Associated Risk Factors and Barriers of Pressure Injury Wound Healing Process: A Retrospective Study of Single-Center Experience

Iman Ateeq\textsuperscript{a} Leena kennedy\textsuperscript{a} Tessy Baby\textsuperscript{a} Imad Amer\textsuperscript{b} Fouad Chehab\textsuperscript{b} Nezar Ahmed Salim\textsuperscript{c}

\textsuperscript{a}Wound Team Management, Dubai Hospital, Dubai Health Authority, Dubai, United Arab Emirates; \textsuperscript{b}Nursing Department, Dubai Hospital, Dubai Health Authority, Dubai, United Arab Emirates; \textsuperscript{c}INOVA Fairfax Hospital, Washington, DC, USA

\textbf{Keywords}
Risk factors · Barriers · Pressure injury · Wound healing process · Wound team management

\textbf{Abstract}

\textbf{Introduction}: Pressure injuries, particularly those involving dressings, are associated with high rates of morbidity, mortality, and costs. Furthermore, it has a significant impact on patients, family members, and health care systems, increasing pain symptoms, wound odor, hospital stay duration, and even mortality, all of which have a negative impact on quality of life. In the medical literature, a number of variables have been identified that predispose patients to poor wound healing. Diabetes mellitus, venous insufficiency, peripheral artery disease, tobacco smoking, low serum albumin, and inflammatory disorders are among the causes. \textbf{Objectives}: The main aim of this study was to identify risk factors and barriers that may confer on poor wound healing. \textbf{Methods}: This is a retrospective study, which was carried out in Dubai Hospital, Dubai Health Authority (DHA), for the period June 2020 until December 2020. \textbf{Result}: The present study consisted of 146 patients. Paired $t$ test revealed statistically significant improvement in pressure injury healing in terms of length and width at discharge compared to pressure injury ($p < 0.05$). On the other hand, depth improvement was not statistically significant ($p > 0.05$). $\chi^2$ test revealed a statistically significant relationship between pressure injury healing and low albumin levels, diabetes, and advanced age ($p < 0.05$), while there was no statistically significant association between the location of the pressure injury and the healing process ($p > 0.05$). Furthermore, there was no statistically significant relationship between Braden category, length of stay, or patient hospitalization and pressure injury healing ($p > 0.05$). \textbf{Conclusion}: The healing process might be influenced by single or multiple factors. The findings of this retrospective study revealed that low albumin levels, diabetes patients, and age all had an impact on the healing of pressure injuries. When planning and implementing a complete pressure injury treatment strategy, health care practitioners should keep these things under consideration. On the other hand, pressure injury’s location, Braden category, length of stay, and patient hospitalization did not reveal a significant effect on wound healing, despite the fact that other studies showed an effect of these factors on the healing process.
**Introduction**

A localized damage to the skin and underlying soft tissue, commonly over a bony prominence or associated with a medical device, is known as a pressure injury (PI). PI can take the form of intact skin or an open ulcer, and it can be painful [1]. Intense and/or persistent PIs, as well as PIs combined with shear, create PIs. Microclimate, nutrition, perfusion, comorbidities, and soft tissue condition may all affect soft tissue tolerance to PIs and shear [2].

PIs are a complicated and multidimensional clinical condition that affects approximately 1 in 20 community patients and 1 in 10 hospital patients. The incidence of PIs has been identified as a quality-of-care indicator for long-term care institutions and also compliance [3]. PIs are one of the five most prevalent causes of patient damage, costing the NHS between £1,214 and £40,234 each occurrence, depending on the severity of the injury and the patient’s health status [4]. According to a research published by Lindholm, the cost of treating PIs worldwide is $11 billion per year [5].

PIs, particularly those involving dressings, are associated with higher rates of morbidity, mortality, and costs. Furthermore, it has a significant impact on patients, family members, and health care systems, increasing pain symptoms, wound odor, hospital stay length, and even mortality, all of which have a detrimental impact on quality of life [6]. Lack of knowledge of preventive measures, comorbidities of patients, imbalanced nutrition, lack of finance, lack of supportive devices, improper incontinence management, attitude of family members, PIs, friction, and other factors all contribute to the development of community-acquired PIs [7]. Patients with PIs experience severe pain and discomfort, as well as longer hospital stays, social isolation, loss of independence, depression, recurrent infection, long and complex treatment and care practices, increased health care costs, decreased life quality, and a higher mortality rate [8].

Patients with PI are three to six times more likely than those without PI to die within 21 months. The mortality rate in patients with bacteremia attributable to wound infection has been recorded to be as high as 50% [9]. Avoidable PIs occur when a patient develops a PI and a health care provider has a negative attitude toward the patient, such as failing to evaluate the patient’s clinical condition and PI risk factors, failing to implement interventions that are reliable with patient needs, and failing to follow standards of practice [10]. Unavoidable PIs, on the other hand, occur after a health care provider has evaluated the patient’s clinical condition and the risk factor for PIs; defined and implemented interventions that are reliable with patient needs and goals, and provide standards of practice; and evaluated and monitored the impact of the interventions [11]. External PIs, on the other hand, do not create an ulcer on their own; rather, the combination of these PIs with internal factors causes tissue destruction [11]. The Braden tool frequently fails to detect the intrinsic element that contributes to the development of a PI. According to traditional view, PIs develop as a result of a combination of PIs, friction, shearing, and moisture, but other elements may also play a significant role; friction and moisture may only play a minor role in correct PI assessment [10]. Although hypoxia is commonly thought to be the primary cause of PIs, reperfusion and compression are increasingly being acknowledged as critical factors.

**Significance of the Study**

In the medical literature, a variety of factors have been identified that predispose patients to poor wound healing. Diabetes mellitus, venous insufficiency, peripheral arterial disease, tobacco smoking, low serum albumin, and inflammatory illnesses (such as pyoderma gangrenosum) are only a few of the underlying diseases [12]. Chronic kidney disease, hypertension, and myocardial ischemia, according to a recent study, are all associated with an increased risk of foot injuries, including severe injuries that necessitate amputation [13]. Furthermore, compared to the general population, patients with chronic venous leg injuries had higher rates of malnutrition and vitamin and mineral deficiencies, such as zinc [14]. While risk factors for skin injuries have been identified, clinical markers of poor wound healing have received less attention. There are no large, well-controlled studies on independent impact of multiple risk factors including demographic, clinical, and laboratory markers on PI wound healing.

**Goals and Objectives**

The main aim of this study was to identify risk factors and barriers that may contribute to poor wound healing.

**Secondary Objectives**

1. Compare the PI measurement (improvement) on admission and discharge.
2. Find the relationship between Braden category, length of stay, and patient hospitalization with PI improvement.
3. Identify the common PI’s location.
Methodology

Study Design and Setting

This is a retrospective study which was carried out in Dubai Hospital, Dubai Health Authority (DHA), for the period June 2020 until December 2020.

Inclusion and Exclusion Criteria

Patients enrolled in a study who met the inclusion criteria, which are age (adults over the age of 13), diagnosis and treatment in a Dubai hospital, and a stay of more than 2 weeks. On the other hand, patients who expired before completing 2 weeks and patients admitted with device PIs were excluded from the study, and patients with missing or incomplete data were excluded from the study.

Data Collection

A data collection sheet was developed by the authors to meet the purpose of the study. Data were collected retrospectively from the Electronic Medical Record of all cases with PIs admitted to Dubai Hospital in the last year, including sociodemographic-related data, clinical-related data, and risk factor-related data. Patients with missing or incomplete data were excluded from the study.

Planned Statistical Analysis

Descriptive statistics were used to find the mean and standard deviation of the sample. $\chi^2$ was used to find the association between the categorical variables, while paired t test was used to find the mean difference of PI measurement upon admission and on discharge. $p < 0.05$ was defined to be statistically significant. Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 26.

Ethical Consideration

Ethical considerations and compliance were taken up to standard. Formal permission was obtained from Dubai Scientific Research Ethics Committee (DSREC) prior to data collection. Ethical principles of confidentiality and anonymity were strictly applied in this study. Patients’ data were anonymous. The data were entered into SPSS and Excel program on the author’s computer and secured with a username and password. The data were discarded after the completion of the study.

Results

The present study consisted of 146 patients; 71 (48.6%) were males and 75 (51.4%) females. In regard to nationality, 77 (52.7%) and 69 (47.3%) were UAE citizens and expatriates, respectively. The majority of patients, 86 (58.9%), had diabetes, with abnormal albumin levels affecting 65 (44.5%). In light of each patient’s condition

| Variable                  | Group      | Frequency | Percentage |
|---------------------------|------------|-----------|------------|
| Gender                    | Males      | 71         | 48.6       |
|                           | Females    | 75         | 51.4       |
| Nationality               | UAE citizens | 77       | 52.7       |
|                           | Expatriates | 69        | 47.3       |
| Diabetes                  | Yes        | 86         | 58.9       |
|                           | No         | 60         | 41.1       |
| Location of PIs           | Sacrum     | 71         | 48.6       |
|                           | Trochanter | 7          | 4.8        |
|                           | Heels      | 8          | 5.5        |
|                           | Buttocks   | 22         | 15.1       |
|                           | Multiple PIs | 23   | 15.8       |
|                           | Others     | 15         | 10.3       |
| Albumin                   | Abnormal (<3.5) | 65 | 44.5       |
|                           | Normal range (3.5–5.5) | 67 | 45.9       |
|                           | Not done   | 14         | 9.6        |
| Patient hospitalization   | Discharge home | 103    | 70.5       |
|                           | Expired    | 43         | 29.5       |
| Patients’ condition upon discharge | Totally healed | 16 | 11.0       |
|                           | Improved but did not heal | 38 | 26.0       |
|                           | Same condition | 71    | 48.6       |
|                           | Deteriorated | 21    | 14.4       |

| Continuous variables      | Variables  | Mean ± SD | Minimum | Maximum |
|---------------------------|------------|-----------|---------|---------|
|                           | Length of stay | 71.97±15.898 days | 21 | 105 |
|                           | Braden     | 11.89±3.149 | 6       | 23      |

Table 1. Participants’ demographical data
upon discharge, 38 (26.0%) improved but did not heal, 16 (11.0%) healed, 71 (48.6%) had the same condition, and 14 (14.4%) deteriorated. Overall, 103 (70.5%) patients were discharged home, and 43 (29.5%) expired. The vast majority of patients were admitted with PI in the sacrum area (71; 48.6%). The median patient age was 75 years, while length of stay was 71.97 ± 15.898 days with mean of Braden score 11.89 ± 3.149 (Table 1).

The mean difference in PI measurement between admission and discharge was determined using a paired t test. In Table 2, the mean PI width at admission was 2.81 ± 2.570 cm, while the average width at discharge was 2.31 ± 1.883 cm, mean difference = 0.505 (95% CI 0.182, 0.828, p < 0.05). In terms of PI length, there was also a statistically significant difference. The mean length of a PI at admission was 3.72 ± 3.131 cm, while the mean length at discharge was 3.10 ± 2.497 cm, mean difference = 0.618 (95% CI 0.209, 1.028, p < 0.05). In contrast, there was no improvement in depth following discharges as compared to the patients’ condition at admission (p value > 0.05).

Table 3 shows the relationship between risk factors and PI condition upon discharge. As noticed from the result below, the majority of deteriorated PI condition, 13 (20.0%), had a low albumin level (p < 0.05). Similarly, there was a statistically significant association between patients with diabetes and degraded PI condition 16 (18.6%; p < 0.05). The patient’s age revealed a significant association with PI healing, whereas the majority of deteriorated PI conditions (17 or 14.3%) were noticed in those aged above 60 years (p < 0.05). On the other hand, there

Table 2. Paired t test result of PI measurements at admission and upon discharge

| Variable | Group                        | Mean ±SD       | Mean difference | N  | 95% CI lower | 95% CI upper | p value |
|----------|------------------------------|----------------|-----------------|----|--------------|--------------|---------|
| Width, cm| Width at admission           | 2.81±2.570     | 0.505           | 146| 0.182        | 0.828        | 0.002   |
|          | Width upon discharge         | 2.31±1.883     |                 |    |              |              |         |
| Length   | Length at admission          | 3.72±3.131     | 0.618           | 146| 0.209        | 1.028        | 0.003   |
|          | Length upon discharge        | 3.10±2.497     |                 |    |              |              |         |
| Depth    | Depth at admission           | 0.37±0.963     | 0.010           | 146| −0.082       | 0.102        | 0.828   |
|          | Depth upon discharge         | 0.36±0.927     |                 |    |              |              |         |

Table 3. Association between risk factors and PI condition upon discharge

| Variables   | Group       | Totally healed, n (%) | Improved but did not heal, n (%) | Same condition, n (%) | Deteriorated, n (%) | p value |
|-------------|-------------|-----------------------|----------------------------------|-----------------------|--------------------|---------|
| Albumin     | 3.5–5.5     | 8 (11.9)              | 17 (25.4)                        | 36 (53.7)             | 6 (9.0)            | 0.04197 |
|             | <3.5        | 5 (7.7)               | 17 (26.2)                        | 30 (46.2)             | 13 (20.0)          |         |
| Diabetic    | No          | 8 (13.3)              | 16 (26.7)                        | 31 (51.7)             | 5 (8.3)            | 0.034411|
|             | Yes         | 8 (9.3)               | 22 (25.6)                        | 40 (65.6)             | 16 (18.6)          |         |
| PI location | Sacrum      | 7 (9.9)               | 17 (23.9)                        | 30 (42.3)             | 17 (23.9)          | 0.14197 |
|             | Trochanter  | 0 (0.0)               | 2 (28.6)                         | 5 (71.4)              | 0 (0.0)            |         |
|             | Heels       | 0 (0.0)               | 2 (25.0)                         | 6 (75.0)              | 0 (0.0)            |         |
|             | Buttocks    | 3 (13.6)              | 4 (18.2)                         | 13 (59.1)             | 2 (8.1)            |         |
|             | Multiple PI | 3 (8.7)               | 4 (30.4)                         | 13 (52.2)             | 2 (8.7)            |         |
|             | Others      | 4 (26.7)              | 6 (40.0)                         | 5 (33.3)              | 0 (0.0)            |         |
| Age         | <30         | 2 (40.0)              | 1 (20.0)                         | 2 (40.0)              | 0 (0.0)            | 0.040902|
|             | 30–39       | 1 (25.0)              | 2 (50.0)                         | 1 (25.0)              | 0 (0.0)            |         |
|             | 40–49       | 0 (0.0)               | 1 (50.0)                         | 1 (50.0)              | 0 (0.0)            |         |
|             | 50–59       | 3 (18.8)              | 2 (12.5)                         | 7 (43.8)              | 4 (25.0)           |         |
|             | >60         | 10 (8.4)              | 32 (26.9)                        | 60 (50.4)             | 17 (14.3)          |         |
was no evidence of association between the location of the PI and the healing process \((p > 0.05)\).

Table 4 shows that there was no statistically significant association between Braden category, length of stay, and patient hospitalization with PI condition upon discharge \((p > 0.05)\).

**Discussion**

The present study aimed to identify risk factors and barriers that influence PIs. This is also the first retrospective study (to our knowledge) carried out in the United Arab Emirates related to this topic. This study finds that albumin, diabetic patients, and age play important factors in PI healing. Moreover, we found that the wound team at Dubai Hospital had a significant role in improving healing of the PIs as the wound measurement was significantly reduced at discharge compared to the patient’s condition at admission.

Wound healing is a multi-step biological process that includes hemostasis, inflammation, proliferation, and remodeling [12]. Multiple factors, classified as local and systemic, can impair wound healing by altering one or more steps of the process. These factors’ impacts are not mutually exclusive. Single or many factors may have a role in one or more individual phases of the healing process, contributing to the overall outcome of the healing process [15]. Patients with advanced age, malnutrition (lower levels of hematocrit or albumin), poor circulation, or smoking are thought to be at a higher risk of developing PIs [16]. Furthermore, for surgical patients, other factors such as anesthetic and operation type, length of surgery, patient position during surgery, warming or moisture devices utilized, and padding type employed [17] might all influence the development of PIs.

Albumin levels, according to our results, play a significant role in wound healing. When patients with abnormal albumin levels \(<3.5\) were compared to those with normal albumin levels \(>3.5\), the majority of patients with deteriorated PIs had an abnormal albumin level \((p < 0.05)\). Friedman et al. [18] observed similar findings, indicating that low blood albumin, at 3.1 g/dL, is a predictor of PI healing and is linked with greater mortality. Terekeci et al. [19] also evaluated 142 ICU patients in a research concentrating on PI risk assessment. The researchers discovered that hypoalbuminemia is a factor in the occurrence of PIs. Furthermore, Jaul et al. [8] reported that increased albumin levels related to faster healing of PIs. However, there is no perfect method of assessing PIs risk; evaluation based on the Braden scale takes into account patients’ nutritional status, the tool.

The association between chronic renal disease and PI is explained by an imbalance in homeostatic processes (body fluids, electrolyte imbalance, and hormonal losses), which appears as poor concentration and dilution, anemia, and soft tissue alterations. According to the Coleman model, direct causative risk factors for PI and chronic renal disease might include inadequate perfusion and a history of skin/PIs. Low albumin and inadequate nutrition might be indirect contributing factors. Other possible concerns include advanced age, medication (anti hypertensive medication may reduce blood PIs, lowering perfusion and activity infection), and chronic disease [20].
The relationship between chronic kidney disease and PI is explained by an imbalance in homeostatic processes (body fluids, electrolytes, and hormone losses), which manifests as poor concentration and dilution, anemia, and soft tissue abnormalities. Inadequate perfusion and a history of skin/PIs may be direct causal risk factors for PI and chronic renal illness, according to the Coleman model. Inadequate diet and low albumin levels might be indirect contributors. Other potential issues include senior age, medication (antihypertensive medication may minimize blood PI by reducing perfusion and activity infection), and chronic disease [20], p 0.05 for poor PI healing. Numerous researches have been conducted to study the function of diabetes in the healing of PIs. Despite the fact that some studies have found a relationship between diabetes and an increased risk of surgery-related PIs, others have found contradictory results. Several studies [21-24] found that patients with diabetes had a higher risk of developing PIs and poor healing than those without diabetes. Others, on the other hand, showed no relationship [25-27]. Despite the fact that two earlier meta-analyses [28, 29] investigated this issue and found a significant association between diabetes and the wound healing process, diabetes-related processes can contribute to the development and severity of PIs, which can occur as a result of capillary blockage by external PIs, resulting in blood supply interruption, cell death, necrosis removal, and ulceration [30].

Diabetes causes a reduction in angiogenesis, which delays wound closure and might result in a common occurrence, namely nonhealing wounds. Diabetes also changes macrophages’ capacity to switch from a pro-inflammatory to a pro-reparative phenotype, increasing the inflammatory profile in diabetic wounds. In diabetic wounds, the expression of angiogenesis-related mRNA and vascular endothelial growth factor is dramatically reduced, thus reducing the quantity of angiogenesis that occurs [31].

The performed tests showed that age revealed a significant factor in PIs healing process. We found that the vast majority of deteriorated cases were reported among patients >60 years (p < 0.05). Similarly, research by Thomas et al. [23] found that nearly two-thirds of PIs occur in elderly adults (60–80 years of age). According to Lyder’s study, the prevalence of PIs in outpatient settings was 1.61% of 75,168 older people and increased to 4.2% for those over the age of 85, with an adjusted RR of 5.06. Older individuals with major acute diseases are generally treated in the hospital, with a significant rise in PI development during a short length of time [27]. In elderly patients, age-related physiological changes can reduce the threshold for PIs, for example an increase in the fragility of blood vessels and connective tissue, as well as a loss of fat and muscle, all of which lead to a diminished capacity to absorb PIs. Any condition is associated with prolonged, impaired wound healing such as diabetes mellitus, which affects 11% of adults over the age of 70 years [32]. Furthermore, research conducted in the USA found that 159,000 nursing home patients (11%) over the age of 65 experienced a PI [8]. According to Swedish research data, 97.7% of patients over the age of 65 developed a PI [33].

According to the above analysis, length of stay did not affect the PIs healing (p > 0.05). In other words, PIs healing relies more on patients’ condition and age rather than the duration of staying in the hospital. Worsley et al. [34] found in a retrospective review of patient records that healing of PIs is influenced by the length of hospital stay and has a greater proportion of PI. However, the current study found that the location of PIs had no effect on healing (p > 0.05).

In terms of patients’ hospitalization and its impact on PI healing, our study found a significant association (p > 0.05). In contrast, a retrospective study found that more than half of the 76 patients admitted to the medical critical care unit had PIs healing and were released [35]. Similarly, 71.5% of patients healed in a retrospective research including 155 patients with Stage 2 PIs at a Korean acute care hospital. Patients who have a PI are more likely to be hospitalized for a longer amount of time than those who do not have a PI [36].

The Braden scale is one of the most reliable tools for predicting the likelihood of PIs. The present study’s patients had a mean Braden score of 11.89 ± 3.149. In the current study, there was no statistically significant relationship between the patient’s Braden score and wound healing (p > 0.05). In a retrospective cohort study published in 2012 by Tescher et al. [36], a PI developed in more than 60% of patients with a Braden score of 6–9 (extremely high risk) after hospitalization, and in 9% of patients with a score of 10–12. The overall Braden scale score was found to be significantly predictive of the development of PIs. In contrast to a retrospective study, Braden ratings differed significantly between patients with PIs that healed and those who did not [36].

Finally, as outlined in the previous analysis, the paired t test result revealed a significant improvement in PIs measured following discharge compared to the patients’ condition at admission. The width and length revealed significant healing, but not the depth. These improvements indicate the wound team’s excellent involvement in the Dubai Hospital. Controlling and preventing PI ne-
cessitates multidisciplinary teamwork. Nurses must request support and advice from other health experts in order to maintain the integrity of their patients’ skin and prevent PI problems.

Conclusion

Our research found that several factors, classified as local and systemic, can cause poor wound healing by impacting one or more steps of the process. These elements’ impacts are not mutually exclusive. A single or multiple might influence the overall outcome of the healing process. The current retrospective study found that low albumin levels, diabetes, and age all had an effect on the healing of PIs. When developing and implementing a complete PI treatment plan, health care providers should keep these factors in mind. However, despite the fact that previous studies have shown an effect of these factors on the healing process, the location of the PI, the Braden category, the length of stay, and the patient hospitalization did not demonstrate a significant effect on wound healing.

Limitation

The limitations of the present study are acknowledged and reported. First, this is a single-center study, which limits the generalization of the results. Second, there was a small sample size due to the incomplete data of PI measurement. Third, nurses failed to properly assess and measure PIs on a regular basis. Records showed that most patients were assessed upon admission and discharge only, without regular assessment during their length of stay in the hospital.

Recommendations

PI management necessitated a multidisciplinary team approach to patient care in order to maximize patient condition and manage PI complications, related factors that affect PI wound healing, and chronic diseases. It is important to begin appropriate and well-balanced nourishment for all patients who are at risk of developing PI or who have developed PI, regardless of the severity of the PI. To ensure wound healing, the diet should be rich in protein, vitamin C, and zinc, among other factors. Therefore, once the patient is admitted, a dietitian referral is highly recommended to ensure high protein nutrition, as protein supplements play a significant role in improving albumin levels and wound healing.

A diabetic patient has more frequent recurrent wound infection than nondiabetic cases; therefore, the health care team is required to have more strategies to monitor wound infection such as frequent observation for PI signs and symptoms of wound infection, wound culture, and local antimicrobial dressing selection by unit nurses and wound management team, with consideration of prescribing proper antibiotics by the primary physician. An aging population requires frequent wound assessment, wound care management and follow-up, frequent positioning, considering proper management for related co-morbidities; in addition, further strategies related to PIs prevention and optimizing patient health status and quality of life should be considered.

Statement of Ethics

The research complies with Helsinki Declaration and was approved by Dubai Scientific Ethical Research Committee (ref. No. DSREC 01/2021_25), dated October 4, 2020. Patients visited Dubai Hospital Clinics and signed general consent to authorize the Dubai Health Authority to allow their medical records to be reviewed and used for scientific purposes while maintaining patient confidentiality.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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None.

Author Contributions

Nezar Ahmed Salim: conceptualization, methodology, investigation, formal analysis, and writing – original draft preparation. Iman Ateeq: methodology, investigation, and writing – original draft preparation. Leena Kennedy, Tessy Baby, Imad Amer, and Fouad Chehab: validation and writing – review and editing. All authors have read and agreed to the published version of the manuscript.

Data Availability

The data that support the findings of this study are not publicly available due to restricted organization rules to share the raw data in public. However, the dataset is available with the corresponding author but with reasonable request.
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