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The burden of pressure ulcers among inpatients in a tertiary physical medicine and rehabilitation center: a retrospective analysis

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ABSTRACT

Aims: This study aimed to describe the clinical characteristics, risk factors, and treatment outcomes of pressure ulcers (PUs) among inpatients in a tertiary physical medicine and rehabilitation (PM&R) center. We hypothesized that advanced-stage ulcers would be associated with longer hospitalization, lower healing rates, and adverse laboratory parameters.

Methods: This retrospective cross-sectional study included 240 adult patients with PUs admitted to the PM&R Hospital of Ankara Bilkent City Hospital between June 1, 2022, and June 1, 2023. Demographic, clinical, laboratory, and wound-related data were extracted from medical records and standardized wound care forms. PUs were staged according to the 2019 EPUAP/NPIAP/PPPIA guideline. Treatment modalities and outcomes were analyzed. Linear regression was performed to identify predictors of residual wound size.

Results: The mean age of patients was 52.8±22.1 years; 63.3% were male. Frequent comorbidities included arterial hypertension (34.6%), hyperlipidemia (40.4%), diabetes mellitus (15.4%), and coronary artery disease (10.8%). The most common admission diagnoses were spinal cord injury (45.0%) and stroke (26.7%). Sacral ulcers (56.1%) predominated, with stage 2–3 lesions representing 77.1% of cases. Overall healing rate was 78.5%, but declined sharply in stage 4 ulcers (25.0%). Predictors of larger residual ulcer size included pre-admission ulcer presence ($p=0.028$), baseline ulcer size ($p<0.001$), and lower albumin ($p=0.002$). Debridement significantly reduced ulcer size ($p<0.001$). Functional outcomes improved, with 57.6% of non-ambulatory patients achieving therapeutic ambulation at discharge ($p<0.001$).

Conclusion: PUs remain a persistent challenge in rehabilitation, limiting both medical care and functional progress. Advanced-stage ulcers, malnutrition, and osteomyelitis predict poor outcomes, whereas surgical debridement is pivotal for healing. Integrating preventive strategies, nutritional optimization, and evidence-based therapies into structured rehabilitation programs can enhance recovery and reduce healthcare burden.

Keywords: Pressure ulcer, rehabilitation, spinal cord injuries

INTRODUCTION

Pressure ulcers (PUs) are a common and consequential health problem, particularly in clinical conditions associated with prolonged immobility. Patients admitted to PM&R clinics due to cerebrovascular events (CVE), spinal cord injury (SCI), or other neurological disorders are at heightened risk. Additional predisposing factors include extended intensive care unit (ICU) stays, advanced age, malnutrition, anemia, cognitive impairment, and restricted mobility.

Beyond local tissue damage, PUs increase the risk of infection and sepsis, contribute to mortality, complicate treatment, prolong hospitalization, escalate healthcare costs, and limit participation in rehabilitation programs, thereby diminishing quality of life. A nationwide cross-sectional study from Finland reported a PU prevalence of 12.7% in acute inpatient care settings, including hospitals and rehabilitation units.[1] In patients with SCI, a systematic review and meta-analysis demonstrated that approximately 32% develop a PU during their lifetime.[2] Among trauma patients, a retrospective study from a referral trauma center in Northern Iran found a prevalence of 27.6%, with older age and lower hemoglobin levels identified as significant risk factors.[3]

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While international guidelines delineate the definition, classification, prevention, and treatment of PUs,[4] patient profiles and outcomes vary substantially across clinical settings. Accordingly, characterizing PU features and admission diagnoses (e.g., CVE, SCI, other neurological conditions) in PM&R inpatients is essential to inform effective treatment strategies and preventive interventions.

This study aimed to describe the clinical characteristics, risk factors, and treatment outcomes of PUs in patients hospitalized at a tertiary PM&R center. We hypothesized that, among PM&R inpatients, advanced-stage PUs would be associated with longer hospital stays, lower healing rates, and adverse laboratory parameters.

METHODS

Ethics

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Ankara Bilkent City Hospital No. 2 Clinical Researches Ethics Committee (Date: 21.02.2024, Approval No: E2-24-6500).

Study Design and Setting

This investigation was designed as a retrospective cross-sectional study and was conducted at the Physical Medicine and Rehabilitation Hospital (PM&RH) of Ankara Bilkent City Hospital between June 1, 2022, and June 1, 2023.

Patient Selection and Characteristics

A total of 240 patients were included in the study.

Inclusion criteria:

- Patients admitted to the PM&RH with a PU at the time of hospitalization
- Patients without a PU at admission but who developed one during follow-up
- Age ≥18 years
- Availability of complete medical records

Exclusion criteria:

- Patients without a PU at admission and who did not develop one during follow-up
- Age <18 years
- Diagnosis of active malignancy
- Congenital or acquired immunodeficiency
- Incomplete clinical or laboratory data

Data Collection

Medical records and standardized wound care forms completed by wound care nurses were retrospectively reviewed. The following variables were extracted for each patient:

- **Demographic data:** Age, sex, height, weight, body-mass index (BMI)
- **Clinical variables:** Comorbidities, admission diagnosis to the PM&R clinic, history and duration of ICU stay, mobility status
- **Wound-related data:** Time of onset, duration, anatomical location, stage, wound size, treatment modalities applied, and wound outcome
- **Laboratory parameters:** Hemoglobin, albumin, and 25-hydroxy vitamin D levels at admission
- **Discharge data:** Discharge destination (home, nursing facility, death) and wound status at discharge

PUs were classified according to the 2019 International Guideline issued by the European Pressure Ulcer Advisory Panel (EPUAP), the National Pressure Injury Advisory Panel (NPIAP), and the Pan Pacific Pressure Injury Alliance (PPPIA).[4]

Wound assessments were based on retrospective chart review. Wound size was documented in centimeters (cm), recorded as the longest measurable length and width noted in the wound care forms. Staging was determined according to clinical notes, and in cases of uncertainty, classifications were confirmed by senior physicians as documented in the medical files.

Treatment modalities were categorized as conventional wound dressings, advanced wound care products (e.g., silver dressings, foam dressings), and negative pressure wound therapy (NPWT). Surgical debridement was recorded as a separate variable due to its invasive nature and distinct clinical implications. All treatment data applied during hospitalization were obtained retrospectively from medical records and wound care documentation.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 26.0 (Armonk, NY, USA). Continuous variables were summarized as mean, standard deviation, median, minimum, and maximum values, whereas categorical variables were expressed as counts and percentages. Normality of distribution was assessed with the Kolmogorov–Smirnov test. For paired comparisons within the same patients, the paired-Samples-t test was used for normally distributed data, and the Wilcoxon signed-rank test for non-normally distributed data. Changes in categorical variables between admission and discharge were evaluated using the McNemar test. To identify factors associated with wound size, a linear regression analysis was performed. A two-tailed $p<.05$ was considered statistically significant.

RESULTS

Between June 1, 2022, and June 1, 2023, a total of 5103 patients aged ≥18 years were admitted to the PM&RH of Ankara Bilkent City Hospital. Among them, 240 patients with PU were included in the study. The mean age was 52.8±22.1 years (range, 18–92), and 63.3% were male. The mean BMI was 25.2±5.2. Regarding comorbidities, 15.4% of patients had diabetes mellitus, 34.6% had arterial hypertension, 40.4% had hyperlipidemia, and 10.8% had coronary artery disease (Table 1).

Table 1. Demographic characteristics and comorbidities of the patients

Characteristic	Value
Age (mean±SD, min-max)	52.8±22.1 (18-92)
Sex	63.3% male
BMI (mean±SD)	25.2±5.2
Diabetes mellitus	15.4%
Arterial hypertension	34.6%
Hyperlipidemia	40.4%
Coronary artery disease	10.8%

SD: Standard deviation, Min: Minimum, Max: Maximum, BMI: Body-mass index

Among patients admitted to the PM&R clinic with PU, the most frequent underlying condition was SCI (45.0%), followed by stroke (26.7%) and immobility syndrome (12.5%). Less common etiologies included anoxic brain injury (10.8%), polyneuropathy (3.8%), and multiple sclerosis (1.3%) (Table 2).

Table 2. Admission diagnoses of patients to the PM&R clinic

Diagnosis	n	%
Spinal cord injury	108	45.0
Stroke	64	26.7
Immobility syndrome	30	12.5
Anoxic brain injury	26	10.8
Polyneuropathy	9	3.8
Multiple sclerosis	3	1.3
Total	240	100

PM&R: Physical medicine and rehabilitation

Of the 240 patients included in the study, 197 (82.1%) presented with a PU at the time of admission to the PM&R clinic. Among these, 38 patients (19.3%) had developed the ulcer during their prior stay in ICUs before referral to rehabilitation. In 30 patients (12.5%), PUs developed during hospitalization in the rehabilitation clinic. In 13 patients (5.4%), the exact onset time of the ulcer could not be determined. The mean duration since diagnosis was 14.8 months (range, 1-360 months). The mean length of hospital stay in the rehabilitation clinic was 53.6 days (range, 6-162 days).

The most frequent site of PUs was the sacral region (56.1%; n=134), followed by the heel (25.1%; n=60) and the ischial tuberosity (13.0%; n=31). The majority of patients (97.5%) received daily dressing care with conventional wound products, whereas only 2.5% underwent NPWT, and 5.0% (n=12) required surgical debridement. Osteomyelitis was identified in 1.7% of cases (n=4). Following treatment, a statistically significant reduction in wound size was observed compared with baseline measurements (p<.001) (Table 3).

Table 3. Comparison of wound size at admission and discharge

	Admission median (min-max) mean±SD	Discharge median (min-max) mean±SD	p
Wound size	4.5 (0.001-3900)	0.5 (0.001-1500)	<0.001

SD: Standard deviation, Min: Minimum, Max: Maximum

Patients with stage 4 PUs had the longest mean length of hospital stay. A statistically significant difference was observed among the stages in terms of the duration elapsed since diagnosis (p=.010). Furthermore, the length of hospital stay increased significantly with advancing ulcer stage (p=.042) (Table 4).

Table 4. Distribution of pressure ulcers by stages and healing rates

Stage	n	%	Healing rate (%)	Mean length of stay (days)
Stage 1	25	10.4	96.0	47.3±28.1
Stage 2	112	46.7	89.3	49.7±26.4
Stage 3	73	30.4	66.7	56.8±29.4
Stage 4	8	3.3	25.0	77.5±39.0
Suspected deep tissue injury	3	1.2	0.0	85.0±40.0
Unstageable pressure injury	19	7.9	18.2	61.6±32.4
Total	240	100	-	-

The laboratory findings of the patients are presented in Table 5. The mean serum 25-OH vitamin D level was 58.3±34.3 ng/ml, albumin level was 36.4±7.6 g/L, and hemoglobin level was 12.5±7.1 g/dl. These results indicate that, particularly albumin and hemoglobin levels, were close to the lower limit of the normal range, reflecting impaired nutritional and hematological status in this patient population.

Table 5. Mean laboratory values of the patients

Parameter	Mean	Standard deviation
25-OH vitamin D level (ng/ml)	58.33	34.29
Albumin level (g/L)	36.42	7.58
Hemoglobin level (g/dl)	12.46	7.13

There was a statistically significant improvement in functional status between admission and discharge among patients with pressure injuries in the rehabilitation hospital (p<.001). A substantial proportion of patients who were non-ambulatory at admission progressed to therapeutic ambulation (57.6%) or indoor ambulation (5.1%) by discharge. Similarly, 31.0% of patients who were initially at the therapeutic ambulation level advanced to indoor ambulation. Although the transition to community ambulation was limited (1% of patients), an overall significant improvement in functional mobility was observed.

A linear regression analysis was performed to identify the factors influencing post-treatment PU size. The model was statistically significant (F=12.141, p<.001), explaining 51% of the variance in ulcer size. Significant predictors included the presence of hyperlipidemia (B=–1.764, p=.001), which was associated with smaller ulcer size, whereas coronary artery disease (B=1.517, p=.004) and arterial hypertension (B=0.632, p=.045) were associated with larger ulcer dimensions. Pre-admission ulcer presence (B=0.854, p=.028) and baseline ulcer size (B=0.904, p<.001) were strong predictors of increased residual wound size. Lower albumin levels (B=–0.681, p=.002) were independently associated with larger ulcers. Hemoglobin level (B=0.251, p=.013) was also identified as a significant predictor, although the direction of this association was clinically unexpected. Debridement significantly reduced ulcer size (B=–3.855, p<.001), whereas the presence of osteomyelitis predicted larger ulcer dimensions (B=2.657, p=.017). Diabetes mellitus,

25-OH vitamin D level, time since diagnosis, and treatment modalities were not statistically significant predictors (Table 6).

Table 6. Factors influencing pressure ulcer size (linear regression analysis)

Variable	B (coefficient)	t value	p value
Comorbidity: diabetes mellitus	0.096	0.221	0.895
Comorbidity: arterial hypertension	0.632	1.874	0.045
Comorbidity: hyperlipidemia	-1.764	-3.033	0.001
Comorbidity: coronary artery disease	1.517	2.628	0.004
Time since diagnosis (months)	-0.004	-1.054	0.293
Presence of PU before admission	0.854	2.209	0.028
Pressure ulcer size (baseline)	0.904	7.658	<0.001
25-OH vitamin D level	0.003	0.808	0.453
Albumin level	-0.681	-3.207	0.002
Hemoglobin level	0.251	2.513	0.013
Presence of debridement	-3.855	-6.373	<0.001
Presence of osteomyelitis	2.657	2.413	0.017
Treatment modalities	-0.852	-0.976	0.354

PU: Pressure ulcer

DISCUSSION

PUs are among the most serious complications in patients requiring prolonged rehabilitation, contributing to increased morbidity, extended hospital stays, and impaired functional recovery. In this study, we evaluated 240 inpatients with PUs admitted to a tertiary PM&R clinic. Lesions were predominantly located in the sacral region and classified as stage 2-3. The overall healing rate was 78.5%; however, this rate declined substantially with advancing ulcer stage, and outcomes were particularly poor in stage 4 and deep tissue injuries. Low serum albumin levels, prolonged ICU stay, osteomyelitis, and larger baseline ulcer size were associated with adverse outcomes, whereas surgical debridement significantly improved healing. Moreover, functional status improved significantly during hospitalization, with more than half of the initially non-ambulatory patients achieving therapeutic ambulation by discharge. Taken together, these findings underscore the critical importance of early identification, risk factor modification, multidisciplinary management, and the integration of functional goals within rehabilitation practice.

In our cohort, PUs were most frequent among patients with SCI and stroke, which is in line with earlier studies. Verschueren et al.[5] identified SCI patients as the group at highest risk for PU development during inpatient rehabilitation. The predominance of sacral ulcers, followed by heel involvement, also reflects patterns reported in previous investigations. Lee et al.[6] confirmed that the heel remains the second most frequent anatomical location for PUs in immobilized patients. Similarly, Alito et al.[7] demonstrated in their seven-year retrospective analysis that the sacrum and heel were consistently the most common sites of ulceration. The predominance of stage 2–3 lesions in our study is also consistent with previous rehabilitation-based cohorts, further underscoring the vulnerability of pressure-bearing areas and highlighting the need for targeted preventive strategies in high-risk populations.

In our study, the most significant factors associated with poor clinical outcomes were low serum albumin levels, prolonged ICU stay, presence of osteomyelitis, and larger baseline ulcer size. These findings are consistent with the literature emphasizing the negative impact of malnutrition and systemic complications on PU healing. Gheri et al.[8] reported that high CONUT scores independently predicted PU development in patients with severe acquired brain injury. Similarly, Langer et al.[9] demonstrated in their systematic review that nutritional interventions, particularly protein supplementation, reduced the incidence of PUs and accelerated healing. Our finding that low albumin levels were strongly associated with worse prognosis aligns with these observations. Osteomyelitis, in particular, was also a significant predictor of adverse outcomes in our cohort. This is consistent with recent evidence showing that PUs complicated by bone infection are especially challenging to manage and are frequently associated with delayed healing and higher recurrence rates, particularly among patients with SCI.[10]

Furthermore, rehabilitation intensity and multidisciplinary management also play a critical role in outcomes. Chen et al.[11] showed that patients receiving high-intensity rehabilitation after ischemic stroke had a significantly lower risk of PU development.

In addition, Alito et al.,[12] in their seven-year single-center neurorehabilitation experience, reported that patients with traumatic and non-traumatic SCI receiving multidisciplinary care achieved significantly better neurological and functional outcomes. Consistent with these findings, our study highlights that intensive rehabilitation programs, combined with nutritional support and integrated wound care, are essential to improving treatment success in the management of PUs.

The prevention of PUs remains a cornerstone of management, particularly in high-risk rehabilitation populations. Self-management interventions and patient education have been proposed to improve skin care practices and reduce PU incidence in individuals with SCI.[13] Similarly, a recent umbrella review identified low mobility, low BMI, and a prior history of PU as the strongest risk factors among wheelchair users.[14] Our findings are consistent with these results, as patients with SCI in our cohort disproportionately presented with advanced-stage ulcers. Furthermore, in this group, PUs not only posed medical risks but also restricted functional recovery and social participation, in line with the findings reported by Piatt et al.[15]

Support surfaces are also a critical component of prevention. Huang et al.[16] demonstrated in their best-evidence summary that dynamic air mattresses and pressure-redistribution systems significantly reduced PU incidence among immobilized patients. However, the integration of international guidelines (EPUAP/NPIAP/PPPIA) into daily clinical practice remains limited, as highlighted in a recent citation analysis by El Genedy-Kalyoncu and Kottner.[17] In our study, staging and classification were based on these guidelines, demonstrating that local practices are in alignment with international standards.

National data from Turkiye further support our results. Several hospital-based studies have reported PU prevalence rates ranging between 7% and 15%, with hypoalbuminemia

and immobilization consistently identified as the strongest risk factors.[18-20] The higher risk profile observed in our cohort can be explained by prolonged ICU stays and neurological morbidity.

With regard to treatment, the use of NPWT was limited in our cohort, being applied in only 2.5% of patients. The main reason was that the device often interfered with mobilization and the performance of active rehabilitation exercises, which are essential in PM&R practice. This finding contrasts with the literature, where NPWT is considered a standard component of advanced wound management, promoting granulation tissue formation, reducing exudate, and accelerating healing when applied appropriately.[21] Therefore, our results highlight the need to carefully balance wound care technologies with rehabilitation priorities to avoid compromising functional recovery.

In contrast, surgical debridement emerged as one of the most effective therapeutic interventions in our cohort. Regression analysis demonstrated that debridement significantly reduced wound size and improved healing outcomes, confirming its central role in PU management. By effectively removing necrotic tissue and bacterial load, surgical debridement creates an optimal wound bed for granulation and epithelialization. Previous studies have similarly reported that debridement, particularly when combined with appropriate wound care and rehabilitation strategies, accelerates healing and reduces the risk of systemic infection.[21-24] Taken together, these findings suggest that while NPWT remains an evidence-based adjunct for selected cases, surgical debridement is an indispensable modality in the management of advanced-stage PUs.

Another noteworthy finding was that higher hemoglobin levels were associated with larger residual ulcer size. This result contradicts existing literature, which typically associates anemia with impaired healing. Indeed, Jeon et al.[25] reported that a hemoglobin level of >11 g/dl was associated with a lower risk of PU worsening. The paradoxical association may be explained by unmeasured confounders (e.g., chronic hypoxia, relative polycythemia in severely immobilized SCI patients) or cohort-specific characteristics. This highlights the complexity of interpreting laboratory markers in heterogeneous rehabilitation populations and underscores the need for prospective studies to clarify the underlying mechanisms.

Wan et al.[26] stated that increasing knowledge and awareness regarding the prevention of PUs, as well as addressing the shortage of pressure-relieving beds and materials, should be among the most important strategies. Sen[27] also 2025 human wound and its burden update, emphasized a wound management system based on PU prevention, strengthened by education and supported by technology. In our study, since the risk of PU development increased with longer hospital stays, having adequate knowledge and a high level of awareness about preventive measures is of great importance.

Finally, rehabilitation-based interventions extend beyond mobilization and nutritional optimization. Physical modalities such as electrotherapy, laser therapy, and ultrasound have been investigated as adjunctive treatments in wound healing. A recent review concluded that these modalities may enhance granulation, improve tissue perfusion, and support scar quality, although the overall certainty of evidence remains moderate.[24] In this context, incorporating selected physical therapies into comprehensive rehabilitation programs may further optimize PU healing and functional recovery.

Looking ahead, artificial intelligence (AI) based applications hold significant potential in the prevention and management of PUs. Recent advances in machine learning algorithms allow the prediction of ulcer risk by identifying patterns from large patient datasets, thereby enabling the implementation of individualized preventive strategies. Furthermore, AI systems integrated with digital wound imaging technologies can automatically analyze wound size, depth, and necrosis ratio, offering clinicians objective and dynamic monitoring. This approach not only provides more accurate prognostic assessment but also supports rational decision-making regarding the selection of treatment modalities (e.g., support surfaces, biological dressings, adjuvant physical therapy). Therefore, integrating AI-supported decision-making mechanisms into multidisciplinary care in PM&R clinics may represent an innovative step toward improving patient outcomes in the future.

Limitations

This study has several limitations. Its retrospective and single-center design precludes establishing causal relationships and limits the generalizability of the findings. Data were obtained from patient charts and nursing records, which may have resulted in incomplete information, particularly regarding the onset of ulcers and variations in treatment processes. In addition, biochemical parameters were recorded only at certain time points, overlooking potential dynamic changes. The heterogeneity of wound care modalities applied during hospitalization also introduces potential bias. For these reasons, multicenter, prospective studies are needed to provide more robust evidence.

CONCLUSION

PUs remain a persistent clinical challenge in PM&R practice, arising from patient related characteristics and multifactorial clinical determinants. Although they are a common complication, timely and evidence-based management can yield substantial improvements, and their presence should not be considered a contraindication to rehabilitation interventions. On the contrary, rigorously structured and scientifically grounded rehabilitation programs have the potential to promote wound healing and positively influence clinical outcomes.

In our cohort, surgical debridement emerged as a cornerstone in the management of advanced-stage PUs, underscoring its indispensable role alongside preventive and rehabilitative strategies. The findings further emphasize that early identification of high-risk patients, the adoption of individualized preventive measures, and the integration of effective rehabilitation approaches are critical for reducing incidence, enhancing functional recovery, and mitigating the healthcare burden.

Taken together, these results highlight the importance of combining preventive strategies with effective therapeutic

modalities within comprehensive rehabilitation frameworks. To strengthen the generalizability of these findings and to establish more robust evidence for optimizing clinical protocols, well-designed prospective multicenter studies are warranted.

ETHICAL DECLARATIONS

Ethics Committee Approval

This study has been approved by the Ankara Bilkent City Hospital No. 2 Clinical Researches Ethics Committee (Date: 21.02.2024, Decision No: E2-24-6500).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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