ORIGINAL ARTICLE

Efficiency of the estimation of physiologic ability and surgical stress (E-PASS) score in predicting postoperative complications after robot-assisted radical prostatectomy

Süleyman Bulut,[1] Yalcin Kizilkan,[1] Hüseyin Gültekin,[1] Ali Yasin Ozercan,[2] Burak Köseoğlu,[3] Halil Demirçak,[4] Tanju Keten,[1] Ünsal Eroğlu,[1] Özer Güzel,[1] Altug Tuncel,[1] Cüneyt Özden[1]

[1]Department of Urology, Ankara Bilkent City Hospital, Ankara-*Türkiye*
[2]Department of Urology, Sirnak State Hospital, Sirnak-*Türkiye*
[3]Department of Urology, Ankara Polatli Duatepe State Hospital, Ankara-*Türkiye*
[4]Department of Urology, Konya Cumra State Hospital, Konya-*Türkiye*

ABSTRACT

BACKGROUND: Robot-Assisted Radical Prostatectomy (RARP) is increasingly becoming the standard surgical treatment for prostate cancer. While some risk factors for postoperative complications of RARP have been identified, no scoring model that incorporates both preoperative physical status of the patient and intraoperative risk factors has been developed. The Estimation of Physiologic Ability and Surgical Stress (E-PASS) score was initially described to predict postoperative complications after gastrointestinal surgical procedures. This study aims to assess the effectiveness of the E-PASS score in predicting postoperative complications of RARP.

METHODS: A retrospective evaluation was conducted on 204 patients who underwent RARP between 2019 and 2022. Demographic data, parameters indicating patients' preoperative physical condition, and intraoperative risk factors were analyzed. The E-PASS score and subscores were calculated for each patient.

RESULTS: Of the patients, 164 (80.4%) were discharged without any postoperative complications (Group 1), and 40 (19.6%) experienced various degrees of complications (Group 2). Patients in Group 2 had higher rates of previous abdominal surgery, elevated Eastern Cooperative Oncology Group (ECOG) performance scores, longer surgical durations, and higher E-PASS scores. To assess the effectiveness of the Comprehensive Risk Score (CRS) as a predictive factor for postoperative complications, a receiver operating characteristic (ROC) curve was constructed with a 95% confidence interval (CI), and a cut-off value was established. The cut-off value for CRS was determined to be -0.0345 (area under the curve [AUC]=0.783, CI: 0.713-0.853; p<0.001). Patients with a CRS higher than the cut-off value had a 16.4 times higher rate of postoperative complications after RARP (95% CI: 5.58-48.5).

CONCLUSION: The E-PASS scoring model successfully predicts postoperative complications in patients undergoing RARP by using preoperative data about the physical status of the patient and surgical risk factors. The E-PASS score and its subscores could be utilized as objective criteria to determine the risk of postoperative complications before and immediately after surgery.

Keywords: Robot-assisted radical prostatectomy; prostate cancer; postoperative complication.

INTRODUCTION

Prostate cancer (PCa) is the second most common cancer diagnosis among males.[1] Robot-Assisted Radical Prostatectomy (RARP) was first described in 2001 and has since gained popularity.[2] RARP is increasingly favored due to its association with reduced perioperative bleeding, decreased postoperative

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Address for correspondence: Süleyman Bulut
Ankara Bilkent City Hospital, Ankara, Türkiye
E-mail: suleyman.bulut3@saglik.gov.tr

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pain, and shorter hospital stays.[3,4] In the United States and England, robotic surgery has become the standard approach for radical prostatectomy (RP).[5]

The literature contains numerous studies evaluating the postoperative complications of RARP. Although risk factors for these complications have been identified, no scoring system has been proposed that simultaneously considers both the preoperative physical condition of the patients and intraoperative risk factors.[6-9]

The Estimation of Physiologic Ability and Surgical Stress (E-PASS) score was originally developed for elective gastrointestinal surgical procedures. This scoring system accounts for the preoperative condition of the patient and intraoperative variables to predict postoperative complications.[10]

This study aims to determine the effectiveness of the E-PASS score in predicting postoperative complications of RARP. It is the first to apply this scoring system in the field of robotic surgery.

MATERIALS AND METHODS

The institutional review board at Ankara City Hospital approved this study (approval number: E2.23.5862), conducted in accordance with the principles of the Declaration of Helsinki. We retrospectively evaluated 229 patients who underwent RARP at our clinic between 2019 and 2022. Patient data were accessed through the hospital information system. We excluded 25 patients with missing or unreliable information from the study. All RARP procedures were performed using the Da Vinci Xi robotic system (Intuitive Surgical, Sunnyvale, CA, USA). We retrospectively analyzed demographic data for all patients including age (years), sex, body mass index (BMI, kg/m2), prior abdominal surgery, American Society of Anesthesiologists (ASA) physical status classification system, and comorbidities such as coronary artery disease (CAD), chronic obstructive pulmonary disease (COPD), and diabetes mellitus (DM). We also examined the duration of surgery (minutes), intraoperative bleeding (mL), blood transfusions, postoperative complications, duration of hospitalization, and E-PASS score, comprising Preoperative Risk Score (PRS), Surgical Stress Score (SSS), and Comprehensive Risk Score (CRS).

E-PASS Scoring System

The E-PASS scoring model was developed to estimate surgical risk and comprises three indicators: PRS, SSS, and CRS. These scores are derived from the two preceding ones. It was first proposed by Haga et al.[10] in 2004, to describe the risk of postoperative complications after elective gastrointestinal surgical procedures. PRS is calculated using age, severe cardiac and pulmonary disease, DM, performance status index, and ASA physical status classification. Meanwhile, SSS is determined by body weight, intraoperative blood loss, surgical duration, and the length of the surgical incision.

The calculation of the E-PASS score and its components are as follows:

PRS = -0.0686 + 0.00345X1 + 0.323X2 + 0.205X3 + 0.153X4 + 0.148X5 + 0.0666X6 (X1: age, X2: presence or absence of severe cardiac disease "1" or "0", X3: presence or absence of severe pulmonary disease "1" or "0", X4: presence or absence of DM "1" or "0", X5: performance status index "0-4", and X6: ASA physical status classification "1-5").

SSS = -0.342 + 0.0139X1 + 0.0392X2 + 0.352X3 (X1: blood lost per body weight [g/kg], X2: duration of surgery [hours], and X3: length of skin incision [0: minor incision without laparotomy or thoracotomy; 1: laparotomy or thoracotomy; 2: both laparotomy and thoracotomy]).

CRS = -0.328 + 0.936 (PRS) + 0.976 (SSS).

Statistical Analysis

Data curation and statistical analysis were conducted using the Statistical Package for the Social Sciences (SPSS) 20.0 software (IBM SPSS Statistics, IBM Corporation, Chicago, IL). Shapiro-Wilk tests were used to identify variables suitable for normal distribution. Non-categorical parameters not fitting a normal distribution were compared using the Mann-Whitney U test. Categorical variables were analyzed using Chi-square or Fisher's exact tests. The predictive value and the best cut-off value of the CRS for postoperative complications after RARP were analyzed using a receiver operating characteristic (ROC) curve with a 95% confidence interval. Logistic regression analysis calculated the increase in risk of postoperative complications above the cut-off value. Statistical significance was defined as a p-value <0.05.

RESULTS

The study population (n=204) had a median age of 64 years (range 42-77). Of these, 164 (80.4%) patients were discharged without any postoperative complications (Group 1), while 40 (19.6%) experienced various degrees of complications (Group 2) (Table 1). Postoperative complications and their frequencies are detailed in Table 2. Patients in Group 2 exhibited a higher rate of previous abdominal surgery, higher Eastern Cooperative Oncology Group (ECOG) performance score, longer surgical duration, extended time to drain and urinary catheter removal, a higher rate of anastomosis leak, and elevated E-PASS scores, including PRS, SSS, and CRS. Demographic, clinical, intraoperative, postoperative, and E-PASS scoring model data for the patients are provided in Table 1.

To determine the effectiveness of CRS, an E-PASS subscore, as a predictive factor for postoperative complications, a ROC curve with a 95% confidence interval (CI) was used, and a cut-off value was established. The cut-off value for CRS was set at -0.0345 (area under the curve [AUC]=0.783, CI: 0.713-0.853; p<0.001) (Fig. 1, Table 3). Patients with a CRS higher than this cut-off value experienced a 16.4-fold increase in

Table 1. Comparison of patients who underwent RARP by postoperative complications based on demographic, clinical, intraoperative, postoperative data, and E-PASS scores

	Total (n=204)	Group 1 (n=164, 80.4%)	Group 2 (n=40, 19.6%)	p
Age (years) (Median) (min-max)	64 (42-77)	64 (42-76)	63 (48-77)	0.559[m]
BMI (kg/m2) (Median) (min-max)	26.8 (20.5-39.2)	26.9 (20.5-39.1)	26.6 (21.4-34.9)	0.862[m]
History of Previous Abdominal Surgery, n (%)	52 (25.4%)	15 (28.8%)	37 (71.2%)	0.000[x]
ASA Score, n (%)				0.170[x]
1	77 (37.7%)	67 (40.9%)	10 (25%)	
2	112 (54.9%)	85 (51.8%)	27 (67.5%)	
3	15 (7.4%)	12 (7.3%)	3 (7.5%)	
4	0 (0%)	0 (0%)	0 (0%)	
ECOG Performance Score, n (%)				0.000[f]
0	166 (81.4%)	163 (99.4%)	3 (7.5%)	
1	37 (18.1%)	1 (0.6%)	36 (90%)	
2	0 (0%)	0 (0%)	0 (0%)	
3	0 (0%)	0 (0%)	0 (0%)	
4	1 (0.5%)	0 (0%)	1 (2.5%)	
5	0 (0%)	0 (0%)	0 (0%)	
D'Amico Risk Classification, n (%)				0.584[f]
Low	80 (39.2%)	65 (39.6%)	15 (37.5%)	
Intermediate	66 (32.4%)	54 (32.9%)	12 (30%)	
High	53 (26%)	42 (25.6%)	11 (27.5%)	
Locally Advanced	3 (1.5%)	2 (1.2%)	1 (2.5%)	
Oligometastatic	2 (1%)	1 (2.5%)	1 (0.6%)	
PSA Value (µg/L), (Median) (min-max)	7.4 (0.6-49)	7.0 (0.6-49)	9.3 (0.5-36)	0.084[m]
Prostate Volume (mL), (Median) (min-max)	40 (10-177)	40 (10-130)	57 (25-177)	0.244[m]
Comorbidities				
CAD, n (%)	37 (18.1%)	29 (17.7%)	8 (20%)	0.819[x]
Chronic Pulmonary Disease, n (%)	6 (2.9%)	4 (2.4%)	2 (5%)	0.335[f]
DM, n (%)	45 (22.1%)	32 (19.5%)	13 (32.5%)	0.090[x]
Intraoperative Data				
Duration of Surgery (minutes) (Median) (min-max)	210 (90-420)	200 (118-330)	236 (90-420)	0.000[m]
Blood Loss (mL) (Median) (min-max)	200 (10-2000)	165 (10-1300)	200 (50-2000)	0.242[m]
Duration of Hospitalization (days) (Median) (min-max)	5 (2-20)	4 (2-18)	7 (3-20)	0.000[m]
Time to Drain Removal (days) (Median) (min-max)	3 (1-23)	3 (1-23)	5 (2-19)	0.000[m]
Duration of Urinary Catheterization (days) (Median) (min-max)	14 (7-43)	14 (10-26)	15 (7-43)	0.000[m]
Surgical Margin Positivity, n (%)	59 (29.1%)	45 (27.6%)	14 (35%)	0.437[x]
E-PASS Scores				
PRS (Median) (min-max)	0.31 (0.15-1.20)	0.29 (0.15-1.00)	0.51 (0.20-1.20)	0.000[m]
SSS (Median) (min-max)	-0.02 (-0.10-0.11)	-0.02 (0.09-0.76)	-0.02 (-0.10-0.10)	0.047[m]
CRS (Median) (min-max)	-0.06 (-0.22-0.85)	-0.10 (-0.22-0.54)	0.14 (-0.14-0.85)	0.000[m]

ASA: American Society of Anesthesiologists; BMI: Body Mass Index; CAD: Coronary Artery Disease; CRS: Comprehensive Risk Score; DM: Diabetes Mellitus; ECOG: Eastern Cooperative Oncology Group; E-PASS: Estimation of Physiologic Ability and Surgical Stress; PRS: Preoperative Risk Score; SSS: Surgical Stress Score; m: Mann-Whitney U Test; x: Chi-Square Test; f: Fisher's Exact Test.

Table 2. Classification of postoperative complications following RARP based on the Clavien-Dindo system

Modified Clavien-Dindo		n (%)
Grade 1	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic, or radiological interventions. Acceptable therapeutic options include antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy.	25 (62.5%)
	Fever requiring antipyretics, lasting less than 48 hours	5 (12.5%)
	Subileus	7 (17.5%)
	Atelectasis resolving within 24 hours	5 (12.5%)
	Long drainage time requiring follow-up	6 (15%)
	Rectus bleeding requiring follow-up	1 (2.5%)
	Femoral nerve palsy	1 (2.5%)
Grade 2	Requires pharmacological treatment with drugs other than those allowed for Grade 1 complications.	9 (22.5%)
	Blood loss requiring transfusions	2 (5%)
	Surgical site infection requiring antibiotics	4 (10%)
	Pneumonia	1 (2.5%)
	Cardiac arrhythmia	1 (2.5%)
	Pulmonary embolism requiring thromboembolic treatment	1 (2.5%)
Grade 3	Requires surgical, endoscopic, or radiological intervention.	5 (12.5%)
Grade 3a	Requires interventions without general anesthesia.	5 (12.5%)
	Development of lymphocele at the surgical site requiring percutaneous drainage treatment	5 (12.5%)
Grade 3b	Requires interventions with general anesthesia.	0 (0%)
Grade 4	Life-threatening complications requiring intensive care unit management.	0 (0%)
Grade 4a	Single organ dysfunction	0 (0%)
Grade 4b	Multi-organ dysfunction	0 (0%)
	Sepsis	0 (0%)
Grade 5	Patient demise	1 (2.5%)

Table 3. Best cut-off point for CRS to differentiate patients with postoperative complications after RARP, with 95% confidence interval and area under the ROC curve

	CRS
AUC	0.783
95% CI	0.713-0.853
p-value	<0.001
Cut-off Value	-0.0345
Sensitivity	0.90
Specificity	0.646

AUC: Area Under the Curve; CI: Confidence Interval; CRS: Comprehensive Risk Score.

the rate of postoperative complications after RARP (95% CI: 5.58-48.5).

DISCUSSION

E-PASS is a scoring model developed to predict postoperative complications using preoperative data and intraoperative variables.[10] This model, which does not require a specific physical examination, was initially utilized in gastrointestinal surgery to predict postoperative complications in elective surgical procedures.[11,12] Kondo et al. reported an increase in the risk of postoperative complications when the E-PASS CRS exceeded -0.058.[12] In research by Tominaga et al., a CRS greater than 0.2 was found to be associated with a higher rate of postoperative complications and mortality after colorectal surgery (p<0.01).[13] Another study involving 2,495 gastric

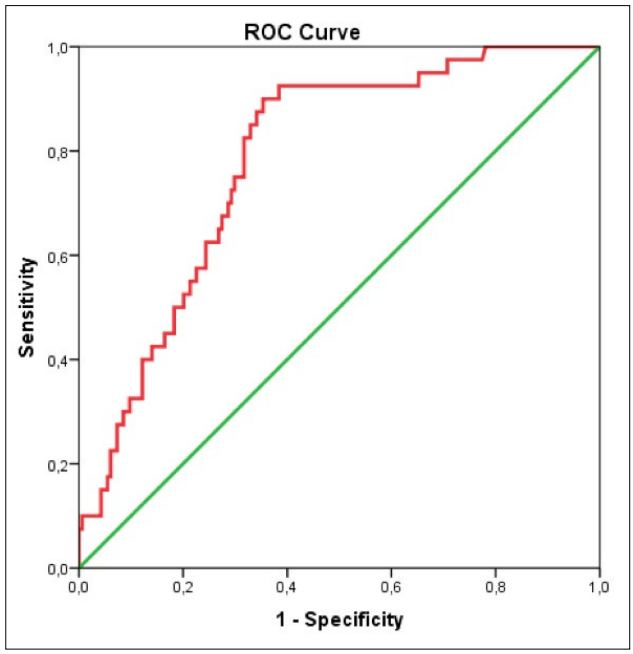

Figure 3. ROC curve evaluating the effectiveness of CRS in predicting postoperative complications of RARP.

cancer patients who underwent elective gastrectomy with curative intent showed that those with E-PASS scores above 0.419 were more likely to experience postoperative complications and had shorter overall survival (p<0.0001).[14]

E-PASS CRS also seems relevant for complications at both surgical and nonsurgical sites following spinal surgery.[15] A positive correlation between the morbidity and mortality of hip fracture surgery and E-PASS CRS was reported in another study.[16] To our knowledge, only two studies have demonstrated the use of E-PASS scores in urologic surgery, specifically in laparoscopy. The first study highlighted the safety of laparoscopic nephrectomy and nephroureterectomy in patients over 70, using the E-PASS scoring model to predict postoperative morbidity.[11] Another study involving 424 cases of laparoscopic simple, donor, and radical nephrectomy identified an E-PASS CRS cut-off value of -0.2996; patients with higher scores had a 2.8-fold increase in postoperative complications.[17] In our study, an E-PASS CRS cut-off value of -0.0345 was found to be associated with postoperative morbidity, and higher scores revealed a 16.4-fold increase in the rate of postoperative complications.

The European Guidelines of Urology indicate that postoperative complication rates after RARP occur at rates of 2.1%, 3.9%, 1.4%, 0.6%, and <0.1% for Clavien grades 1, 2, 3, 4, and 5, respectively.[18] According to the Cochrane database, despite technological advances and the refined definition of minimally invasive techniques, open, laparoscopic, and robotic RP have not shown superiority over one another in terms of oncologic or functional outcomes. However, open RP is at a disadvantage in terms of blood transfusion rates and duration of hospital stay compared with minimally invasive techniques.[19] In this study, we observed postoperative complications at rates of 12.2%, 4.4%, 2.4%, and 0.4% for Clavien grades 1, 2, 3 and 5, respectively. We experienced no Clavien grade 4 complications.

Previous abdominal surgeries often result in the development of adhesions and abnormal fibrous bands between organs and/or the abdominal wall, affecting more than 90% of patients.[20] These adhesions pose challenges during surgical procedures and increase the rate of surgical complications. In our study, patients with a history of previous abdominal surgery were more likely to experience postoperative complications compared to those without prior abdominal surgery (71.2% vs. 28.8%, p=0.000).

As with most surgical practices, the success and rate of complications in robotic surgery correlate closely with the surgeon's experience. Complications are potentially more frequently encountered during the initial learning curve of a surgeon. Studies have reported significantly fewer major and minor complications once the console surgeon exceeds 200 cases.[21,22] Additionally, malfunctions in the robotic system have been documented; a review of 50,000 RARP cases from 2000 to 2007 noted various device failures in 168 cases performed by Da Vinci surgical systems.[23] The rate of conversion to open surgery in these surgical series varies between 0-1.1%.[24] In our case series, there were no conversions to open surgery.

The addition of lymph node dissection (LND) to RARP, when indicated, is known to increase both the complication rate and the surgical duration.[25] In our study, lymphocele requiring percutaneous drainage developed in five patients who underwent LND. There was also an incident where the right external iliac vein was injured during LND in one case, which was primarily repaired. Among the 204 patients in this series, one patient died on postoperative day 8 due to pulmonary embolism. Notably, this patient had a history of CAD and had undergone LND as part of their RARP.

This study aims to investigate the potential role and efficiency of the E-PASS score in determining postoperative complications using preoperative and intraoperative data. This is the first report in the literature demonstrating the use of the E-PASS scoring model for robotic surgery and the third study regarding the use of the E-PASS score in the field of urology.

Limitations of this study include its single-center, retrospective design, the involvement of multiple surgeons, and the fact that some patients were operated on during the surgeons' learning curves.

CONCLUSION

The E-PASS scoring model effectively predicts postoperative complications in patients undergoing RARP by utilizing preoperative data about the patient's physical condition and surgery-related risk factors.

E-PASS and its subscores can serve as objective criteria to estimate the risk of postoperative complications both before and immediately after surgery. Future prospective, multicenter studies involving larger populations may help establish the use of the E-PASS scoring system in the field of robotic surgery.

Ethics Committee Approval: This study was approved by the Ankara City Hospital Ethics Committee (Date: 08.12.2021, Decision No: E2-21-1097).

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ORİJİNAL ÇALIŞMA - *ÖZ*

Robot yardımlı radikal prostatektomi yapılan hastalarda postoperatif komplikasyonların öngörülmesinde E-PASS skorunun etkinliğinin değerlendirilmesi

Süleyman Bulut,[1] Yalcin Kizilkan,[1] Hüseyin Gültekin,[1] Ali Yasin Ozercan,[2] Burak Köseoğlu,[3] Halil Demirçak,[4] Tanju Keten,[1] Ünsal Eroğlu,[1] Özer Güzel,[1] Altug Tuncel,[1] Cüneyt Özden[1]

[1]Ankara Bilkent Şehir Hastanesi, Üroloji Kliniği, Ankara, Türkiye

[2]Şırnak Devlet Hastanesi, Üroloji Kliniği, Şırnak, Türkiye

[3]Ankara Polatlı Duatepe Devlet Hastanesi, Üroloji Kliniği, Ankara, Türkiye

[4]Konya Çumra Devlet Hastanesi, Üroloji Kliniği, Konya, Türkiye

AMAÇ: Robot Yardımlı Radikal Prostatektomi (RYRP), günümüzde prostat kanseri cerrahi tedavisinde standart yaklaşım haline gelmiştir. RYRP'nin postoperatif komplikasyonlarını öngören bazı risk faktörleri tanımlanmış olsa da, hastanın preoperatif fiziksel durumunu ve intraoperatif değişkenleri eş zamanlı olarak ele alan bir skorlama sistemi henüz önerilmemiştir. Estimation of Physiologic Ability and Surgical Stress (E-PASS) skoru, ilk olarak gastrointestinal cerrahilerden sonra gelişen postoperatif komplikasyonların öngörülmesinde kullanılmıştır. Çalışmamızda, E-PASS skoru ve alt skorlarının RYRP'nin postoperatif komplikasyonlarını kestirmek amacıyla kullanılmasının başarısını tespit etmeyi amaçladık.

GEREÇ VE YÖNTEM: 2019 ve 2022 yılları arasında RYRP yapılmış olan 204 hasta retrospektif olarak değerlendirildi. Demografik veriler, hastaların preoperatif fiziksel durumunu belirten parametreler ve intraoperatif risk faktörleri analiz edildi, tüm hastalar için E-PASS skoru ve alt skorları hesaplandı.

BULGULAR: 164 (%80.4) hasta komplikasyonsuz taburcu edildi (Grup 1); fakat 40 (%19.6) hastada çeşitli postoperatif komplikasyonlar geliştiği görüldü (Grup 2). Grup 2'de yer alan hastaların daha yüksek oranda geçirilmiş batın cerrahi öyküsü, daha yüksek ECOG performans skoru, daha uzun cerrahi süresi ve daha yüksek E-PASS skorları olduğu gözlendi. Kapsamlı Risk Skoru (CRS) skorlarının etkinliğini değerlendirmek amacıyla %95 güven aralığıyla ROC eğrisi oluşturuldu ve kestirim değeri belirlendi. CRS için kestirim değeri -0.0345 olarak belirlendi (EAA= 0.783, GA: 0.713–0.853; p<0.001). Kestirim değerinden yüksek CRS skoru olan hastaların RYRP sonrası komplikasyon gelişme riski 16,4 kat artmış olarak görüldü (%95 GA 5.58-48.5).

SONUÇ: E-PASS skorlama sistemi RYRP'nin postoperatif komplikasyonlarını preoperatif fiziksel kondisyon ve cerrahi değişkenleri ele alarak başarılı bir şekilde öngörebilmektedir ve cerrahi öncesi ve cerrahiden hemen sonraki dönemde objektif bir kriter olarak kullanılabilmek için adaydır.

Anahtar sözcükler: Prostat kanseri, postoperatif komplikasyon; robot yardımlı radikal prostatektomi.

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