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Outcomes of present-on-admission pressure injuries at discharge and potential prognostic factors: A historical cohort study in China

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Abstract

Background: The prevalence of present-on-admission pressure injuries (POA-PIs) is much higher than hospital-acquired pressure injuries (HAPIs). But scant attention has been paid to POA-PIs, especially the healing rate and potential prognostic factors.

Objective: To describe the characteristics of POA-PIs at admission and the outcomes of POA-PIs at discharge, and to explore potential prognostic factors of POA-PIs wound healing.

Methods: This study analyzed electronic health records (EHRs) for 838 POA-PIs among 586 patients from a Chinese tertiary hospital in 2018. The outcomes of POA-PIs were identified into four categories by comparing POA-PIs' wound area and exudation amount scores at admission and discharge: deteriorating, stable, improving, and healed. The generalized estimating equation (GEE) was carried out to screen the prognostic factors of POA-PIs wound healing.

Results: Among this population, 66.38% of the patients were male, 44.03% patients had a Braden Score less than 12 and the median of the Charlson comorbidity index was 5. The most common location of POA-PI wounds was the sacrum and the most common stage of them was Stage II. Nearly half of wounds (45.78%) were larger than 15cm², 26.61% were deeper than 0.5cm, and 61.81% of the wounds were painful. When the patients were discharged, 29.71% wounds were healed, 36.16% were in improving status, 25.78% kept stable, and 8.35% wounds were in deteriorating status. Wound depth was the only independent prognostic factor for POA-PIs wound healing.

Conclusions: The healing rate of POA-PIs is quite low, and the only independent prognostic factor of POA-PIs was wound depth.

Keywords

Present-on-admission pressure injuries, Wound healing rates, Prognostic factor

Abbreviations

PIs= pressure injuries

HAPIs =hospital acquired pressure injuries

CAPIs=community acquired pressure injuries

POA-PIs=present-on-admission pressure injuries

EMRs=electronic health records

PIRES= pressure injury report electronic system

1.Introduction

Pressure injuries (PIs), formerly called pressure ulcers, are localized skin and/or deep tissue injuries that result from pressure alone or in combination with shear.¹ The occurrence of PIs leads to increase of hospital infection, pain, psychological problems, prolonged hospital stay, caregiver burden, and economic cost.²⁻³ Given the aging population and high prevalence of chronic diseases, the challenges brought by PIs are increasing not only in hospitals but also in community settings.⁴ Therefore, it is not surprising to find patients admitted to hospitals with pre-exist PIs, although these PIs are not always the primary diagnosis of hospitalization.⁵ It was reported that the point prevalence of present-on-admission pressure injuries (POA-PIs) was 6.9%, which was much higher than hospital-acquired pressure injuries(HAPIs) (0.9%).⁶ This means that, compared with HAPIs, POA-PIs are more common among hospitalized patients but scant attention has been paid to them⁶.

Most of the existing studies focusing on POA-PI are limited to the prevalence,^{4,6,7,8} and only a few studies have analyzed the characteristics of POA-PI patients: After analyzed the age, gender and length of stay(LOS) of POA-PI patients, Peter et al. found that compared with HAPI, POA-PI patients were older and had a shorter LOS,⁹ which was consistent with Holly et al.¹⁰ Furthermore, to the best of our knowledge, few studies has described detailed wound characteristics of POA-PIs except stages, locations, and numbers of wounds.^{7,8,9}

POA-PI and HAPI are different in the occurrence environment and patient characteristics, and it is reported that there are differences in risk factors between them.^{11,12} Therefore, it is a critical need to stratify POA-PIs by healing likelihood. Risk stratification based on the healing likelihood would help to inform the management of POA-PIs, lay the foundation for monitoring quality of care, and arrange health resources and facilities. However, the healing rate and potential prognostic factors of POA-PIs keep hitherto unknown.

POA-PIs' wound characteristics can guide therapeutic interventions during the hospital stay and predict the prognosis of POA-PIs, and it should be evaluated and recorded once the POA-PI is screened out. Risk stratification models of HAPIs, venous leg ulcers (VLU), and other chronic wounds have been developed.^{13,14,15} Some

variables such as wound area have proven to be good predictors of chronic wound healing. It is reported that wound-level characteristics, such as location, area, and depth, were more sensitive predictors than patient demographics and co-morbidities.^{14, 16} Whether these factors also play a role in predicting the healing of POA-PI needs further verification.

Therefore, this study aimed to explore the outcomes of POA-PIs at discharge and their potential prognostic factors by analyzing the electronic health records (EHRs) of adult patients hospitalized at a Chinese university tertiary hospital in 2018.

2.Methods

2.1 Study population

Data for this study were derived from EHRs of a tertiary hospital in China, a provincial medical center with over 3800 inpatient beds. Every year more than 140,000 inpatients are admitted to this hospital. Following current guidelines, nurses in this hospital take skin inspection within 8 hours of admission to identify POA-PIs.¹⁷ PI diagnosing and staging criteria refer to the guidelines published by the national pressure ulcer advisory board (NPUAP).¹⁷ Once POA-PIs are identified, the responsible nurse will record the information of patients and wounds into a self-designed Pressure Injury Report Electronic System (PIRES). Patient information in PIRES contains age, sex, comorbid conditions, and Braden scores. Wound characters recorded in PIRES comprise location, size, depth, exudate, odor, and pain. During hospitalization, the routine therapeutic interventions for POA-PIs are delivered to patients according to practice guidelines.¹⁷ When patients with POA-PIs are going to be discharged, nurses will re-evaluate the wounds based on Pressure Ulcer Scale for Healing (PUSH) score and upload the outcomes of POA-PIs into PIRES on the discharge day. The input interface of PIRES was shown as Fig. S1.

Cases of POA-PIs in PIRES from 1st January to 31st December 2018 were retrospectively reviewed. All cases of adult inpatients with at least one POA-PI were included except for those with less than 24 hours in hospital, with the loss of partial information, or dead during hospitalization. Totally, 838 POA-PIs among 586 patients were included (Fig. S2). Ethical approval for the present study was obtained from the

Ethical Review Committee of the First Affiliated Hospital of Nanjing Medical University (Nanjing, China), and patient information was kept strictly confidential during and after the investigation.

2.2 Selection of candidate predictors

According to some published predictive models for chronic wound healing, we screened potential prognostic variables of POA-PI in patients' demographic, clinical, and wound characteristics.^{18, 14} Gender, age, Braden score, and Charlson comorbidity index were chosen as patient-level candidate predictors.¹⁸ Wound characteristics documented in PIREs were all included into analysis, including wound location, stage, size, depth, pain, exudation amount, exudation type, and odor.

Following Charlson, M. E, Charlson comorbidity index consists of the age score and the comorbidity score, which is calculated according to the relative risk (RR) of 1-year mortality of patients with different diseases.¹⁸ Wound location was documented as multiple pressure sore prone site by *Fundamentals of nursing*.¹⁹ Wound stage was coded into 6 stages as NPUAP guided.¹⁷ The width, length, and depth of wounds were measured with cm rulers and wounds sizes were calculated by width×length.¹⁷ Wound pain was evaluated orally by nurses and was documented into five categories: no pain, pain only when changing wound-dresses, sometimes pain besides changing wound-dresses, persistent pain, and loss of sense or consciousness.¹⁹ Exudation amount was estimated according to the PUSH and was recorded into 4 levels from none to heavy amount.²⁰ If exudation exists, its types were described as serous, bloody, or Purulent.¹⁹ The odor of wound, seen as an indicator of infection, was also recorded into PIREs as a binary variable.¹⁹

This study aimed to develop a model to predict the outcomes of POA-PI when discharged rather than after a given fixed period. That means the length of stay(LOS) is an unavoidable confounding variable and should be controlled in analysis. In this study, LOS was calculated by discharge date minus admission date.

2.3 Definition of Outcomes

Two subscores of PUSH, wound area and exudation amount, were applied to define outcomes of POA-PIs. PUSH is a tool developed by the NPUAP in 1997 to evaluate the healing of pressure ulcer injury.¹⁹ The current version 3 of PUSH contains 3

items: wound area (length × width), amount of exudation and tissue type (Fig. S3)²¹. The item of tissue type was not adopted in this study mainly with three considerations. First, as described by Gardner et al., the score of tissue type seldom changed in 4 weeks.²¹ The average LOS in this study is about 8 days, which means the score of tissue type at discharge is likely to be the same as at admission. Moreover, the un-changeability of tissue type further limits its prognostic value of chronic wounds.²² The last consideration is that tissue type is evaluated subjectively with low inter-evaluators validities as Melo et al. reported recently²³.

Based on the above considerations, as shown in Fig. S3, the total score of the wound area (scored from 0 to 10) and exudation amount (scored from 0 to 3) was applied to define outcomes of POA-PIs at discharge into four categories: deteriorating with a higher score than at admission, stable with the same score as at admission, improving with less score than at admission, and healed with a score of 0. In addition, when it comes to the prognostic analysis, the outcomes of POA-PI were divided into healing and non-healing (deteriorating, stable and improving).

2.4 Statistical analysis

This study firstly described demographic, clinical, and wound characteristics variables. The continuous variables were described by mean ± standard deviation (c) or median and interquartile range when applicable, and the categorical variables were described as frequency and percentage. In this study, the generalized estimating equation (GEE) model with binary function and logit link was used to investigate the factors affecting wound healing. This could account for the correlation of the wounds from the same patients. Univariate analysis for each variable with the healing rate was analyzed and variables with *p* values less than 0.1 were included in multiple regression analysis. The relative risk of regression analysis is expressed by odds ratio (OR) and 95% confidence interval (CI). All statistical analyses were conducted using SPSS 26.0 (IBM Corp., New York, USA) software with *p* < 0.05 as statistically significant.

Results

Totally 586 POA-PI patients were included in this study. Among this population, the mean age was 73.67 ± 16.69 years; 389 (66.38%) were male, and 197 (33.62%) were female; 298 (50.85%) were from home, and 288 (49.15%) were from other medical institute; 258 (44.03%) POA-PI patients' Braden Score were less than 12, 206 (35.15%) were between 13 and 15, and 122 (20.82%) were more than 16; Charlson comorbidity index ranged from 1 to 10 with a median score of 5; and the median hospitalization time was 8 (2-17) days. There were 447 (76.28%) patients admitted with one wound of POA-PI, 74 (12.63%) with 2 wounds, 39 (6.66%) with 3 wounds, 5 (0.85%) with 4 wounds, and 21 (3.58%) with more than 4 wounds (Table 1).

Table1. Demographics and clinical characteristic of POA-PI patients (N=586)

Variable	Overall (N=586)
Gender	
Male	389(66.38%)
Female	197(33.62%)
Age (years)	73.67 ± 16.69
Age category	
<60	104(17.70%)
60~79	199(34.00%)
≥ 80	280(47.80%)
Patient origin	
Home	298(50.85%)
Other medical institute	288(49.15%)
Charlson comorbidity index	
≤ 3	146(24.92%)
4~6	394(67.24%)

	≥7	46(7.85%)
Braden Score		
	≤9	57(9.73%)
	10~12	201(34.30%)
	13-15	206(35.15%)
	≥16	122(20.82%)
Number of wounds from PIs		
	1	447(76.28%)
	2	74(12.63%)
	3	65(11.09%)
	4	5(0.85%)
	≥5	21(3.58%)
Hospitalization Time (days)		8(2,17)

Data are presented as n (%) or mean (SD) or Median(Q1,Q3)

POA-PI: present-on-admission pressure injury; PIs: pressure injuries

Among the 838 wounds analyzed in this study, 423 (50.48%) occurred at the sacrum; 167 (19.93%) were in stage I, 321 (38.31%) were in stage II, and 221 (26.37%) were in stage III; 188(22.43%) wounds larger than 36 cm²; 223 (26.61%) wounds deeper than 0.5cm; 314 (37.47%) wounds contained exudate; 111 (13.25%) wounds had odor and 518(61.81%) wounds had varying degrees of pain (Table 2).

Table2. Wound characteristic of POA-PIs (N=838)

Wound characteristics	Overall (N=838)
Location	
Sacrum	423(50.48%)
Feet	163(19.45%)
Trochanter	64(7.64%)

	Crista iliaca	50(5.97%)
	Ischium	40(4.77%)
	Legs	19(2.27%)
	Shoulder	22(2.63%)
	Head-face	13(1.55%)
	Spine	17(2.03%)
	perineum	11(1.31%)
	Arms	8(0.96%)
	Others	8(0.96%)
Stage		
	Stage I	167(19.93%)
	Stage II	321(38.31%)
	Stage III	221(26.37%)
	Stage IV	60(7.16%)
	SDTI	20(2.39%)
	Unstageable	49(5.85%)
Size (cm²)		
	≤6	277(33.06%)
	6~15	157(18.74%)
	15-36	216(25.78%)
	>36	188(22.43%)
Depth (cm)		
	≤0.1	263(31.38%)
	0.1-0.5	352(42.01%)
	>0.5	223(26.61%)
Exudate amount		
	None	524(62.53%)
	Small	213(25.42%)
	Moderate	79(9.43%)
	Large	22(2.63%)

Exudate type		
	None	524(62.53%)
	Bloody	168(20.05%)
	Serous	37(4.42%)
	Purulent	109(13.01%)
Odor		
	None	727(86.75%)
	Odor	111(13.25%)
Pain		
	No pain	320(38.19%)
	Pain only when changing wound-dresses	261(31.15%)
	Sometimes pain besides changing wound-dresses	186(22.20%)
	Persistent pain	34(4.06%)
	Loss of sense or consciousness	37(4.42%)

POA-PIs: present-on-admission pressure injuries; SDTI: suspected deep tissue injury

As shown in Figure 1, 249 (29.71%) wounds were healed, 303 (36.16%) were in improving status, 216 (25.78%) kept stable, and 70 (8.35%) wounds were in deteriorating status when patients with POA-PI were discharged (Figure 1).

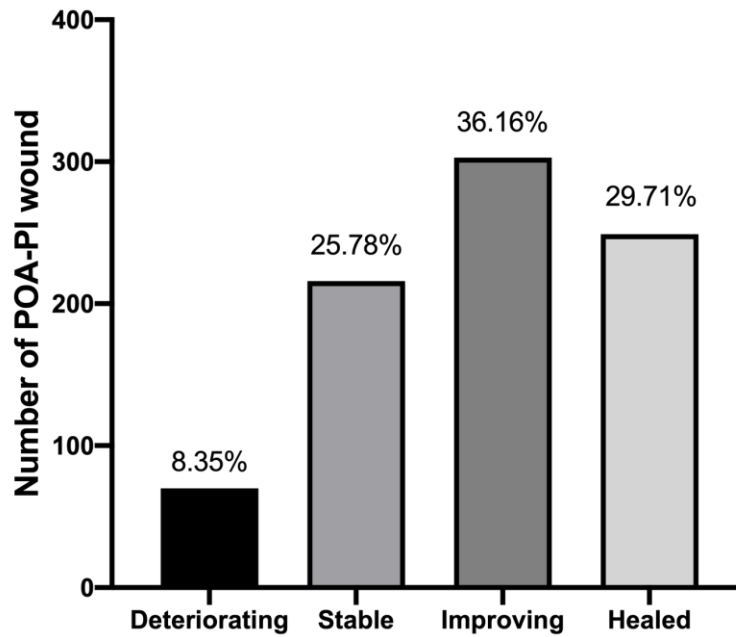


Fig. 1. The outcome of POA-PIs at discharge: Among the 838 wounds analyzed in this study, the percentages of deteriorating, stable, improving and healed POA-PIs was 8.35%, 25.78%, 36.16% and 29.71%, respectively. POA-PI, present-on-admission pressure injury.

The characteristics of patients and wounds between wound healing and non-healing groups were shown in Table 3. The distribution of wound stage(stage I vs stageIII, stage IV and SDTI: OR=1.482, 1.983 and 1.794, 95%CI =1.023-2.147, 1.254-2.979 and 1.091-2.951, $p=0.038$, 0.003 and 0.021), depth(≤ 0.1 vs >0.5 : OR=1.570, 95%CI =1.209-2.039, $p=0.001$) and exudate odor(none vs odor: OR=1.392, 95%CI =1.038-1.868, $p=0.027$) showed statistically significant differences between the two groups (all $p<0.05$).

Table 3. Univariate analysis of POA-PI wounds based on GEE model (N=838)

Variable	Healing rate	OR value	<i>P</i>
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	n(%)/ Median(Q1,Q3)	Point Estimate	95% Confidence Interval	
Demographic characteristics				
Gender				
Male	150(60.241)		Reference	
Female	99(39.759)	0.825	0.574-1.187	0.300
Age category				
<60	58(23.293)		Reference	
60~79	91(36.546)	1.410	0.857-2.320	0.176
≥80	100(40.161)	1.324	0.828-2.116	0.241
Patient origin				
Home	114(45.800)		Reference	
Other medical institute	135(54.200)	1.085	0.767-1.533	0.646
Clinical characteristics				
Charlson comorbidity index				
≤3	84(33.735)		Reference	
4~6	147(59.036)	1.439	0.967-2.140	0.073
≥7	18(7.229)	1.239	0.614-2.499	0.549
Braden Score				
≥16	26(10.442)		Reference	
13~15	82(32.932)	1.542	0.966-2.463	0.070
10~12	82(32.932)	1.526	0.952-2.446	0.079
≤9	59(23.695)	1.650	0.833-3.269	0.151
Hospitalization Time (days)	12(3.5 , 26)	0.996	0.988-1.003	0.263
Wound characteristics				
Location				
Sacrum	123(49.398)		Reference	

Feet	42(16.867)	0.988	0.779-1.252	0.918
Trochanter	21(8.434)	0.787	0.562-1.102	0.163
Crista iliaca	17(6.827)	0.899	0.608-1.327	0.591
Ischium	11(4.418)	1.198	0.790-1.817	0.396
Legs	8(3.213)	1.110	0.623-1.978	0.722
Shoulder	4(1.606)	0.906	0.534-1.537	0.713
head-face	7(2.811)	0.712	0.330-1.536	0.387
Spine	3(1.205)	1.279	0.688-2.375	0.437
perineum	5(2.008)	0.704	0.320-1.548	0.382
Arms	4(1.606)	0.970	0.396-2.380	0.947
Others	4(1.606)	0.494	0.177-1.378	0.178
Stage				
Stage I	59(23.695)		Reference	
Stage II	97(38.956)	1.463	0.924-2.317	0.105
Stage III	67(26.908)	1.482	1.023-2.147	0.038
Stage IV	10(4.016)	1.933	1.254-2.979	0.003
SDTI	3(1.205)	1.794	1.091-2.951	0.021
Unstageable	13(5.221)	1.811	0.955-3.434	0.069
Size (cm²)				
≤6	94(37.751)		Reference	
6~15	41(16.466)	1.191	0.949-1.494	0.131
15-36	56(22.490)	1.211	0.884-1.658	0.234
>36	58(23.293)	1.264	0.882-1.812	0.201
Depth (cm)				
≤0.1	91(36.546)		Reference	
0.1-0.5	111(44.578)	1.216	0.962-1.538	0.102
>0.5	47(18.876)	1.570	1.209-2.039	0.001
Exudate amount				
None	162(65.060)		Reference	
Small	66(26.506)	0.952	0.767-1.182	0.656

Moderate	17(6.827)	1.448	0.965-2.172	0.074
Large	4(1.606)	1.115	0.848-1.465	0.435
Exudate type				
None	162(65.060)		Reference	
Bloody	49(19.679)	1.039	0.829-1.302	0.739
Serous	12(4.819)	1.068	0.616-1.853	0.815
Purulent	26(10.442)	1.165	0.900-1.508	0.245
Odor				
None	227(91.165)		Reference	
Odor	22(8.835)	1.392	1.038-1.868	0.027
Pain				
No pain	92(36.948)		Reference	
Pain only when changing wound- dresses	80(32.129)	0.993	0.839-1.176	0.937
Sometimes pain besides changing wound-dresses	57(22.892)	0.937	0.766-1.145	0.523
Persistent pain	10(4.016)	1.167	0.803-1.696	0.418
Loss of sense or consciousness	10(4.016)	1.097	0.697-1.726	0.689

POA-PI: present-on-admission pressure injury; SDTI: suspected deep tissue injury

After the Univariate analysis, variables with *p* values less than 0.1 were included in multiple regression analysis: Charlson comorbidity index, Braden Score, stage, depth, exudate amount and exudate odor (Table 4). Meanwhile, LOS was included in the Generalized Estimating Equation as a covariable so as to control it in analysis. Regression results showed that wound depth (≤ 0.1 vs > 0.5 : OR=1.590, 95%CI =1.098-2.302, *p*=0.014) was the independent prognostic factor of wound healing of POA-PIs (Table 4).

Table 4. Generalized Estimating Equation of POA-PI wounds (N=838)

Variable	OR value		<i>p</i>
	Point Estimate	95% Confidence Interval	
Charlson comorbidity index			
≤3		Reference	
4~6	1.459	0.979-2.174	0.064
≥7	1.337	0.647-2.762	0.433
Braden Score			
≥16		Reference	
13~15	1.430	0.890-2.297	0.139
10~12	1.504	0.939-2.409	0.089
≤9	1.630	0.825-3.221	0.16
Stage			
Stage I		Reference	
Stage II	1.400	0.841-2.329	0.195
Stage III	1.007	0.604-1.680	0.977
Stage IV	1.349	0.655-2.777	0.417
SDTI	1.517	0.848-2.715	0.16
Unstageable	1.504	0.769-2.944	0.233
Depth(cm)			
≤0.1		Reference	
0.1-0.5	1.115	0.873-1.424	0.384
>0.5	1.590	1.098-2.302	0.014
Exudate amount			
None		Reference	
Small	0.825	0.617-1.103	0.193
Moderate	1.151	0.724-1.832	0.552

	Large	0.615	0.309-1.222	0.165
Odor	None		Reference	
	Odor	1.230	0.847-1.784	0.277

POA-PI: present-on-admission pressure injury; SDTI: suspected deep tissue injury

Discussion

This study retrospectively collected data from a self-designed PI online reporting system, described the profiles of patients with POA-PIs, analyzed wound characters and the outcomes of POA-PIs, and explored potential prognostic factors of POA-PIs.

Our results indicated that the profiles of patients with POA-PIs were old, male, and with high Braden scores. The mean age of patients with POA-PIs was 73.67 years, male percentage (66.382%) was almost two times of female (33.618%). Due to the lack of skin perfusion and moisture, the incidence of PU increases with age.²⁴ A Portuguese study showed that having a POA-PIs was associated with advanced age.⁸ Stevenson R et al found that the mean age of patients admitted with pressure ulcers was 78.0 and 77.3 years in two community centers.⁴ Consistent with these studies, our results also showed that POA-PIs are more likely to be found among elders. However, as to the gender proportion, Stevenson R et al reported twice the numbers of females than males (site 1: 65.9% female; site 2: 61.8% female),⁴ while Corbett LQ et al found 52.4% of community-dwelling subjects with POA-PIs were male.²⁵ Both the results are not consistent with this study in which twice the number of the male than female was reported. That means the gender ratio among patients with POA-PIs keeps uncertain and needs further larger sample studies. The same situation exists in term of prehospital residency. A Norway study showed nursing homes were found to have the highest prevalence figures,²⁶ while our results found half (50.85%) of patients with POA-PIs were admitted from home. The differences may reflect different care systems in the two countries. In China, with the influence of traditional filial piety, old people are mainly resident at their own homes and are cared by family members rather than nursing staffs.²⁷ This may partly explain the high proportion of from-

home admission among patients with POA-PIs in our study. As to Braden scores, 44.03% patients' Braden Scores were lower than 12, and only 122 (20.82%) were more than 16. Braden Scale is a tool to assess patients' risk level of developing PIs.²⁸ With a cut-off point of 16 out of 23, a lower Braden score means a higher risk level to develop PIs.²⁸ In this study, almost 80% patients were identified to be in risk of developing PIs with a lower score than 16, and 44.03% patients' Braden Scores were lower than 12 which means a very high risk of PIs.²⁸ Similar results have been reported in other studies.^{25,26} These results implicated that population with high Braden Scores are not only likely to develop PIs during hospital stay but also likely to be admitted with existing PIs.

Regarding the wound characteristics of the 838 wounds analyzed in this study, more than half of them were located at the sacrum, Stage II (38.31%) was the most common stage, 45.78% wound had an area larger than 15cm², 26.61% were deeper than 0.5cm, and 61.81% wounds brought patients the experience of pain (Table 2). The percent of sacral PIs was consistent with other studies.^{4,11,14,26} The high incidence of sacral PIs was caused by the shape of the bony prominence, physical properties of soft tissue, and patient migration in bed.²⁹ Followed by Stage III and Stage I, Stage II was the most common POA-PIs, and these results were consistent with other studies.^{8,9} However, we found much less Stage IV (7.16%) than a Portuguese study in which 36.5% Stage IV PIs was reported.⁸ We assumed that this difference may be explained by the improvement on PIs management during recent years. As to wound size, nearly half of POA-PIs had an area larger than 15 cm², and more than a quarter of wounds were deeper than 0.5cm. The exudation evaluation showed that more than 60% of POA-PIs were dry wounds; For the other 40% wet wounds, the most common type of exudate was bloody. An unexpected result of this study is the odor evaluation of POA-PIs. Wound odor is led by tissue necrosis and is often clinically used for diagnosing wound infection.³⁰ It has been agreed that bacteria would rapidly colonize in open wounds of PIs and result in wound infections and tissue necrosis. Considering the lack of professional wound care in home or the nursing home, the wounds of POA-PIs were assumed with a high proportion of infections. However, our results showed that only 13.25% wounds of POA-PIs had odor. In one hand, this result indicated that as a subjective sense of smelling, the evaluation of wound odor varies among individuals; on the other hand, rather than judgement on the existence of odor,

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more standardized tools, such as the Teler system, should be implemented to evaluate wound odor by intensity.³¹

At the time of discharge, the outcomes of POA-PIs were: healed wounds 29.71%, improved 36.16%, stable 25.78%, and deteriorated wounds 8.35% (Figure 1). The healing rate in this study seemed lower than some other studies, in which the healing rates of PIs ranged from 34.6% to 65.5%.^{32, 33, 34} The short hospital stay may be the main reason of the lower healing rate. As a kind of chronic wound, the time for PIs to heal was reported from 2.7 to 16 weeks.³³ However, the median hospitalization time of our population was only 8 days, so there is no doubt the healing rate of POA-PIs at discharge time would not be high. The high proportion of non-healing POA-PIs indicated that most patients admitted with existing PIs eventually returned to home or nursing home with their original POA-PIs. This result highlighted the urgent need to improve wound care ability of home members and community care staffs.³

Although the expected healing rate of POA-PIs is quite low, but to stratify POA-PIs based on the likelihood of healing is an urgent and essential clinical need, so as to care for the sickest patients do not appear to have worse outcomes.³³ So this study further explored what factors could be used to predict POA-PIs' healing likelihood. As seen in Table 3 and Table 4, Charlson comorbidity index, Braden score, stage, depth, exudate amount and exudate odor were included into the generalized evaluation equation. Among of them, only depth was a independent prognostic factor, and wounds deeper than 0.5cm were less likely to heal at the time of discharge (Table 4). Based on the analysis of 180,696 wounds, Jung K et al found that wound depth was one of the strongest predictive factors of PI healing.³⁵ Wound depth's predictive performance was confirmed by Cho SK in other kinds of chronic wounds.¹⁴ Several tools also involved the wound depth to evaluate wound healing status. Considering the developing mechanism of PIs, deep tissue injuries are being believed existent in all stages of PIs.³⁶ So, there is no surprise the wound depth could predict the healing likelihood of POA-PIs. However, somewhat surprisingly, the other factors (e.g., Charlson comorbidity index, Braden score, wound stage, wound area) were not proved to be predictive variables, and this was not consistent with quite a few studies. For example, in terms of comorbidity, a long list of chronic diseases has been thought to be relevant with the developing and/or healing of PIs.^{7, 14, 25} Regarding complicated

interactions between these diseases, some studies have tried to test whether the number of comorbid conditions, rather than their kinds, could better predicted the occurrence of PIs.^{7,26} Charlson comorbidity index is a widely-used tool to measure health status and predict PIs' prognosis.¹⁸ But our results did not support this opinion and whether this index can predict the outcomes of POA-PIs keeps unknown by now.

This study has some unavoidable limitations. Firstly, wound duration (also called wound age) was reported to be a prognostic factor of PIs,^{13,14} but was excluded from this study based on some realistic considerations. Since half of our population were admitted from home and their main caregivers were family members lack of professional knowledge, it was impossible to get the accurate wound age because the caregivers even did not realize the existence of PIs. Secondly, considering that the healing likelihood of POA-PIs should be evaluated at admission, we specifically did not evaluate the therapeutic factors (e.g., negative pressure wound therapy) but focused on patient and wound factors. At last, the use of retrospective data may limit the representability of this study's results and further prospective research is needed.

Conclusions

Our study is the first to describe detailed wound characteristics of POA-PIs in a city of China, including size, depth, pain and other variables and to explore potential prognostic factors of POA-PIs wound healing. We found that the healing rate of POA-PIs is quite low, and the only confirmed prognostic factor of POA-PIs was wound depth. Further study should continue to explore the Healing predictive models of POA-PIs, which can help to inform the risk prediction and wound management of POA-PIs.

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Conflict of interest

None.

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Supplemental Files

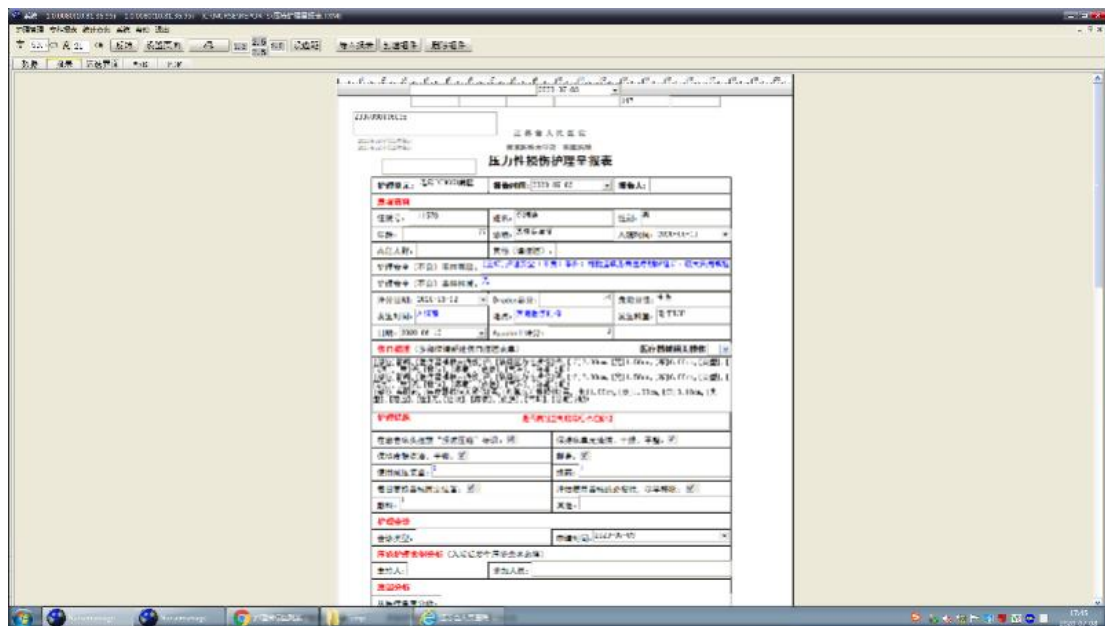


Fig. S1. Input interface of PIRES

When patients with POA-PIs are going to be discharged, nurses will re-evaluate the wounds based on PUSH score and upload the outcomes of POA-PIs into PIRES on the discharge day. Here is The input interface of PIRES. PIRES, Pressure Injury Report Electronic System.

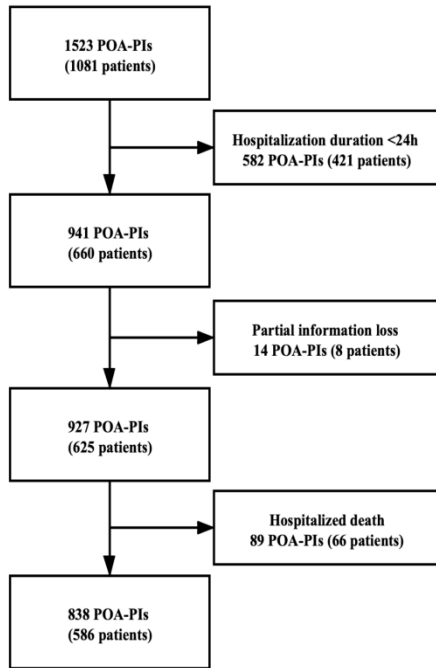


Fig. S2. Case screening flowchart

All cases of adult inpatients with at least one POA-PI were included except those that were hospitalized less than 24h, with the loss of partial information, or dead during hospitalization. POA-PI, present-on-admission pressure injury.

Adopted In this study	Sub-score items	Score standards					
		0	1	2	3	4	5
Yes	Wound area (cm ²)	0	<0.3	0.3-0.6	0.7-1.0	1.1-2.0	2.1-3.0
		6	7	8	9	10	
		3.1-4.0	4.1-8.0	8.1-12.0	12.1-24.0	>24.1	
Yes	Exudate amount	0 None	1 Light	2 Moderate	3 Heavy		
No	Tissue type	0 Closed	1 Epithelial tissue	2 Granulation tissue	3 Slough	4 Necrotic tissue	

Fig. S3. The Pressure Ulcer Scale for Healing (PUSH)

The current version 3 of PUSH contains 3 items: wound area (length×width), amount of exudation and tissue type.