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Incidence of pressure ulcers in intensive care units and direct costs of treatment: Evidence from Iran

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ABSTRACT

Background and objective: Pressure ulcer (PU) is one of the important and frequent complications of hospitalization, associated with high treatment costs. The present study was conducted to determine the incidence of PU and its direct treatment costs for patients in intensive care unit (ICU) in Iran.

Material and methods: In this retrospective study, medical records of 643 discharged patients from ICU of two selected hospitals were examined. The demographic and clinical data of all patients and data of resources and services usage for patients with PU were extracted through their records. Data analysis was done using logistic regression tests in SPSS 22 software. The cost of PU treatment was calculated for each grade of ulcer.

Results: The findings showed that 8.9% of patients developed PU during their stay in ICU. Muscular paralysis (OR = 5.1), length of stay in ICU (OR = 4.0), diabetes (OR = 3.5) age (OR = 2.9), smoking (OR = 2.1) and trauma (OR = 1.4) were the most important risk factors of PU. The average cost of PU treatment varied from USD 12 for grade I PU to USD 66 834 for grade IV PUs. The total treatment costs for all studied patients with PU was estimated at USD 519 991.

Conclusion: The cost of PU treatment is significant. Since the preventive measures are more cost-effective than therapeutic measures, therefore, effective preventive interventions are recommended.

1. Introduction

Pressure ulcer (PU) is one of the important and frequent complications of hospitalization, associated with high treatment costs, longer stay in hospital, increased risk of infection, and serious consequences for the patient's health [1–3]. Despite being preventable, studies have shown that 3–34% of hospitalized patients develop ulcers during their stay [4]. On average, 7–23% of hospitalized patients in Europe and North America suffer from PU [5]. In Iran, it has been estimated that 19% of hospitalized patients develop PU [6].

Critically ill patients, as one of the most vulnerable populations [7], are exposed to a high risk of PU due to clinical instability, invasive nature of interventions, limited physical activity and mobility, and multiple treatments [8–10]. The intensive care unit (ICU) is a unit in a hospital setting, accounting for the highest incidence of PU [11,12]. The global incidence of PU in ICUs has been estimated at 3.3%–39.3% [13,14], while a recent study from Iran reported a prevalence rate of 21% in ICUs [15].

Some of potential PU risk factors that are mentioned in the literature are patient's age, length of stay, smoking and prolonged mechanical ventilation. In addition, comorbidities such as diabetes mellitus, cardiovascular disease, renal disease/failure, pulmonary disease and trauma have a positive effect on the risk of developing PU among ICU patients [4,9,14,16,17].

Patients, families, hospitals, and societies are significantly affected by the physical, mental, financial, and social consequences of PU. PU not only negatively impacts the patient's quality and length of life [18], but also leads to the spread of infection in clinical settings and increases morbidity and mortality among patients [4,10,19]. Economically, PU imposes different costs on the healthcare system due to nursing care for wound healing, pharmaceuticals, wound dressing for advanced ulcers, surgeries, and additional hospital stay [20]. Globally, the annual treatment cost of PU and its associated complications is estimated at USD 11 billion [12]. In this regard, Demarre et al. reported treatment costs, ranging from € 1.7 to € 470 per day [5]. Also, treatment costs for grade III-IV ulcers have been estimated at USD 70–150 000 per patient [21].

Considering the clinical and economic implications of PU, it is

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Table 1
Direct PU treatment costs and calculation methods.

Cost items	Calculation methods
Specialist consultation	Number of consultations multiplied by the approved tariff
Pharmaceuticals and wound dressing	Number of drugs and dressing bags multiplied by the price
Imaging and laboratory services	Number of laboratory tests and imaging services multiplied by the price
Surgery	Cost of surgery (surgeon's salary and operating room costs)
Additional hospital stay (hospital hoteling)	Number of additional hospital stays due to PU treatment multiplied by the approved tariff
Nursing care	Equivalent to 4% hospital hoteling tariff
Average total cost of PU treatment	Total cost of treatment for patients with PU divided by the number of cases during the study

essential to identify the risk factors and adopt proper preventive measures for patients at risk in ICUs [12]. Also, an understanding of treatment costs for preventable events, such as PU, is important in hospitalized patients. By recognizing the treatment costs, healthcare systems and authorities can focus on PU prevention guidelines and reduce the high costs of treatment [5]. In addition, The identification of patients at risk is essential for the effective implementation of prevention interventions and appropriate use of resources [10,13].

To the best of our knowledge, previous studies in Iran have examined the prevalence and incidence of PU in hospitals, while there are no studies related to the costs associated with PU. Therefore, the present study was conducted to determine the incidence of PU, its risk factors and direct treatment costs for patients in ICUs.

2. Materials and methods

This retrospective study was conducted in two public hospitals, affiliated to Shahid Beheshti University of Medical Sciences (SBMU, Tehran, Iran) in 2016–2017(from 21 Mar 2016 to 20 Mar 2017). The study population included all patients discharged from the ICUs of these hospitals. Based on previous studies, the average incidence of PU is about 30% in ICUs [13,14]. According to below formula, with the assumption of $p = 0.3$, $q = 0.7$, $d = 0.05$, $\propto = 0.05$, and $\beta = 0.2$, and for precaution with an extra 10%, the sample size was measured at 642 cases:

$$n = \frac{\left(z1 - \frac{\propto}{2} + z1 - \beta\right)^2 \mathrm{pq}}{d^2}$$

The samples were allocated to each hospital, based on the number of ICU beds. Hospital A had 10 and hospital B with 14 ICU beds; both was medical/surgical ICUs and both ICUs admit traumatic and non-traumatic patients. The total number of discharged patients from tow ICU units during the study period were 1,423.

An experienced nurse examined the medical records of ICU-discharged patients, extracted the required data, and recorded them in a special form, which was divided into two sections. The first part contained the patient's demographic and clinical data, which was completed for all patients. If PU was diagnosed and recorded by the physician or nurses in the patient's medical file, the second part of the form, which included data on the use of hospital resources for PU treatment and its costs, was completed.

Hospitalization in ICU for at least 24 h was the inclusion criteria in the study, while patients who had PU at the time of hospital admission were excluded (27 patients). PU was detected based on the medical records.

Data were analyzed using descriptive statistics and logistic regression analysis in SPSS version 22. The study data were analyzed in two sections. First; Logistic regression was used to determine the risk factors of PU among ICU's patients effect of demographic and clinical variables on ulcer development. In this model, the outcome variable was the presence of ulcers (yes/no) and independent variables were demographic and clinical features including patient's age, length of hospital stay, cause of hospitalization (trauma/non-trauma), diabetes mellitus (yes/no), muscular paralysis (yes/no), malnutrition (yes/no), kidney failure (yes/no), and smoking (yes/no). As mentioned in the introduction, these variables have been identified as risk factors of PU in the literature. In this study, muscular paralysis was the paresis and paralysis of the limbs due to the spinal cord injury caused by underlying diseases (including trauma, stroke, neurological problems, or neuropathic disease leading to paresis or paralysis of the lower or upper limbs). Kidney failure is a medical condition in which the kidneys no longer function which includes acute and chronic failure. Malnutrition is diagnosed based on the patient's technical assessment by the hospital nutritionist; both on the patient's apparent symptoms and laboratory tests, and then recorded in the patient's medical record. The patient's smoking status is asked during his/her admission and recorded by physician in patient medical history. Patients are questioned in this way: “Do you use tobacco (cigarette, water pipe, pipe) routinely”? In addition, we categorized patients into two groups of trauma and non-trauma based on physician's diagnosis.

In the second part, the direct cost of treatment has been analyzed. Generally, direct treatment costs are the costs directly related to disease prevention, treatment, and rehabilitation [5]. In the present study, direct PU treatment costs included the costs of pharmaceuticals, wound dressing, imaging procedures (such as medical ultrasound for diagnosis the depth of the wound), laboratory tests, surgeries, specialist consultation, additional hospital stay, and nursing care related to PU treatment, as presented in Table 1.

The average total treatment cost for PU was the sum of treatment costs for PU patients, divided by the number of cases during the study. The cost was estimated separately for four grades of PU. Also, the exchange rate of Iranian Rial (IRR) to USD was 32 000 IRR per USD according to the Central Bank in 2016 [22].

This study was approved by the Ethics Committee on Research in Health Sciences and Neuroscience of SBMU (code IR.SBMU.PHNS.REC.1395.78).

3. Results

Based on the demographic findings, the study sample mainly included female patients (52%), above 50 years of age (52.5%), affected by diabetes (45%), kidney failure (52%), and muscular paralysis (24%). The average length of stay was 8.9 days (range:1–45) and the mean age of patients was 52.4 years (range: 19–72). The findings showed that 57 (8.9%) patients developed PU during their stay in ICU. Grade I (33%) and grade IV (12.2%) ulcers accounted for the highest and lowest frequencies of PU, respectively.

Based on the bivariate analysis, a significant relationship was found between PU and the patient's age, length of hospital stay, cause of hospitalization, diabetes mellitus, muscular paralysis, malnutrition, and smoking ($P < 0.05$). These variables were entered into the logistic regression model (Table 2). According to the regression analysis, the odds of PU in patients with muscular paralysis was 5.1 higher than other patients. Also, the risk of PU in patients with more than 10 days of hospitalization and diabetic patients was 4.0 and 3.5 times higher than other patients, respectively. In addition, the odds of PU was higher among smokers (OR, 2.1) and traumatic patients (OR, 1.4). On the

Table 2
Logistic regression test: Risk factors of PU.

Variables		OR	SE	p
Age (years)	≥50	2.9	0.342	0.001
	< 50	-	-	
Smoking	Yes	2.1	0.254	0.001
	No	-	-	
Length of stay (days)	≥10	4.0	0.289	0.001
	< 10	-	-	
Cause of hospitalization	Trauma	1.4	0.125	0.001
	Non-trauma	-	-	
Diabetes mellitus	Yes	3.5	0.424	0.001
	No	-	-	
Muscular paralysis	Yes	5.1	0.298	0.001
	No	-	-	

Table 3
Pattern of average resources and services utilization in the treatment of PUs.

Resources and services	Unit	Grade I	Grade II	Grade III	Grade IV
Drugs	Dosage	5	8	13	22
Dressing	Pack		2	9	21
Laboratory tests	Number	-	-	4	8
Imaging	Number	-	-	5	9
Specialist consultation	Visit	-	-	2	5
Surgery	Number	-	-	1	2
Additional stays	Day	-	7	21	43

other hand, older patients were at a 3 fold higher risk than younger patients ($P < 0.001$).

The pattern of resource and service consumption based on the PU grade is demonstrated in Table 3. The findings showed that the highest rate of consumption was related to grade IV ulcers. Wound dressing was replaced every 48–72 h. Also, the most common drugs for the treatment of grade III and IV PUs included ciprofloxacin and colomycin. On the other hand, zinc oxide and ointment were used for the treatment of grade I PUs, while anesthetic gel and ointment (Camfield and Ejicot) were applied for grade II PUs. Also, laboratory tests for grade III and IV PUs included blood cultures, cultures from ulcers sites, urea test, and creatinine test. Furthermore, medical ultrasound was used for the treatment of grade III and IV ulcers. As the findings revealed, treatment of grade II, III, and IV ulcers imposed 7, 21, and 43 additional hospital stays on patients, respectively.

The findings on the direct costs of PU treatment showed that the average cost of treatment varied from USD 12 for grade I PU to USD 66 834 for grade IV PUs (Table 4). Nearly 95% of total PU treatment costs was related to grade IV ulcers, 4.6% to grade III ulcers, 0.53% to grade II ulcers, and an insignificant amount of 0.01% to grade I ulcers.

Table 4
The pattern of PUs treatment direct cost (USD).

Cost items	Grade I		Grade II		Grade III		Grade IV	
	Cost	%	Cost	%	Cost	%	Cost	%
Drugs	12	100	82	22	1,844	56.9	63,457	95
Dressing	-	-	28	7.5	137	4.2	1,176	1.7
Laboratory tests	-	-	-	-	106	3.3	121	0.2
Imaging	-	-	-	-	126	3.9	125	0.2
Specialist consultation	-	-	-	-	44	1.3	54	0.01
Additional stays and nursing care	-	-	263	70.5	789	24.5	1,614	2.4
Surgery	-	-	-	-	187	5.8	287	0.5
Total cost (USD)	12		373		3,233		66,834	
Total cost (IRR)	384,000		11,936,000		103,456,000		2,138,688,000	

%: the share of each cost items in the total cost of PU treatment.

Drugs accounted for the majority of treatment cost (68.4%), followed by hospital hoteling (24.3%). The total treatment cost was USD 228 for 19 patients with grade I ulcers and USD 6341 for 17 patients with grade II ulcers. In addition, the treatment cost was USD 45 444 for 14 patients with grade III ulcers and USD 467 978 for 7 patients with grade IV ulcers. Finally, the total treatment costs for all studied patients with PU was estimated at USD 519 991.

4. Discussion

The aim of this study was to determine the incidence of PU and direct costs of PU treatment in the ICUs of two general and teaching hospitals of SBMU. The findings showed that 8.9% of patients developed PU (grade I to IV) during their stay in the ICU. Generally, ICUs are units with the highest risk of adverse events due to the patient's clinical instability, besides multiple clinical interventions. PUs are the most common adverse events with the highest prevalence and incidence in ICUs [12]. The incidence rate of PU was 39.3 in Saudi Arabia [10], 29.6% in Greece [23],8.1–16% in Spain [3,13], 15.5% in Turkey [24],11–13.6% in Brazil [25,26]. Iranmanesh et al. found that the incidence of PU for ICU's patients was 13.4% in Iran [27]. The discrepancy in the results can be attributed to the characteristics of the study populations, inclusion criteria, methodology (direct observation or review of medical records), data collection methods, and different preventive methods in hospitals.

The highest frequency of PU (33.3%) was related to grade I ulcers, while the lowest frequency (12.2%) was attributed to grade IV ulcers. The findings of studies from Portugal [28], Belgium [29], Norway [30], China [31], and Iran [6,32] are consistent with our results. The lower rate of grade III and IV ulcers may be related to preventative measures, used by the ICU staff to prevent the progress of PU in the first stage [32].

The findings of the present study showed that age is a predictor of vulnerability to PU among ICU patients. Studies from Iran [27,32], Portugal [28], Brazil [25], Greece [3], Norway [30], and United States [33] have also identified age as a risk factor for PU. Based on two review studies, age is a major risk factor in most PU-related studies [14,17,32], and older patients have a higher risk of developing ulcers. In fact, reduction of mobility and activity, tissue tolerance, skin vessels, and pain perception results in an increase in the vulnerability of aged people to PU [14,32].

The length of hospital stay had a significant positive impact on the occurrence of PU. The findings of three review studies revealed that length of ICU stay is one of the most important risk factors for PU [4,14,16]. Studies from Iran [32], Portugal [28], Brazil [12,25], Greece [3], Saudi Arabia [10] and United States [33] have indicated a positive relationship between the length of hospital stay and risk of PU, which is consistent with our study. Evidently, when a patient stays in bed for longer periods, his/her body tissues become immobilized under pressure, and risk of PU increases.

Smoking was the another most important risk factor for PU in this study. Two studies by Nassaji et al. [32] and Akbari Saari et al. [15] also reported smoking as a risk factor for PU, which is consistent with our findings. In fact, smoking exerts vasoconstrictive effects on the capillaries of skin surface, thereby reducing the amount of oxidized blood in tissues. Nicotine often acts as a mediator of such effects. It inhibits the distribution of prostacyclin and produces vasoconstrictive effects in the skin. On the other hand, carbon monoxide and hydrogen cyanide are involved in ulcer improvement [32].

The findings of our study showed that patients with diabetes have a greater risk of developing PU. Other studies from Iran [15,32,34], Greece [3], and Norway [30] have also reported a positive relationship between diabetes and PU. Two review studies also identified diabetes as an important risk factor for PU [14,17]. In addition, patients with muscular paralysis are exposed to a greater risk of PU. In this regard, Akbari Sari et al. from Iran reported that muscular paralysis causes a

five-fold increase in the risk of PU [15], which is consistent with our findings. In fact, muscular paralysis reduces mobility, increases pressure on the underlying tissues, and increases the risk of necrosis in these tissues.

Also, traumatic patients are exposed to a higher risk of PU. Nassaji et al. reported trauma as the most important risk factor for PU; the risk was 15 times higher in these patients, compared to others [32]. This finding might be attributed to a rapid increase in injuries and incident fractures, which makes hospitalized patients stay immobilized in bed for longer periods, exerts pressure on one part of the body, and increases the risk of PU development. Overall, reduced motility and activity are predictors of ulcers [4,17].

In this study, direct costs of PU treatment ranged from USD 12 for grade I ulcers to nearly USD 67 000 for grade IV ulcers. Dealey et al. estimated the treatment costs of PU from £1214 (grade I) to £14 108 (grade IV) in the UK [35]. Demarre et al. In Belgium calculated the cost of treatment for I-IV PU as €17.7, 1709.5, 1784.9, and 2500.2, respectively [29]. Gethin et al. in Ireland estimate the cost of treating a patient with IV ulcer as €119,000 [36]. In addition, the findings of a review study showed that treatment costs per patient varied from € 20 for grade I ulcers to € 69 000 for grade IV ulcers [5]. The difference in the reported figures can be attributed to variations in the used methods, costing perspectives, study setting (hospitals or nursing homes), country of the study, treatment methods, hospitalization policies, drugs, and nursing costs. In some studies, costs of the associated complications and continuance of treatment after hospital discharge were also evaluated, resulting in an increase in the costs [37]. On the other hand, some researchers have only calculated the routine costs of treatment, resulting in the lower estimation of total costs [37].

In our study, the highest treatment cost was attributed to grade IV ulcers, which is similar to some previous research [5,30,35,38]. Treatment Costs increase with ulcer severity because the healing time is longer, and need for surgery and further complications [35,37]. Grade IV ulcer is the most advanced type of PU, causing severe harm to tissues under pressure due to long ICU stay, with the probability of infections affecting other tissues and damaging a large surface of the patient's body. Therefore, immediate and specialized care is required to prevent death or permanent impairment and amputation of the damaged body part. Treatment of grade III and IV ulcers requires a higher rate of drug and dressing use, longer hospitalization, and more nursing care. It takes longer to treat these patients, leading to additional hospital stay and costs [38]. The increase in the hospital stay and the subsequent hoteling costs in our study confirms this finding.

Contrary to our study, In European studies, the largest share of PU's treatment costs was related to nursing staff [29,35]. Our findings showed the largest share of total treatment cost was allocated to pharmaceuticals. Most of drugs used to treat III and IV ulcers are imported and therefore expensive, which has led to a large share of treatment cost belonged to the medication. This difference is related to the cost calculation method. In Iran, the cost of nursing care is not calculated individually, and it is equivalent to 4% of the hospital hoteling costs in patient bill.

Since 92% of PU treatment costs pertains to hospital hoteling and drugs, the most important practice to reduce the need for treatment includes prompt diagnosis and prevention of disease progress to more advanced stages. This important objective can be fulfilled by training the nursing staff, as well as patients, and raising their awareness of pain and high costs of PU treatment. Through diagnosis and treatment of grade I and II PUs, the need for treatment interventions, hospital stay, and costs decrease considerably. According to the findings, by increasing awareness and improving care for patients, we can treat PU by spending USD 12 instead of USD 67 000.

5. Limitations

The present study had some limitations. First, due to limited data in the patients' records, all risk factors of PU identified in the literature were not entered in the regression model. Second, only direct treatment costs were considered in this study, and indirect costs, such as depreciation and overhead costs, were not included in the calculations. Similarly, non-treatment costs, such as transportation and absence from work, were not considered in the measurements. Third, in some patients, particularly those with grade IV ulcers, post-hospitalization follow-ups or sometimes plastic surgery might be needed; these cases were excluded from the study, as we only considered the duration of patient's stay in the hospital.

6. Conclusions

The cost of PU treatment is significant and imposes great financial burdens on patients, insurance companies, healthcare systems, and communities. Considering the significant amount of wound-healing costs associated with hospital hoteling, reducing the length of hospital stay can lead to a significant reduction in treatment costs. In fact, costs can be reduced, and hospital resources can be used efficiently by transferring uncomplicated cases to rehabilitation centers for continuing treatment. Preventive measures are more cost-effective than therapeutic measures [18]. So, based on the findings of this study, effective preventive interventions are recommended.

Declarations of interest

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