when they last attended MDRPI training or lectures, and whether they have attended MDRPI training or lectures. Nursing administrators should focus on MDRPI training and develop MDRPI training programs. The training content should be updated according to the latest evidence. Efforts should also be made to train wound care specialist nurses to improve the quality of care for MDRPI and reduce the incidence of MDRPI.

6 | LIMITATIONS

This study used convenience sampling with a small sample size. The sampling scope and sample size can be expanded in the future to conduct in-depth research studies of ICUs in multi-region and multi-level hospitals.

AUTHOR CONTRIBUTIONS

Fang Fu and Xiaoli Wang: study design, data analysis, and paper writing; Lanlan Zhang: research guidance and paper revision; Jiexin Fang, Fangfang Wang: Acquisition of data.

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Not applicable.

CONFLICT OF INTEREST

All authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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