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Determination of Incidence and Risk Factors of Perioperative Pressure Injury in Surgical Patients: A Descriptive, Prospective, and Comparative Study

Cerrahi Hastalarında Perioperatif Basınç Yaralanması İnsidansının ve Risk Faktörlerinin Belirlenmesi: Tanımlayıcı, İleriye Yönelik ve Karşılaştırmalı Bir Çalışma

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ABSTRACT Objective: This study aimed to determine the incidence and risk factors of perioperative pressure injury (PI) in surgical patients. **Material and Methods:** This descriptive, prospective, and comparative study was conducted with 101 patients who underwent general surgery in a training and research hospital in İstanbul between September 2018 and June 2019. Data were collected using the "Patient Data Form," the "Braden Scale," and the "International Pressure Injury Classification System." Data were analyzed with parametric and nonparametric tests using the SPSS package program. The statistical significance level was taken as $p<0.05$. The necessary institutional and ethics committee permission was obtained to conduct the study. **Results:** In this study, it was observed that the incidence of perioperative PI was 12.9% (13/101) in surgical patients, and most developed after pancreaticoduodenectomy (38.5%). Preoperative hemoglobin and serum albumin levels, surgical time longer than 185 minutes, and intraoperative hypotensive episodes were found to be determinant risk factors in the development of PI ($p<0.01$). **Conclusion:** Surgical nurses should carefully evaluate individual and surgery-related risk factors and implement evidence-based interventions in the prevention of pressure injuries.

Keywords: Pressure injury; incidence; risk factors; perioperative nursing; general surgery

ÖZET Amaç: Bu çalışmanın amacı, cerrahi hastalarında perioperatif basınç yaralanması insidansını ve risk faktörlerini belirlemektir. **Gereç ve Yöntemler:** Bu tanımlayıcı prospektif ve karşılaştırmalı çalışma, Eylül 2018-Haziran 2019 tarihleri arasında İstanbul'da bir eğitim ve araştırma hastanesinde genel cerrahi uygulanan 101 hasta ile gerçekleştirildi. Veriler "Hasta Veri Formu," "Braden Ölçeği" ve "Uluslararası Basınç Yaralanması Sınıflandırma Sistemi" kullanılarak toplandı. Veriler, SPSS paket programı kullanılarak parametrik ve parametrik olmayan testler ile değerlendirildi. İstatistiksel anlamlılık düzeyi $p<0,05$ olarak alındı. Araştırmanın gerçekleştirilebilmesi için gerekli kurum ve etik kurul izinleri alındı. **Bulgular:** Bu çalışmada, cerrahi hastalarında perioperatif basınç yaralanması insidansının %12,9 (13/101) olduğu ve en çok pankreatikoduodenektomi sonrası (%38,5) geliştiği görüldü. Perioperatif basınç yaralanması gelişiminde belirleyici risk faktörlerinin; ameliyat öncesi hemoglobin ve serum albumin düzeyleri, ameliyat süresi (≥185 dk) ve intraoperatif hipotansif atakların olduğu belirlendi ($p<0,01$). **Sonuç:** Cerrahi hemşireleri, perioperatif basınç yaralanmalarının önlenmesinde bireysel ve cerrahi ile ilişkili risk faktörleri dikkatli bir şekilde değerlendirmeli ve kanıta dayalı girişimleri uygulamalıdır.

Anahtar Kelimeler: Basınç yaralanması; insidans; risk faktörleri; perioperatif hemşirelik; genel cerrahi

Pressure injury (PI) is the main healthcare issue, which is common in Turkey and worldwide.[1-3] The National Pressure Injury Advisory Panel defined PIs as localized damage to the skin and deep tissue usually over a bony prominence or related to medical devices.[4] A perioperative PI is described as PIs that occur in a patient undergoing surgical treatment, during a few hours of surgery, and within the first 72 hours after surgery.[5,6]

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Patients undergoing surgical treatment under general anesthesia are known to be the highest risk group for PI due to sensory impairment, prolonged immobility, impaired positioning, protective reflexes and muscle tone, inadequacy to sense the developing ischemia, length of surgical time, hemodynamic instability, and use of vasoactive medications during surgery.[7-9] It has been reported in the literature that the incidence of perioperative PIs varies between 1.3-66% and this rate constitutes 45% of all hospital-acquired PIs.[6,10-12] In a systematic review of 17 studies, it was stated that the incidence of perioperative PIs ranged from 0.3-57.4% in 10 countries, with an average of 15%.[1] In studies conducted in Turkey, it was determined to be approximately 40.4% and 54.8%.[2,13]

Perioperative pressure injuries are an important, partially predictable, and often preventable indicator of the quality of perioperative care and are a costly complication that can lead to delayed recovery after surgery, reduced health-related quality of life, prolonged hospital stay, and negative outcomes.[3,7-10] Preventing PIs can be effective in improving patient outcomes and reducing healthcare costs.[7,14] To prevent PIs, high-risk patients should be determined and the evidence-based preventive care provided.[3,8,15] Healthcare professionals may prevent PIs by taking initiative and recognizing related risk factors; this initiative is one of the main responsibilities of a nurse.[2,12,15] Knowing the incidence of PIs and evaluating risk factors are very important in determining effective prevention methods.[2,15] Nowadays, Braden, Norton, and Waterlow scales are widely used, especially in elderly and long-term inpatients to assess PI risk factors. However, these scales are recommended not to be used alone to determine the risk of perioperative PIs, due to their low predictive validity. Therefore, a new risk assessment model is required for perioperative PIs.[7,9,14,16] Understanding the incidence of perioperative PIs and the risk factors for their development can help identify means for their prevention.[2] When the international literature was examined, although studies were investigating the incidence and risk factors of PIs in many different clinical areas outside the operating room, several studies were found to specify the incidence and risk factors of perioperative PIs.[5,8,10,14,15] In Türkiye, there are only 2 studies on this subject.[2,13] The most important feature of this study, which distinguishes it from other studies, is that it only included patients who underwent general surgery, and the PI follow-up took a long time. Based on this, this study was conducted to determine the incidence and risk factors of perioperative PI in surgical patients.

Research questions:

1. What is the incidence of perioperative PI in surgical patients?

2. What risk factors related to patient and surgery affect perioperative PI?

MATERIAL AND METHODS

STUDY DESIGN AND SETTING

The descriptive, prospective, and comparative study was carried out with 101 surgical patients at a training and research hospital in İstanbul.

STUDY PARTICIPANTS

The population of the study consisted of 228 patients who had cholecystectomy, gastrectomy, pancreaticoduodenectomy, or hepatectomy surgery in the general surgery service between September 2018 and June 2019 in a training and research hospital in İstanbul. The sample size of the study was calculated using data from a similar study with Minitab-10 statistical software (Minitab Inc, Quality Plaza, Pennsylvania, USA).[11] In the calculations with the Minitab program, when the Type 1 error was 5% and the power of the study was 95%, in order to show the expected standard deviation of 8.1 and 2.96 units of a difference the number of patients required to be included was found to be at least 100. During the data collection process, 172 patients who had cholecystectomy, gastrectomy, pancreaticoduodenectomy, or hepatectomy surgery were reached. The study was conducted with 101 patients who met the inclusion criteria.

The study included patients who met the following criteria: At least 18 years of age, underwent an elective cholecystectomy, gastrectomy, pancreaticoduodenectomy, or hepatectomy procedure lasting at least one hour under general anesthesia, were hospitalized for at least 72 hours after surgery, and were willing to participate in the study.

DATA COLLECTION

The data were collected with the "Patient Data Form" which was developed in the light of the literature, the "Braden Scale," and the "International National Pressure Ulcer Advisory Panel (NPUAP)", "European Pressure Ulcer Advisory Panel (EPUAP)" and "Pressure Injury Classification System."[7,8,10,13]

Patient Data Form*:* This form consisted of 2 parts. The first part consisted of five questions that evaluate the sociodemographic characteristics of the patients such as age, gender, body mass index (BMI), and comorbidities (diabetes mellitus, hypertension, heart disease, cancer, etc.). The second part consisted of 20 questions about the albumin, hematocrit, and hemoglobin levels (obtained from laboratory results), American Society of Anesthesiologist-American Association of Anesthesiologists (ASA) score, methylprednisolone usage; surgery type, surgical time, type and duration of anesthesia, position, pressure areas, support systems, hypotension episodes (diastolic blood pressure less than or equal to 60 mmHg) and the presence, stage, and location of PIs.

Braden Scale: The Braden Scale was developed by Bergstrom et al., considering the PI risk factors of patients receiving care at home.[17] The scale consists of 6 subscales: Sensory perception, moisture, activity, mobility, nutrition, and friction and shear. The total scores range from 6-23. A score of 15 to 18 means a mild risk, 13 to 14 means a moderate risk, 10 to 12 means a high risk, and 9 or lower means a very high risk.[17,18] Pınar and Oğuz tested the validity and reliability of the Braden Scale in Türkiye in 1998, and the Cronbach's alpha value of the scale was 0.88.[18] The Braden Scale Cronbach's alpha value for this study was 0.82.

International NPUAP/EPUAP Pressure Injury Classification System*:* The classification system published in 2014 by EPUAP, NPUAP, and Pan Pacific Pressure Injury Alliance (PPPIA) was used.[4]

Data were collected from patients who met the inclusion criteria between September 2018 and June 2019, at time intervals that did not interfere with the patient's treatment and care interventions. The third author of this study (A.A.) collected data using three different instruments (eg, scales, questionnaires), conducted one-on-one interviews, and reviewed patient records during the perioperative periods. The author (A.A.) who evaluated patients for the development of PIs has a doctorate degree in surgical nursing. In addition, she has 10 years of operating room experience and works as a manager nurse in the hospital where the study was conducted.

In the preoperative period, the author (A.A.) completed face-to-face interviews with the patients admitted to the general surgery ward, evaluating the sociodemographic characteristics and preoperative period parts of the Patient Data Form and the Braden Scale. The same author examined the records of the patients in the Post-anesthesia Care Unit, filled the intraoperative period part of the Patient Data Form, and evaluated the presence of any skin injury in the patient using the International NPUAP/EPUAP Pressure Injury Classification System. Finally, the postoperative period part of The Patient Data Form was evaluated and filled in daily, up to 72 hours postoperatively, using the International NPUAP/EPUAP Pressure Injury Classification System.

ETHICAL APPROVAL

To carry out the study, necessary institutional permission from the relevant departments and ethics approval (Date: 05/04/2018-Number: 128448) from the Clinical Research Ethics Committee of İstanbul University Cerrahpaşa Faculty of Medicine were obtained. Also, before initiating the data collection process, because the use of human beings in the study required the protection of an individual right, the "informed consent" condition was required as an ethical principle and written and verbal permissions of the participants were obtained, too. In this study, the Declaration of Helsinki's principles were considered.

DATA ANALYSIS

Data were analyzed by using the SPSS 22.0 (IBM Corp., Armonk, New York) package program. The descriptive data were analyzed using descriptive statistics (frequency, percentage, mean, etc.). Potential factors associated with the development of PI were initially evaluated with univariate tests. Continuous variables were compared via the Mann-Whitney U and Kruskal-Wallis test, categorical variables were compared via the chi-square test. First, variables were

tested using univariate analysis, and p<0.05 values were considered to determine which variables to include in logistic regression. Then, logistic regression analysis was performed to assess the relationship between these clinically relevant variables and the development of PI and p<0.05 values were considered statistically significant.

RESULTS

The median age was 39-year (range 18 and 92-year) and the mean BMI was 29.39±3.51 kg/m². The incidence of PI by type of surgery is summarized in Table 1. PI developed in a total of 13 (12.9%) patients, and it was mostly observed after pancreaticoduodenectomy (38.5%) (Table 1).

PI was detected in 5 (4.9%) of 101 patients on postoperative day 0; all were classified as Stage I. Only one patient had PI in more than one area. PI was found in 4 (4.2%) patients on the first postoperative day; one patient had Stage II PI. On the second postoperative day, PI was observed in 4 (4.2%) patients; one patient had Stage II PI. The most common area was the sacrum/coccyx (69.2%), followed by the heels (38.5%) (Table 2).

TABLE 1: Distribution of pressure injuries by types of surgery (n=101).

Surgery type	Number of patients	Number of patients with PI
	n	n(%)
Cholecystectomy	39	1 (7.7)
Total/subtotal gastrectomy	21	3 (23)
Pancreaticoduodenectomy	18	5 (38.5)
Hepatectomy	23	4 (30.8)

PI: Pressure injury.

In univariate analysis, significant differences were observed between PI and age, preoperative hemoglobin and serum albumin levels, surgery type (pancreaticoduodenectomy), surgical time, and intraoperative hypotensive episodes (respectively p=0.022, p=0.002, p=0.000, p=0.037, p=0.003, and p=0.000) (Table 3).

In the next step, a logistic regression analysis was performed. Preoperative hemoglobin (cut-off point at 10.02 g/L for increased risk of PI) and albumin levels (cut-off point at 2.31 g/L for increased risk of PI), surgical time (cut-off point at 185 minutes for increased risk of PI), and intraoperative hypotensive episodes (cut-off point at more than 7 for increased risk of PI)

TABLE 2: Pressure injury areas and stages (n=13).*

Days n (%)	Patient no	Occiput stage		Hips stage		Sacrum/coccyx stage		Heels stage		Others stage	
		I	II	I	II	I	II	I	II	I	II
Postoperative day 0											
5 (4.9)	P1					X					
	P2					X					
	P3					X					
	P4					X				X	
	P5							X			
1st day after surgery											
4 (4.2)	P6			X		X		X			
	P7					X		X			
	P8					X				X	
	P9								X		
2nd day after surgery											
4 (4.2)	P10			X							
	P11					X					
	P12						X			X	
	P13							X			
Total n (%)*		-		2 (15.4)		9 (69.2)		5 (38.5)		3 (23.1)	

*Pressure injury developed in more than one area in one patient. Numbers and percentages were calculated based on the total number of patients who developed pressure injuries.

TABLE 3: Comparison of pressure injury risk factors in patients with and without pressure injury (n=101).[a]

	PI group (n=13)	Without PI group (n=88)	p value
Age (year)	58 (23-92)	40(18-84)[b]	0.022
Gender (female/male)	3/10	38/50	0.231
BMI (kg/cm^2)	29.74±5.11	27.04±5.39	0.701
ASA score (I/II)	7/6	36/52	0.388
Comorbidities (n)	4	24	0.751
Preoperative Hb (g/L)	11.27±2.15	13.65±1.86[b]	0.002
Preoperative Alb (g/L)	2.98±0.50	3.72±0.36[b]	0.000
Preoperative Braden score	16 (12-20)	17 (13-20)	0.790
Surgery type			
Cholecystectomy	1	38[b]	0.037
Total/subtotal gastrectomy	3	18[b]	
Pancreaticoduodenectomy	5	13[b]	
Hepatectomy	4	19[b]	
Surgical time (min)	335 (60-460)	225 (60-350)	0.003
Hypotensive episodes (n)	10b	9	0.000
Use of warming blanket (n)	6	34	0.410
Use of methylprednisolone (n)	3	12	0.298
Blood loss (mL)	350 (150-500)	450 (100-600)	0.697

[a]Values are shown as mean±SD or median (ranges); [b]p<0.05; Compared with the pressure injury group; Alb: Albumin; ASA: American Society of Anesthesiologist; BMI: Body mass index; Hb: Hemoglobin; PI: Pressure injury.

were found to be determinants in the development of PI (respectively p=0.001; p=0.001; p=0.001; p=0.010). However, it was observed that age (cut-off point at 55 years for increased risk of PI) and surgery type were not associated with the development of PI (respectively p=0.226, p=0.325) (Table 4).

DISCUSSION

In this study, the incidence of perioperative PI in patients undergoing surgical intervention and the effect of selected perioperative variables on the development of PI were determined. These findings showed that many intraoperative risk factors played a role in the development of PIs in surgical patients.

In this study, it was observed that the incidence of perioperative PI was 12.9%, and this rate was within the ranges specified in the studies in the literature.[1,7,8,10,12] It has been reported in the literature that the incidence of perioperative PIs varies between 1.3-66% and this rate constitutes 45% of all hospital-acquired PIs.[6,10-12] In a systematic review of 17 studies, it was stated that the incidence of perioperative PIs ranged from 0.3-57.4% in 10 countries, with an average of 15%.[1] Chen et al. determined that 19.8% of the patients had PIs in the early postoperative period and 24.5% of these injuries occurred on the first postoperative day and 20.8% on the second postoperative day.[8] Kim et al. reported that 37.2% of patients had

TABLE 4: Factors affecting the development of pressure injuries: Univariate logistic regression analysis (n=101).

Variables	β	p value	OR	95% CI
Age (RC: >55 years)	0.117	0.226	1.017	0.993-1.042
Preoperative Hb (RC: <10.02 g/L)	0.138	0.001	2.951	2.140-7.258
Preoperative Alb (RC: <2.31 g/L)	0.147	0.001	2.879	1.545-5.432
Surgical time (RC: 185 min)	0.107	0.001	1.003	1.001-1.005
Surgery type (RC: Pancreaticoduodenectomy)	0.217	0.325	1.368	0.713-2.503
Hypotensive episodes (RC: >7)	0.212	0.010	1.020	1.003-1.040

β: Regression coefficient; OR: Odds ratio; CI: Confidence interval; RC: Reference category; Hb: Hemoglobin; Alb: Albumin.

PIs in the early postoperative period.[14] In studies conducted in Türkiye, it was determined to be approximately 40.4% and 54.8%.[2,13] The fact that the incidence of PI in surgical patients (12.9%) was within the range reported in the literature and was relatively lower compared to the results of many studies suggested that healthcare professionals were aware of the importance of preventing perioperative PIs and considered PI prevention strategies.[1,2,8,10-14]

This study showed that perioperative pressure injuries primarily developed in the sacrum/coccyx region (69.2%), especially in patients who underwent surgical intervention in the supine position. This finding is consistent with the results of many studies can be explained by the information in the literature that the high prevalence of PI in abdominal surgeries is associated with prolonged tissue hypoperfusion in the affected areas (occiput, hips, sacrum/coccyx and heels) in the supine position and that the supine position has a higher interface pressure (max=49.2 mmHg) than other positions.[2,8,11,19]

In this study, it was determined that there was a significant difference when the age variable was compared with patients with and without PIs, but it was not an effective determinant in the development of PIs. Although the literature reports that advanced age is a risk factor for the development of perioperative PI, Wright et al.'s study found a decreased age associated with PI.[12,14,20] The reason for this difference was explained by the fact that Wright et al.'s study had a smaller sample size (n=88) and was conducted in a group of patients who had undergone head and neck surgery.[20] Contrary to those results, there are also many studies that found no significant relationship between advanced age and perioperative PI, consistent with this study.[2,8,9] It is a physiological process inherent in aging that the skin elasticity and tissue, muscle mass, inflammatory response, serum albumin levels, and subcutaneous tissue decrease in elderly patients, making their skin more fragile to pressure and consequently the development of tissue damage.[21] On the other hand, the finding in this study that age was not an effective determinant in the development of perioperative PIs can be explained by the fact that surgical intervention is generally avoided in very elderly individuals due to the risk of many complications.

This study indicated that preoperative hemoglobin and albumin levels were risk factors for perioperative PIs. Similarly, there are various studies demonstrating that the development of perioperative PIs is associated with preoperative hemoglobin and serum albumin levels.[3,14,22,23] van Stijn et al. stated in a systematic review, that preoperative albumin levels in elderly patients are associated with postoperative results; however, Mistrik et al. reported that skin blood flow measured with a laser Doppler line scanner in chronic hemodialysis patients was remarkably correlated with serum albumin levels.[24,25] Fernandes et al. stated that there was no significant relationship between the risk of PI and hemoglobin and hematocrit levels; there was a positive relationship between serum albumin level and the higher the albumin level, the lower the risk of developing PIs.[23] Kim et al. found a statistically significant relationship between preoperative hemoglobin and serum albumin levels and the development of PI.[14] As stated in the EPUAP, NPUAP, and PPPIA quick reference guide, low preoperative hemoglobin, and serum albumin levels may indicate impaired nutritional status, and this may explain its significant positive association with the development of PIs.[4]

The incidence of PIs was 38.5% in patients who underwent pancreaticoduodenectomy in this study. Similarly, Lumbley et al. reported that the most common type of surgery with PI was abdominal surgery (44.1%).[11] Chen et al. also stated that pancreaticoduodenectomy surgery (41.5%) was a predictor of PI development.[8] The high prevalence of PIs in abdominal surgeries may be associated with prolonged tissue hypoperfusion in the affected areas (occiput, hips, sacrum/coccyx and heels) in the supine position.[11] In addition, considering that pancreaticoduodenectomy is a treatment method applied in pancreatic diseases; the presence of diabetes mellitus and low weight due to medical diagnosis in the preoperative period; longer surgical time in the intraoperative period; in the postoperative period, the length of hospital stay compared to other surgery types may be associated with many factors that may influence the risk of PIs.

In this study, surgical time longer than 185 minutes which led to the development of PI is quite sim-

ilar to the results reported in other studies.[8,11,19] Although the effective surgical time in the development of PIs varies according to the patient, PIs may develop two and a half hours after surgery.[11] Connor et al., specified a surgical time of four hours and 12 minutes for patients with PI versus four hours 48 minutes for patients without PI.[19] Lumbley et al. reported that the mean effective surgical time in the development of PI was three hours and 55 minutes.[11] Chen et al. stated that surgical time longer than 197 minutes was a risk factor of PI development.[8] This finding, which supports the knowledge that longer surgical times is an important risk factor in the development of PIs, can be explained by the greater effect of pressure on fragile bony prominences as the surgical time increases.

This study showed a significant relationship between intraoperative hypotensive episodes (diastolic blood pressure ≤60 mmHg) and perioperative PIs. Similarly, Nixon et al. reported that intraoperative minimum diastolic blood pressure was independently associated with the development of PI.[22] Chello et al. recommended precise blood pressure management, which includes avoiding long-term hypotension and long-term use of vasoactive medications to prevent perioperative PI.[26] Huang et al. listed the hypotension episodes and the use of vasoactive medications among risk factors associated with the postoperative PI.[27] This may be explained by the fact that hypotension leads to impaired peripheral tissue perfusion which increases susceptibility to PI in areas of the body exposed to prolonged pressure.[7,8]

This study has several limitations. Initially, since this study included only general surgical patients, these findings may be different from other surgical types such as cardiovascular surgery, orthopaedic surgery, or neurosurgery. Second, although a large number of unchangeable factors have been determined (e.g. surgical treatment), the focus is on modifiable factors associated with the risk of PI. In addition, the limited sample size associated with known risks of bias and the fact that data such as preoperative hemoglobin and serum albumin level, diastolic blood pressure, and blood loss for the intraoperative period were obtained from patient records are other limitations of our study.

CONCLUSION

This study showed that the incidence of PI in patients who underwent general surgery is 12.9%, and preoperative hemoglobin and albumin levels, surgical time, and intraoperative hypotensive episodes are determinant risk factors for PIs. Perioperative nurses should carefully evaluate individual and surgery-related risk factors and implement evidence-based interventions in the prevention of PIs. Maintaining hemodynamic stability and taking more effective skincare measures during major surgical procedures may reduce the risk of PI in this vulnerable population. In addition, there is a need for studies with high levels of evidence and comprehensive clinical guidelines that can guide healthcare professionals in the prevention of these injuries, in which different risk factors play a role in the perioperative period. Thus, it may be recommended that independent variables that may be associated with perioperative PIs should be investigated in longitudinal studies with multi-center and long-term follow-up, including larger sample groups.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Didem Kandemir;* ***Design:*** *Didem Kandemir, Yasemin Özhanlı;* ***Control/Supervision:*** *Didem Kandemir;* ***Data Collection and/or Processing:*** *Fatma Yayla, Atiye Aydın;* ***Analysis and/or Interpretation:*** *Zeynep Temiz;* ***Literature Review:*** *Didem Kandemir;* ***Writing the Article:*** *Didem Kandemir;* ***Critical Review:*** *Tuluhan Ayoğlu, Zeynep Temiz;* ***References and Fundings:*** *Yasemin Özhanlı, Atiye Aydın;* ***Materials:*** *Atiye Aydın.*

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