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Pressure injury prevalence and risk factors in Chinese adult intensive care units: A multi-centre prospective point prevalence study

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Abstract

Despite increasing preventive efforts, pressure injury still occurs in intensive care patients. This study was aimed to describe pressure injury prevalence, risk factors, and prevention practices in adult intensive care patients. This was a multi-centre, one-day, prospective point prevalence study in which a total of

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198 intensive care units from 21 provinces in China participated. Overall and ICU-acquired prevalence in intensive care patients were 12.26% and 4.31%, respectively. Consistent with earlier reports, almost half of the ICU-acquired pressure injuries were at stage I, one-fourth were at stage 2, and the most common body sites for pressure injuries were sacral and heel region. Risk factors identified were consistent with prior studies. Repositioning was the most commonly used pressure injury prevention strategy, followed by alternating pressure mattresses/overlays, floating heels, and air-filled mattresses/overlays. These reflect a good level of adherence to recommended international pressure injury prevention clinical practice guidelines. The results provide a baseline reference for overall and ICU-acquired prevalence among adult intensive care patients in China. Future research on what contributed to the lower pressure injury incidence in China needs to be conducted to inform healthcare organisations on their future preventive strategies for pressure injury prevention.

KEYWORDS

critical care, pressure injury, prevalence, prevention, risk factors

Key Messages

- this first large-scale prospective study conducted in adult intensive care units in China provides important baseline data on pressure injury prevalence, risk factors, and prevention strategies used in this population in the Chinese context
- repositioning, alternating pressure mattresses/overlays, floating heels, and air-filled mattresses/overlays were the common prevention strategies
- future research needs to be conducted to explore why overall and ICU-acquired prevalence of pressure injuries found in this study were lower than those reported in other countries and in the international population
- future research is needed to help understand the contributing factors to the differences in pressure injury prevalence, risk factors, and prevention practices across regions

1 | INTRODUCTION

Pressure injury (PI) is an adverse event that occurs in patients admitted into hospitals.[1] It is defined as localised lesions to the skin or underlying tissue caused by pressure or pressure combined with shear.[2] PI contributes to significant patient morbidity and mortality, reduces quality of life, and adds significant costs to the healthcare system and burden to patients.[3-5] A systematic review found that the cost per patient for pressure injury prevention and treatment ranged from US$18 to US$84832, expressed as current valuta, across different settings in the United States, United Kingdom, the Netherlands, Germany, and Spain.[6] Intensive care patients are at higher risk for PI due to immobility, vasopressor medication use, and poor perfusion.[7] It has been reported that PI incidence in the intensive care population was 10.0% to 25.9%,[8] which is much higher than those in the general hospital population (5.4%).[9]

A nationwide study conducted in China reported a hospital-acquired PI incidence rate of 1.23% in immobile patients,[3] and 0.63% to 1.54% in hospitalised patients,[10,11] which was significantly lower than those reported from other countries.[9] What factors contributed to these differences is unknown. To our knowledge, to date, the extent of PI occurrence, risk factors to PI in adult intensive care patients in Chinese hospitals have not been reported. The findings from this large study will provide a clear understanding of the PI occurrence and prevention practices in the intensive care units (ICU) in China, which may inform researchers and clinicians on their PI prevention research and practice worldwide.

2 | AIM

This study was aimed to describe the PI prevalence and risk factors in intensive care patients in China. Specifically, we aimed to answer the following questions:

1. What is the prevalence of overall and ICU-acquired PIs in adult ICU patients in China?
2. What are the location and stages of ICU-acquired PIs in this population?
3. What are the differences in ICU-acquired PIs in different types of ICUs, types of hospitals, hospital levels, and ICUs located in different geographic areas in China?
4. What are the risk factors for pressure injuries in adult ICU patients in China?
5. What PI prevention strategies are used in adult ICU patients in China?
6. What are the differences in PI prevention strategy used among ICUs located in different jurisdictional/geographic areas in China?

3 | METHOD

This was a multi-centre, one-day, prospective point prevalence study, with a follow-up outcome assessment until hospital discharge (maximum of 12 weeks). In 2018, an international point prevalence study[12] was conducted to describe PI prevalence and risk factors, in which 198 ICUs from Mainland China participated in the data collection. We undertook a secondary data analysis for the data collected in Mainland China with an aim to interpret the findings in relation to the Chinese healthcare context. In this paper, we name the secondary data analysis as "this study," and the main international study as "the bigger study."

3.1 | Study team

The China study team consisted of three national representatives, led by the first author, who coordinated the site recruitment, data collection preparation and training, and data collection in China for the international study. A provincial coordinator was recruited from participating provinces to coordinate data collection within their provinces. Each study site (ICUs) nominated their own coordinator for the data collection.

3.2 | Setting

The study was conducted in 198 adult ICUs of 161 hospitals, from 21 provinces and municipalities in Mainland China.

3.3 | Sample

All adult patients (≥18 years) staying in the participating ICUs on the data collection day (15 May 2018) were recruited to participate in the study. There were no exclusion criteria.

3.4 | Tool translation and testing

The English version data collection tools, including a case report form and a centre (ICU) report form, which were rigorously developed and tested by the executive research committee of the bigger study,[12] were translated into Chinese following a commonly used back-translation process.[13] They were translated into Chinese by an experienced Australian nurse who is fluent in both English and Chinese, and then the Chinese version was translated back into English by another bilingual nurse from China. The two versions were compared by the lead author (FL), and revisions were made. The tools were then tested by a panel of PI expert clinicians working in various hospitals throughout China, and revisions, mainly the tweaking of the language to suit the Chinese context, were made.

The case report form included data in the following categories: demographic data, physiological data on the study day, the severity of disease assessment using the Simplified Acute Physiology Score II (SAPS II).[14] PI occurrence was measured by direct observation according to the international staging definitions.[15] PI risk was assessed using the Braden Scale that combines six sub-scales: mobility, activity, sensory perception, skin moisture, nutritional state, and friction/shear, with lower scores reflecting higher risk.[16] The centre report form included information such as type and capacity of the hospital and ICU, ICU speciality, number of occupied beds and number of nurses on the day of the study, preventive measures and risk assessment scale used in ICU, and the primary trigger to use extra preventive measures for the patients. The English version of the main study protocol, which contains detailed definitions for terms used in the data collection, and data collection instructions can be accessed online.[17]

3.5 | Data collection training

To ensure the consistency of data collected and the quality and accuracy of data entered, and because this was the first time when many of the site coordinators ever participated in a research project, rigorous training for the provincial coordinators and site coordinators was conducted by two of the lead authors (FL and JL). A suite of training materials including the translated training module for PI staging developed by the bigger study

team,[12] a PowerPoint with screenshots of the web page for online data entry, and all the English words in the screenshots were translated into Chinese. A chatroom on the Chinese social media platform Wechat[18] was established to facilitate effective communication among coordinators from each study site. Before the formal data collection day, all data collection sites participated in a pilot data collection on the same day, which gave the site data collectors the opportunity to clarify any questions/issues they encountered, and the way data were entered.

3.6 | Data collection

The study sites were recruited through Chinese intensive care professional bodies, at conference events, and through the research team members' professional networks. On 15 May 2018, data were collected in the ICUs that agreed to participate in the study. Study site coordinators completed one centre report form (including type of hospital and ICU speciality) for each ICU, and one case report form (including patient demographics, data on severity of underlying disease and acute illness, organ failure, pressure ulcers, major risk factors for pressure ulcers, and measures taken to prevent pressure injuries) for each patient who was in the ICU on the day from midnight to midnight.

Some site coordinators entered their data into the online data form directly. For the ICUs where the site coordinators could not read English, data were collected on paper using the Chinese version data collection forms, which were later scanned and emailed to two study team members in China who entered the data into the electronic data entry form on the bigger study project's website. After the international data collection day, the bigger study team downloaded the data, checked the data, and entered the data into SPSS as reported in the published bigger study paper.[12] The main study team then emailed the data in SPSS database for all Chinese ICUs to this study team for secondary data analysis. All Chinese study sites agreed for the data to be used in this secondary data analysis.

3.7 | Primary outcome

Overall PI prevalence was calculated as the number of patients with at least one PI divided by the number of all patients in this study on the study day. ICU-acquired PI was defined as PI acquired in ICU prior or on the study day (no time limits). ICU-acquired PI prevalence was calculated as the number of all patients in this study on the study day divided by the number of patients with at least one PI acquired in ICU during this admission up to the day when this survey was conducted.

PI assessment and staging followed the classification system including stage I to stage IV, unstageable, and suspected deep tissue injury, recommended in the Prevention and Treatment of Pressure Injuries: clinical practice guideline.[15,19]

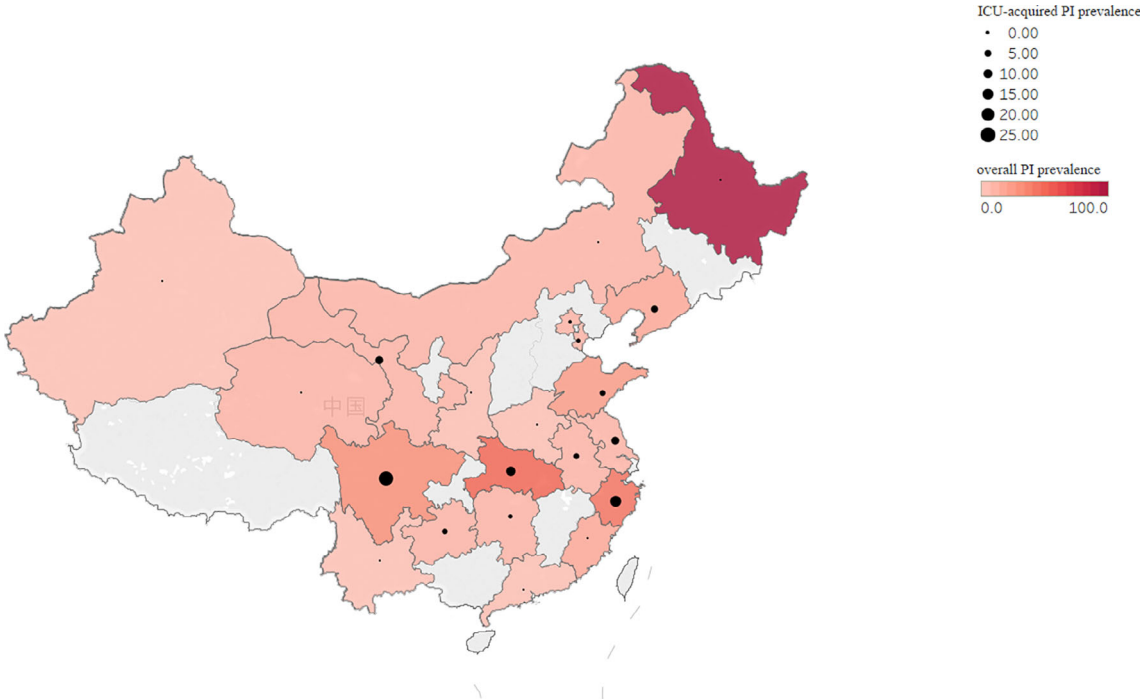

FIGURE 1 Geographical locations of participating sites in China, and pressure injury prevalence

TABLE 1 Characteristics of included patients (n = 2459)

Variables		All patients (n = 2459)	Patients without ICU-acquired pressure injuries (n = 2353) n (%)	Patients with ICU-acquired pressure injuries (n = 106) n (%)	Z/χ^2 value	*P* value
Age (M, IQR)		66 (52.0, 78.0)	66 (52.0, 78.0)	73(54.8, 84.0)	−2.860	0.004
Gender	Male	1574 (64)	1500(63.7)	74 (69.8)	1.618	0.203
BMI[#] (M, IQR)		24.03 (21.3, 25.6)	23.94 (21.4, 25.6)	25.14 (21.3, 26.0)	−1.152	0.249
Source of admission (n, %)*[a]	Other hospital	179 (7.3)	174(7.4)	5 (4.7)	11.732	0.019
	Emergency Room	852 (34.8)	819 (35.0)	33 (31.1)		
	Operating Room	501 (20.5)	487 (20.8)	14 (13.2)		
	General ward	758 (31.0)	710 (30.3)	48 (45.3)		
	Other	157 (6.4)	151(6.5)	6 (5.7)		
Mechanical ventilation on ICU admission *[b]	Yes	1376 (56.3)	1300 (55.6)	76 (72.4)	11.467	0.001
	No	1066 (43.7)	1037 (44.4)	29 (27.6)		
Type of admission	Medical	1142 (46.4)	1087 (46.2)	55 (51.9)	1.989	0.575
	Elective surgical	693 (28.2)	669 (28.4)	24 (22.6)		
	Emergency surgical	514 (20.9)	492 (20.9)	22 (20.8)		
	Trauma and Burns	110 (4.5)	105 (4.5)	5 (4.7)		
Primary diagnosis						
Admission reason: neurological	No	1864 (75.8)	1791 (76.1)	73 (68.9)	2.905	0.088
	Yes	595 (24.2)	562 (23.9)	33 (31.1)		
Admission reason: respiratory	No	1836 (74.7)	1768 (75.1)	68(64.2)	6.473	0.011
	Yes	623 (25.3)	585 (24.9)	38 (35.8)		
Admission reason: cardiovascular	No	2124 (86.4)	2023 (86.0)	101 (95.3)	7.467	0.006
	Yes	335 (13.6)	330 (14.0)	5 (4.7)		
Number of comorbidities	0	1277 (51.9)	1233 (52.4)	44 (41.5)	30.422	<0.001
	1	675 (27.5)	651 (27.7)	24 (22.6)		
	2	313 (12.7)	298 (12.7)	15 (14.2)		
	3	140 (5.7)	124 (5.3)	16 (15.1)		
	>3	54 (2.2)	47 (2.0)	7 (6.6)		
Comorbidities						
COPD	No	2244 (91.3)	2154(91.5)	90 (84.9)	5.60	0.018
	Yes	215 (8.7)	199 (8.5)	16 (15.1)		
Malignancy	No	2333 (94.9)	2237 (95.1)	96 (90.6)	4.233	0.040
	Yes	126 (5.1)	116 (4.9)	10 (9.4)		
Immunocompromised	No	2399 (97.6)	2300 (97.7)	99 (93.4)	6.343	0.012
	Yes	60 (2.4)	53 (2.3)	7 (6.6)		
Heart failure	No	2313 (94.1)	2218 (94.3)	95 (89.6)	3.910	0.048
	Yes	146 (5.9)	135 (5.7)	11 (10.4)		
Impaired mobility	No	1941 (78.9)	1871 (79.5)	70 (66.0)	11.081	0.001
	Yes	518 (21.1)	482 (20.5)	36 (34.0)		
Malnutrition	No	2305 (93.7)	2211(94.0)	94 (88.7)	4.828	0.028
	Yes	154 (6.3)	142 (6.0)	12 (11.3)		
Therapeutic hypothermia use*[c]	No	2165 (88.8)	2079 (89.1)	86 (82.7)	4.078	0.043
	Yes	273 (11.2)	255 (10.9)	18 (17.3)		
Vasopressor use *[d]	No	2112 (86.3)	2022 (86.4)	90 (84.9)	0.195	0.659
	Yes	334 (13.7)	318 (13.6)	16 (15.1)		
Sedation use*[e]	No	1818 (74.2)	1739 (74.2)	79 (74.5)	0.005	0.944
	Yes	631 (25.8)	604 (25.8)	27 (25.5)		

(Continues)

TABLE 1 (Continued)

Variables		All patients (n = 2459)	Patients without ICU-acquired pressure injuries (n = 2353) n (%)	Patients with ICU-acquired pressure injuries (n = 106) n (%)	Z/χ^2 value	*P* value
Muscle relaxant use*[f]	No	2416 (99.0)	2312 (99.0)	104 (98.1)	0.167	0.683
	Yes	25 (1.05)	23 (1.0)	2 (1.9)		
Mechanical ventilation on study day *[g]	No	1353 (55.3)	1317 (56.3)	36 (34.0)	20.484	<0.001
	Yes	1092 (44.7)	1022 (43.7)	70 (66.0)		
Simplified Acute Physiology Score II category[§]	≤23	581 (23.6)	572 (24.3)	9 (8.5)	37.273	<0.001
	24–33	607 (24.7)	595 (25.3)	12 (11.3)		
	34–44	565 (23.0)	531 (22.6)	34 (32.1)		
	≥45	706 (28.7)	655 (27.8)	51 (48.1)		
Braden score category[&] *[h]	No risk (19–23)	147 (6.1)	147 (6.3)	0 (0)	41.058	<0.001
	Mild risk (15–18)	470 (19.4)	463 (20.0)	7 (6.6)		
	Moderate risk (13, 14)	421 (17.4)	409 (17.7)	12 (11.3)		
	High risk (10–12)	1003 (41.4)	951 (41.1)	52 (49.01)		
	Very high risk (≤9)	381 (15.7)	346 (14.9)	35 (33.0)		
Length of stay in ICU before study day (days) (M, IQR) *[j]		5 (1, 14)	5 (1, 13)	17 (7.75, 31.75)	−7.581	<0.001

[#]Body Mass Index is body weight in kilograms divided by body height in meters squared.
[§]Range of possible scores is 0∼163; a higher SAPS II score indicates a higher severity of disease and acute illness; scores are categorized according to the sample's quartiles.
[&]Range of possible scores is 6∼23.
*Missing data: a:12; b:17; c: 21; d: 13; e: 10; f: 18; g:14; h: 37; j: 7.

3.8 | Data analysis

Data were analysed using SPSS Version 26.0.[20] For continuous variables, data were summarised as median and interquartile range (IQR). For categorical variables, data were summarised as frequencies and percentages. No assumptions were made for missing data. Chi-square test and Mann-Whitney *U* test were used to compare the patients with and without pressure injuries. A logistic regression model was used to identify the possible risk factors for ICU-acquired PIs. Those variables that showed a statistically significant difference in the univariate analysis were included in the multivariate analysis at $P < .05$, and removed from the model at $P > .10$. Dummy variables were created for categorical determinants. A two-tailed $P < .05$ was considered statistically significant. A likelihood ratio (LR) with forward entry was used to examine the possible variables. The results of the logistic regressions are presented as odds ratios (ORs), 95% confidence intervals (CIs), and corresponding *P* values.

3.9 | Ethical considerations

Ethical review was granted by the Institutional Ethics Committee of Peking University First Hospital (Number: 2018-Research-63). This ethical approval was submitted to the ethics committees of other hospitals involved in the study and passed ethical review. Because we did not collect any identifiable patient information and because of the non-interventional nature of the study, patient consent was not required as approved by the ethics committees.

4 | RESULTS

A total of 2459 patients were included in the survey, which were from 198 ICUs of 161 hospitals, situated in 21 provinces and municipalities throughout Mainland China. This represents 21 of 32 (66%) provinces and municipalities in Mainland China (see Figure 1). Patients' demographic characteristics are presented in Table 1.

4.1 | PI prevalence

There were a total of 474 pressure injuries documented for 304 patients on the study day, which shows an overall PI prevalence of 12.36% (calculated as 304 of 2459 patients), and an ICU-acquired prevalence of 4.31% (106 of 2459 patients).

A total of 164 ICUs were part of level 3 (tertiary) hospitals (highest level hospitals that are often located in major cities, and provide full range of healthcare services) and 34 ICUs were from level 2 hospital (mid-level referral

TABLE 2 Overall and ICU-acquired PI prevalence according to regions (n = 2459)

	All (n = 2459)	North China (n = 858)	Northeast China (n = 288)	East China (n = 525)	Central South China (n = 70)	Southwest China (n = 636)	Northwest China (n = 82)
Patients with at least one pressure injury (n)	304	71	51	102	14	58	8
Overall Pressure injury prevalence (%)	12.36%	8.28%	17.71%	19.43%	20%	9.12%	9.76%
Patients with at least one ICU-acquired pressure injury (n)	106	14	22	32	3	33	2
ICU-acquired pressure injury prevalence (%)	4.31%	1.63%	7.64%	6.10%	4.29%	5.19%	2.44%

Note: North China: example cities include Beijing, Tianjin, Hohhot. Northeast China: example cities include Shenyang, Jinzhou, Dalian. East China: example cities include Jinan, Anqing, Hefei. Central South China: example cities include Wuhan, Changsha, Jingzhou. Southwest China: example cities include Guiyang, Zunyi, Liupanshui. Northwest China: example cities include Lanzhou, Xining, Urumqi.

TABLE 3 ICU-acquired pressure injuries according to anatomical location and stages

Anatomical location	Stage I n (% within each body site)	Stage II n (% within each body site)	Stage III n (% within each body site)	Stage IV n (% within each body site)	Unstageable n (% within each body site)	Suspected deep tissue injury n (% within each body site)	Total n (%)	All body sites (%) N = 156
Head	8 (61.54)	1 (7.69)	1 (7.69)	0 (0)	1 (7.69)	2 (15.38)	13 (100)	8.33
Ears	1 (100)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (100)	0.64
Nose	1 (33.33)	2 (66.67)	0 (0)	0 (0)	0 (0)	0 (0)	3 (100)	1.92
Mouth	0 (0)	2 (100)	0 (0)	0 (0)	0 (0)	0 (0)	2 (100)	1.28
Chest	0 (0)	1 (50)	1 (50)	0 (0)	0 (0)	0 (0)	2 (100)	1.28
Shoulder back	0 (0)	4 (80)	0 (0)	1 (20)	0 (0)	0 (0)	1 (100)	3.21
Hips	3 (21.43)	7 (50)	1 (7.14)	3 (21.43)	0 (0)	0 (0)	14 (100)	8.97
Genitals	1 (25)	1 (25)	0 (0)	2 (50)	0 (0)	0 (0)	4 (100)	2.56
Sacral region	32 (45.71)	14 (20)	10 (14.29)	5 (7.14)	1 (1.43)	8 (11.43)	70 (100)	44.87
Knees	0 (0)	3 (75)	1 (25)	0 (0)	0 (0)	0 (0)	4 (100)	2.56
Calves	6 (66.67)	2 (22.22)	1 (11.11)	0 (0)	0 (0)	0 (0)	9 (100)	5.77
Feet	3 (75)	25	0 (0)	0 (0)	0 (0)	0 (0)	4 (100)	2.56
Heels	19 (76)	1 (4)	1 (4)	0 (0)	1 (4)	3 (12)	25 (100)	16.03
Total (n, %)	74 (47.44)	39 (25)	16 (10.26)	11 (7.05)	3 (1.92)	13 (8.33)	156 (100)	100

Note: No pressure injury recorded in the following locations: forehead, cheeks, chin, throat, shoulder front, back, forearms, thighs, ankles, toes, elbows, and hands.

healthcare facilities that deliver main healthcare services) in the Chinese hospital classification system.[21] Most of the participating ICUs were mixed medical-surgical ICUs (n = 139; 70.2%) and in university hospitals (n = 111; 56.1%). For the ICU-acquired prevalence, there were no significant statistical differences between hospital type and among ICU specialty.

Overall and ICU-acquired PI prevalence across the six jurisdictional regions in Mainland China is shown in Table 2. The ICU-acquired prevalence in ICUs located in North China (including Beijing, Tianjin, and Inner Mongolia Autonomous Region) is the lowest (1.63%), with those located in Northeast China (including Liaoning Province and Hei Longjiang Province) the highest (7.64%). Chi-square test for comparison among six regions shows that ICU-acquired prevalence in North China is significantly lower than those in Northeast China, East China (including Jiangsu province, Zhejiang

TABLE 4 Multivariate logistic regression analysis of ICU-acquired pressure injury prevalence (n = 2459)

Variables	B	SE	Wald	*P*	Odds ratio	95% confidence interval
Region						
North China	Reference					
Northeast China	1.531	0.374	16.741	<0.001	4.624	2.221–9.629
East China	1.307	0.338	14.945	<0.001	3.695	1.905–7.168
Central South China	1.385	0.669	4.282	0.039	3.996	1.076–14.840
Southwest China	1.219	0.337	13.079	<0.001	3.385	1.748–6.554
Northwest China	0.639	0.778	0.674	0.412	1.895	0.412–8.710
Comorbidities and severity of disease						
Mechanical ventilation on study day	0.611	0.244	6.625	0.012	1.842	1.141–2.972
Simplified Acute Physiology Score II score	0.017	0.007	6.500	0.011	1.018	1.004–1.031
Number of comorbidities						
0	Reference					
1	−0.056	0.270	0.043	0.836	0.946	0.558–1.604
2	−0.041	0.340	0.014	0.904	0.960	0.493–1.869
3	1.150	0.339	11.529	0.001	3.157	1.626–6.131
>3	0.987	0.472	4.373	0.037	2.682	1.064–6.762
Days in ICU before study day						
0 to 3 days	Reference					
4 to 6 days	0.598	0.427	1.965	0.161	1.819	0.788–4.198
7 to 9 days	0.831	0.459	3.285	0.070	2.297	0.935–5.644
10 to 12	1.597	0.414	14.846	<0.001	4.937	2.191–11.122
>12	1.731	0.310	31.132	<0.001	5.644	3.073–10.367

province, Anhui province, Fujian province, Jiangxi province, and Shandong province), and Southwest China (including Sichuan province, Guizhou province, and Yunan province). Results showed that the most common body sites for ICU-acquired PI were sacral (n = 70/156, 44.87%) and heel (n = 25/156, 16.03%), and almost half of these PIs were at stage I (n = 74/156, 47.4%) (see Table 3).

4.2 | Risk factors of PIs in adult ICU patients

The characteristics of patients with and without ICU-acquired PIs were compared using univariate analysis (shown in Table 1). PI was significantly more prevalent in patients who were older; admitted into ICU from general ward; on mechanical ventilation on ICU admission; with respiratory disorder as primary diagnosis; increased number of comorbidities; with comorbidities including chronic obstructive pulmonary disease (COPD), malignancy, immunocompromised, heart failure, impaired mobility, and malnutrition; having had therapeutic hypothermia use; being on mechanical ventilation on study day; having a higher SAPS II score; lower Braden score; and longer length of stay (LOS) in ICU before study day.

The multivariate analysis identified that the following factors were significantly associated with a higher risk of developing a PI among ICU patients: region (Northeast China, East China, or Southwest), absence of cardiovascular disease, being mechanically ventilated on study day, a higher SAPS II score, a LOS in ICU before study day exceeding 9 days, and increased number of comorbidities (≥3) (see Table 4).

4.3 | Prevention strategies used

Table 5 shows the PI preventive measures used for the included 2459 ICU patients, with data regarding preventive strategies used in the patients with and without ICU-acquired PI group. Overall, 87.7% (n = 2156) of ICU patients received repositioning from nurses, and nearly half (n = 1244) of the patients used alternating pressure mattresses/overlays and floating heels. Air-filled mattresses/overlays were used in 703 ICU patients (28.6%), and nearly one in five patients (n = 563) used soft silicone multi-layered foam dressing and standard foam mattresses.

\Table 6 shows the top five preventive measures used for ICU patients in different regions. Patient repositioning was the most commonly used preventive practice among ICUs in all six regions. Except central South China,

TABLE 5 Preventive measures used (n, %)

Preventive measures	All patients (N = 2459)	Patients without ICU-acquired pressure injuries (N = 2353)	Patients with ICU-acquired pressure injuries (N = 106)
Patient repositioning	2156 (87.7)	2055 (87.3)	101 (95.3)
Alternating pressure mattresses/overlays	1244 (50.6)	1193 (50.7)	51(48.1)
Floating heels	1021 (41.5)	965 (41.0)	56(52.8)
Air-filled mattresses/overlays	703 (28.6)	664 (28.2)	39 (36.8)
Soft silicone multi-layered foam dressing	563 (22.9)	521 (22.1)	42 (39.6)
Standard foam mattresses	440 (17.9)	415 (17.6)	25 (23.6)
Turning beds/frames	414 (16.8)	390 (16.6)	24 (22.6)
Bolstering of the heels	376 (15.3)	357 (15.2)	19 (17.9)
Hydrating body moisturisers	340 (13.8)	328 (13.9)	12 (11.3)
Foam cushions	144 (5.9)	140 (5.9)	4 (3.8)
Non-foam cushions, except ring cushions	124 (5.0)	115(4.9)	9 (8.5)
Fibre-filled mattresses/overlays	98 (4.0)	96 (4.1)	2 (1.9)
Alternative foam mattresses/overlays	90 (3.7)	86 (3.7)	4 (3.8)
Gel-filled mattresses/overlays	88 (3.6)	83 (3.5)	5 (4.7)
Ring cushions	38 (1.5)	36 (1.5)	2 (1.9)
Low air-loss beds	35 (1.4)	33 (1.4)	2 (1.9)
Water-filled mattresses/overlays	30 (1.2)	30 (1.3)	0 (0)
Continuous bedside pressure mapping devices	30 (1.2)	21 (0.9)	9 (8.5)
Air-fluidised beds	14 (0.6)	13 (0.6)	1 (0.9)
Bead-filled mattresses/overlays	0	0	0
Sheepskins	0	0	0
Ice friction	12 (0.5)	11 (0.5)	1 (0.9)
Blow-drying	9 (0.4)	9 (0.4)	0 (0)

TABLE 6 Top five preventive measures used in different regions in China (n, %)

Preventive measures	North China (N = 858)	Northeast China (N = 288)	East China (N = 525)	Central South China (N = 70)	Southwest China (N = 636)	Northwest China (N = 82)
Patient repositioning	717 (83.6)[a]	261 (90.6)[a]	470 (89.5)[a]	64 (91.4)[a]	570 (89.6)[a]	74 (90.2)[a]
Alternating pressure mattresses/overlays	394 (45.9)[b]	220 (76.4)[b]	318 (60.6)[b]	10 (14.3)	257 (40.4)[c]	45 (54.9)[d]
Floating heels	327 (38.1)[c]	147 (51.0)[c]	262 (49.9)[c]	9 (12.9)	226 (35.5)[d]	50 (61.0)[b]
Air-filled mattresses/overlays	189 (22.0)[d]	93 (32.3)[d]	121 (23.0)	27 (38.6)[b]	258 (40.6)[b]	15 (18.3)[e]
Soft silicone multi-layered foam dressing	196 (22.8)[e]	37 (12.8)	192 (36.6)[d]	13 (18.6)	76 (11.9)	49 (59.8)[c]
Standard foam mattresses	92 (10.7)	27 (9.4)	158 (30.1)[e]	21 (30.0)[d]	131 (20.6)	11 (13.4)
Bolstering of the heels	119 (13.9)	60 (20.8)[e]	79 (15.0)	22 (31.4)[c]	92 (14.5)	4 (4.9)
Foam cushions	17 (2.0)	0	44 (8.4)	20 (28.6)[e]	63 (9.9)	0

Note: Superscript letters a,b,c,d,e mean top 1, 2, 3, 4, 5 preventive measure used in each region.

alternating pressure mattresses/overlays and floating heels were commonly used in all other five regions. Except east China, air-filled mattresses/overlays were commonly used in the other five regions. For soft silicone multi-layered foam dressing, it was commonly used in northwest China. Foam cushion was commonly used in central South China.

5 | DISCUSSION

5.1 | PI prevalence

To the best of our knowledge, this was the first point-prevalence multi-centre study conducted containing data from 198 ICUs of 161 hospitals, covering 66% of geographical locations in Mainland China. The PI prevalence found in this study is much lower than that in the international population in the bigger study.[12] It is consistent with previous reports from China[8] and a recent study conducted in the United States.[22] This difference may be related to the following reasons. First, PI prevention has been a top priority for healthcare organisations and clinicians in China. Hospital-acquired PIs have been considered as a sensitive nursing quality indicator in hospitals since 2008. It has been a standard reporting item on the country's hospital adverse event reporting system.[3] PI occurrence often has serious consequences such as drawing the attention of local governmental departments to scrutinise the hospital/department's practices, and intensive resources are often needed to address the issue in an often urgent and timely manner. Consequently, PI prevention measures are often performed carefully and diligently by clinicians. For example, in this study, repositioning was implemented in 87.7% of ICU patients, which was higher than those reported in Australia (66.4%)[8] and Sweden (44.3%).[23] This high repositioning compliance rate was similar to what was reported in a previous study conducted by Liu et al in China.[3]

Secondly, previous studies from China argued that the lower PI incidence in hospitalised patients was influenced by patients' acuity in Chinese hospitals. Because there is a lack of community care in China, many less acute patients are often admitted into acute care hospitals.[3] However, our study showed that patients' acuity in Chinese ICUs is similar to the international ICU population (Simplified Acute Physiology Score II).[12] Therefore, future research is needed to understand the contributing factors for the low PI prevalence rate in Chinese ICU patients. Lessons learned in future research could inform decision-making on PI prevention internationally.

We found that almost half of ICU-acquired PIs were at stage I, one-fourth were at stage II, and the most common body sites for PIs were sacral and heel region. These findings were consistent with findings from the bigger study,[12] the findings from the national study conducted in the Chinese population in immobile patients,[3] and other previous studies in hospitalised patients.[9] The higher percentage of stage I PIs may reflect the timely PI assessment by ICU nurses. Prompt identification and appropriate management of stage I PIs may prevent further irreversible skin damage, thus stage I PIs should be considered as quality indicators for timely identification of PIs and in PI prevention. Consistent with many other earlier reports, the findings emphasise again that ICU nurses should pay more attention to the most common body sites where PIs occur to prevent ICU-acquired PIs.[3,12]

This study also showed jurisdictional region-related differences on ICU-acquired PI prevalence across China. The ICU-acquired PI prevalence in North China is the lowest (1.63%), with those located in Northeast China as the highest (7.64%). One possible explanation may be related to contextual differences among the regions. The North China region is where China's capital city of Beijing and a large metropolitan city of Tianjin are located. Hospitals in these cities are often better equipped with clinicians with high levels of expertise in patient management, better staff-to-patient ratios, more professional development opportunities for clinicians, and physical resources. In addition, many hospitals in this region accept visiting nurses from other parts of China for training. These visiting nurses are fully licensed and are able to take patient load on shifts. This subsequently increases the staff-to-patient ratio in these hospitals, which could have contributed to the lower PI prevalence. Nurse/patient ratios have been proven to impact on patient outcomes,[24,25] and studies have also shown that the high nurse/patient ratio in ICUs was significantly associated with better quality of care and positive patient outcomes.[26] Another explanation could be that there is a big variation on patient participant numbers from different regions (ranged from 70 to 858 patients). The North China region had the largest number of patient participants. The small patient participant numbers (the denominator) in some regions could make the PI prevalence and incidence skewed (higher). Future research that provides a deeper understanding of the reasons of this difference across regions in China may inform future PI prevention planning in China and internationally.

5.2 | Risk factors of pressure injuries in adult ICU patients

This study compared the characteristics of ICU patients with and without PIs. The results again show that PI development is related to an interplay of a

number of factors. The findings are consistent with the results from the bigger study[12] in relation to risk factors including older age, higher SAPS II score, being on mechanical ventilation on study day, and increased number of comorbidities (≥3). These are consistent with findings from other previous studies as reported in a systematic review.[7] It is worth noting that longer LOS in ICU before study day (>9 days) was a risk factor for the development of ICU-acquired PIs, while in the bigger study, it was >3 days. This time difference may indicate that effective PI prevention in the Chinese context may have delayed the development of PIs and subsequently reduced the PI prevalence.

This study showed that contextual factors may have contributed to the ICU-acquired PI prevalence in some regions. We found that Northeast China had the significantly highest ICU-acquired prevalence than all other regions. A possible explanation of this difference may be because hospitals in this region often have fewer resources than hospitals in other parts of China such as Beijing as we discussed earlier. It is common knowledge that healthcare quality and resources distribution are inconsistent across China, with better quality care and resources are concentrated in bigger cities and top-level healthcare facilities.[27] This inequity of healthcare may also impact on nurses' access to up to date training on PI prevention, which would consequently impact on patient outcomes. Future research is needed to understand what contributed to this difference.

In this study, we found that Braden score was not associated with the occurrence of PIs in ICU adult patients. A recent meta-analysis also showed that the Braden Scale only had a moderate predictive value with good sensitivity and low specificity for determination of risk of PIs in adult ICU patients.[28,29] Even though Braden Scale covers seven domains to determine the skin condition, it does not include other specific risk factors of PIs in ICU patients such as age, sedation, vasoactive agents, and mechanical ventilation. In any case, the observation that the Braden Scale was not associated with ICU-acquired PI risk, while it was in the bigger study, supports the hypothesis by Deschepper et al[30] that case-mix and contextual factors are more detrimental in assessing PI risk compared with the more generic Braden Scale. Future research may be needed to explore other reliable PI prediction tools for ICU patients. Braden score is used to predict PI risk; therefore, for the patients who had high score on admission, more rigorous and comprehensive preventive strategies might have been used. Therefore, the relationship between Braden score and ICU-acquired PI prevalence should be interpreted with caution. In this study, consistent with findings from the bigger study,[12] patients with higher SAPS II score had a higher risk of PI. Higher SAPS II score represents higher level of patient's disease severity.[14] Since the SAPS II represents an overall disease severity level of ICU patients, it may be a more appropriate tool to predict PI risk than Braden score.

5.3 | Prevention strategies used in ICUs

International PI prevention clinical practice guideline recommends that common components of PI prevention strategies include staff education, regular risk assessment, mobilisation, repositioning, appropriate support surfaces, skin care protocols, and nutrition.[15] These strategies were reported to be implemented in the ICUs participated in this study. The most common strategy implemented among the six jurisdictional regions of China was repositioning, which is consistent with PI prevention practices reported in the literature.[31,32] Repositioning is a high-volume nursing activity in ICUs (patients are often turned at least once every 2 hours); however, debate exists on the frequency needed to reposition patients for PI prevention,[33] and on how to turn haemodynamically unstable patients in clinical practice.[34,35] Furthermore, nearly half of the patients used alternating pressure mattresses/overlays and floating heels. These may be related to the strong recommendations from international clinical practice guidelines. Even though there are some differences in the top five prevention strategies used across six regions in China, alternating pressure mattresses/overlays and floating heels, air-filled mattresses/overlays were the common prevention strategies. These again showed good compliance with the international PI prevention clinical guidelines.

Finally, we found that some high cost strategies including soft silicone multi-layered foam dressing were commonly used in northwest China (an economically disadvantaged region) and foam cushion were commonly used in central south China. There has been some high-level evidence on the effectiveness of multi-layered foam dressings on PI prevention;[36-38] however, the quality of these evidence has been questioned due to issues with concealment during randomisation, and the failure to blind the outcome assessors.[39] High uptake of these strategies contributes to significant healthcare costs to the patients and hospitals. The Chinese population, like many countries in the world, is large. PI prevention is a high-volume nursing task, which could add up to significant labour and equipment cost. In addition, in China, patients often incur large sum of co-payments for healthcare cost. Currently, there is a lack of robust research evidence on the effectiveness of many of these costly PI prevention strategies. Therefore, there is an

urgent need to conduct high quality research to test the effectiveness of some of these high cost and high-volume prevention strategies.

5.4 | Strengths and limitations

One strength of this multi-site study is that the study sites cover more than two-thirds of the Chinese geographic location, in Mainland China. It adds to the literature important data on PI prevalence, its risk factors, and preventive measures used in Chinese ICUs. While it has the strength of bigger data, it also brought many challenges to data collection.[40] Some of the data collectors from participating study sites never participated in any research prior to this study. The data were collected by trained site data collectors. There was no double checking of the accuracy of the data collected, and those data that were entered into the English database directly by the study sites. Thus, there may be variations and inaccuracies to the data collected. However, the rigorous training we provided would, at least partially, have minimised this inaccuracy. The data were in a self-report form, which can be prone to social desirability as reported in the bigger study paper. Further, this is a cross-sectional study, which only provides a snapshot of overall and ICU-acquired PI prevalence. Consequently, the true PI incidence of ICU patients, which is defined as PIs acquired during the whole ICU admission, will most likely be different from what we reported as ICU-acquired PI prevalence here. Finally, the sample sizes are variable across the regions, ranging from 70 to 858. Thus, the comparison results across regions need to be interpreted with caution.

Besides a rough estimate of the nutritional status at ICU admission ("malnutrition"), no data were collected regarding caloric intake on the study day. Only one single-centre observational study was able to demonstrate a link between failure of achieving nutritional goals (ie, caloric and protein intake) and PI risk in ICU patients.[41] The study however was criticised because of its high risk of bias and confounding, including the calculation method of caloric needs.[42]

6 | CONCLUSION

This was the first large-scale, point-prevalence multicentre study conducted in China to describe overall (12.36%) and ICU-acquired PI prevalence (4.31%). These results provide a baseline reference for PI prevalence among adult ICU patients in China. The findings support previous studies that overall and ICU-acquired PI prevalence in ICUs in Chinese hospitals are lower than those in other countries and regions. Future research on what contributed to the lower prevalence rate in China needs to be conducted. Learning from this future research will inform healthcare organisations on their future preventive strategies for PI prevention.

Findings from this study were consistent with earlier studies in relation to PI stage, and body sites. Prompt identification of stage I PI is key to prevent irreversible skin damage, and ICU nurses should continue to pay special attention to the sacral and heel region as these are the sites where PI occurs frequently. Except for the similar risk factors to PI development with the bigger study, this study has demonstrated some specific contextual factors including jurisdictional region-related factor and cardiovascular disorder, which contributed to differences in ICU-acquired PI prevalence. Future research is needed to understand what contributed to the differences. Repositioning was the most common PI prevention strategy used in participating ICUs, followed by alternating pressure mattresses/overlays, floating heels, and air-filled mattresses/overlays. These reflect a good level of adherence to recommended international PI prevention clinical practice guidelines. Moreover, this study showed that soft silicone multi-layered foam dressing and foam cushion, which are high cost strategies, were implemented at some poorer jurisdictional areas of China. Future high quality research is urgently needed to provide robust evidence on the effectiveness of high cost PI prevention measures.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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