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90-Day Hospital Readmission Rate in Patients Discharged on Home Non-Invasive Ventilation

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ABSTRACT

Introduction: It is known that home non-invasive mechanical ventilation (NIMV) is gaining traction in the treatment of chronic hypercapnic respiratory failure, which improves quality of life and reduces hospital expenditure. Nevertheless, the problem is a high readmission rate, which creates sick care rather than health care. **Objective:** To find out the 90-day hospital readmission rate among the patients who were discharged on home NIMV, as well as risk factors, and outcomes. **Methods and Materials:** This retrospective cohort study used data on the 160 patients on home NIMV discharged in Aga Khan University Hospital, Karachi from 1st January, 2023 to 31st August, 2023. This study utilized data retrieved from electronic health records approved by the Ethical Review Committee. Demographics, comorbidities, and risk factors associated with readmission were analyzed using descriptive statistics as well as multivariate logistic regression. **Results:** 28.1 percent (45) of 160 patients were readmitted within 90 days. Readmission was predicted by bronchiectasis (OR: 5.18; 95% CI: 1.26-21.30; p = 0.023), prior hospitalization, and frequent follow-ups. There was a longer hospital stay (40%), hospital-acquired infection (17.8%), and 90-day mortality (24.4%) among readmitted patients. **Conclusion:** The readmission rate is just 28.1%, indicating that it is recommended to implement specific interventions, especially when working with bronchiectasis patients, using airway management and standardized follow-ups to enhance the results.

INTRODUCTION

Non-invasive mechanical ventilation, or NIMV, used at home has remarkably grown in patients with chronic hypercapnic respiratory failure occasioned by chronic disease conditions like chronic obstructive lung disease (COPD), obstructive sleep apnea (OSA), and obesity hypoventilation syndrome (OHS) (1). Such conditions negatively affect the process of gas exchange, resulting in an increased level of carbon dioxide and respiratory distress, which necessitates the use of ventilatory support to stabilize breathing (2). The application of NIMV has proved to be of great value, as it showed positive effects both in patient outcomes and reduction of healthcare burden. Through the studies, NIMV has the potential to increase the quality of life through decreasing the occurrence of dyspnea and fatigue and enabling them to become more active in daily affairs (3). It is also seen to aid in the minimization of nosocomial infections, owing to the minimized exposures to hospitals, which is crucial to patients whose breathing systems are impaired (4). NIMV is also cost-effective since it reduces the number of readmissions and ED visits and thus the hospital expenditures (5). It improves survival due to the creation of long-term respiratory stability and the prevention of the appearance of acute exacerbations (6).

Included other than COPD, OSA and OHS, the insidious and home to NIMV are also attributable to the neuromuscular disorders (e.g., amyotrophic lateral sclerosis, muscular dystrophy) and diseases involving the chest wall (e.g., kyphoscoliosis) in that they can stimulate respiratory failure because of the poor or limited muscle tone (7). In this case, NIMV normalizes the process of breathing, reduces the likelihood of acute respiratory arrest, and provides people with more freedom, as they can be treated at home (8). Several technological innovations have enhanced the effectiveness and patient acceptability of NIMV delivery, particularly in terms of monitoring and patient interface (9). Even though there exist several positive attributes about home NIMV, one of its profound drawbacks is that it poses a substantial risk of readmission to the hospital, which leads to extra burdening of healthcare costs and patient and healthcare

system outcomes (10). According to the guidelines of the American Association for Respiratory Care (AARC), the death of a patient or readmission to the hospital in the home part of the process when NIMV is performed is the result of aggravation of the underlying illness, including exacerbation of COPD or exacerbation of the neuromuscular illness (11). Respiratory infections, such as pneumonia, can prolong respiratory failure, and in most cases, acute care is required in an intensive care unit or hospital ward (12).

Moreover, failure to set up the ventilation (poor device setting or non-compliance), as well as side effects of airway management (mask intolerance or skin breakdown), are among the causes that lead to readmissions (13). All this justifies the relevance of intensive patient education and effective follow-up as a means to ensure that the NIMV is used optimally (14). Several factors have been identified to predict hospital readmission among patients with chronic hypercapnic respiratory failure. The old age risk factor means that the older ones are less multimorbid and physiologically healthier (15). The other thing that may occur is a gender influence on readmission, possibly because of the difference in the prevalence or availability of treatment for a disease (16). The existence of comorbidities in the disease, including hypertension, diabetes mellitus, and cardiovascular disease, makes it somewhat challenging to manage, and the probability of re-admission is high. More risk is posed by the presence of smoking, either as a former practice or current. The former is likely to magnify the lung pathology and aggravate the response to treatment.

Body mass index (BMI) is of particular interest in the case of OHS, as obesity is one of the factors that contribute to respiratory load and hypoventilation (17). The risk of readmission comprises a substantial part of the disease burden and is linked with the Medical Research Council (MRC) grade of dyspnea, an internationalized scale of the magnitude of breathlessness symptoms. The issue of prior hospitalization also plays a certain role in influencing the readmission rates because it can either refer to the severity of the disease or the fact that the patient has not been successfully treated in the outpatient setting (18).

In this study, we will calculate the 90-day rate of hospital readmission after patients stopped receiving care following their index hospital stay, during which they began using home NIMV or continued to use it for those who had already done so. Through these factors, the study is designed to offer recommendations aimed at improving the management of home NIMV, enhancing patient outcomes, and reducing healthcare spending. Such results will be critical as part of the evidence base regarding home NIMV, with clinical implications and potential interventions for decreasing readmission among vulnerable populations (8).

Objective

To establish the rate of 90-day hospital readmission in patients who are discharged under home non-invasive ventilation (NIMV). Additional goals include identifying risk factors and assessing the consequences of readmission for patients who use NIMV at home.

MATERIALS AND METHODS

Study Design: Retrospective cohort study.

Study Setting: Aga Khan University Hospital Karachi.

Study Duration: The study was conducted over six months, 1st January, 2023 to 31st August, 2023.

Sample Size: It is estimated that 5% to 19.45% of hospitalized patients are discharged with home NIV. Based on this, assuming that 10 percent of all patients in the hospital are known to leave on Home NIV, we did a sample size of 113 patients. Taking the margin of error of 5% and a CI 95% population, it is estimated that the population of the sample is 600 admissions in 8 months.

Sample Technique: Non-Probability consecutive sampling

Inclusion Criteria

The inclusion criteria for this study include male and female patients aged 18 years or above who were discharged home with non-invasive ventilation (NIMV) from Aga Khan University Hospital Karachi from 1st January, 2023 to 31st August, 2023.

Exclusion Criteria

The excluded patients are those transferred to another health care center, patients who left against medical advice during the index hospital stay, and those admitted through any planned procedure or rehabilitation program.

Methods

The proposed study is a retrospective cohort study to be conducted at Aga Khan University Hospital in Karachi, targeting patients discharged home on non-invasive ventilation (NIMV) from 1st January, 2023 to 31st August, 2023. The study sample of the population is of male and female patients 18 years and older discharged home on NIMV who have fulfilled the inclusion criteria. The study exclusion criteria are designated as patients transferred to another healthcare facility, patients left against medical advice, and those admitted to a hospital during the index hospital stay with a planned procedure or through a rehabilitation program. The sampling method used to select participants involved a non-probability, consecutive sampling technique. Once approved by the Ethical Review Committee (ERC) of the Hospital, the data were extracted based on the condition that met the inclusion criteria using the electronic health records (EHRs) of patients. Patients were advised, and the next of kin signed a consent form. The primary investigator then recorded the results of the patients in a pre-formed proforma. De-identified data were stored and kept secure in a password-protected electronic file, accessible only to the principal investigator. They used descriptive statistics to describe patient demographics, comorbidities, and NIMV settings.

RESULTS

There were 160 patients discharged on home NIV, of whom 45 patients faced re-admission within the 90-day discharge period during the study period. The patient

population consisted of 61.25% females and 38.75% males, with an average age of 66.6 ± 12.79 years. The most prevalent comorbidities were hypertension (65.63%), followed by diabetes mellitus (49.38%), COPD (36.25%), and OSA/OHS (38.75%). The history of smoking was observed in 34.38 per cent of patients, and out of that, the number of ex-smokers was 26.25, and the current smokers were 8.13, and there was no significance in the two groups (p=0.592). Both OS/OHS (24.44%) and bronchiectasis (17.78%) were significant comorbidities associated with a 90-day readmission, of which 11 of the 98 readmission patients had OSA (24.40%) and 8 had bronchiectasis (17.800). The top 3 admitting diagnoses were COPD exacerbation (31.25 percent), pneumonia with sepsis (21.25 percent), and OSA/OHS exacerbation (18.13%).

The most common reasons for hospitalization were COPD exacerbation (26.67%) and pneumonia with sepsis (22.22%) in the readmitted group. Index length of stay (LOS) was also longer in the readmitted group (4.89 +/- 3.23 days) than in the no-readmission group (4.29 +/- 2.69days). A previous history of NIV was observed among 43.75 percent of patients, and the rate was not significantly different in either the readmitted or non-readmitted populations. The readmission was significantly associated with the number of follow-up visits after initial admission. The readmitted group had more follow-up visits (2.00 (IQR 1.00, 3.00)) than the no-readmission group (1.00, IQR 0.00–2.00).

Table 1

Clinical Characteristics of Home NIV Patients without and with 90-Day Readmission.

Characteristics	Total (*n*=160)	No Readmission (*n*=115)	90-Day Readmission (*n*=45)	*P* value
Age (Years), Mean ± SD	66.60 ± 12.79	66.11 ± 13.14	67.84 ± 11.92	0.443
Gender				
Female	98 (61.25%)	72 (62.61%)	26 (57.78%)	0.573
Male	62 (38.75%)	43 (37.39%)	19 (42.22%)	
Comorbidities				
DM	79 (49.38%)	56 (48.70%)	23 (51.11%)	0.861†
HTN	105 (65.63%)	73 (63.48%)	32 (71.11%)	0.459†
IHD	27 (16.88%)	16 (13.91%)	11 (24.44%)	0.157†
CKD	8 (5.00%)	7 (6.09%)	1 (2.22%)	0.443†
CVA	2 (1.25%)	2 (1.74%)	0 (0.00%)	1.000†
Asthma	30 (18.75%)	22 (19.13%)	8 (17.78%)	1.000†
COPD	58 (36.25%)	42 (36.52%)	16 (35.56%)	1.000†
ILD	17 (10.63%)	11 (9.57%)	6 (13.33%)	0.569†
OSA/OHS	62 (38.75%)	51 (44.35%)	11 (24.44%)	0.030†
Bronchiectasis	13 (8.13%)	5 (4.35%)	8 (17.78%)	0.009†
Smoking Status				
Never	105 (65.63%)	75 (65.22%)	30 (66.67%)	0.592†
Ex-Smoker	42 (26.25 %)	29 (25.22%)	13 (28.89%)	
Current Smoker	13 (8.13%)	11 (9.57%)	2 (4.44%)	
WHO Functional Class				
I	7 (4.38%)	5 (4.35%)	2 (4.44%)	
II	71 (44.38%)	56 (48.70%)	15 (33.33%)	0.329†
III	69 (43.13%)	45 (39.13%)	24 (53.33%)	
IV	13 (8.13%)	9 (7.83%)	4 (8.89%)	
Admitting Diagnosis				
Asthma Exacerbation	21 (13.13%)	15 (13.04%)	6 (13.33%)	1.000†
Bronchiectasis Exacerbation	9 (5.63%)	4 (3.48%)	5 (11.11%)	0.118†
COPD Exacerbation	50 (31.25%)	38 (33.04%)	12 (26.67%)	0.570†
ILD Exacerbation	16 (10.00%)	10 (8.70%)	6 (13.33%)	0.389†
OSA/OHS Exacerbation	29 (18.13%)	25 (21.74%)	4 (8.89%)	0.069†
Pneumonia with Sepsis	34 (21.25%)	24 (20.87%)	10 (22.22%)	0.833†
Parapneumonic Effusion	2 (1.25%)	1 (0.87%)	1 (2.22%)	0.485†
Decompensated CHF	7 (4.38%)	4 (3.48%)	3 (6.67%)	0.403†
NMD with Respiratory Failure	4 (2.50%)	2 (1.74%)	2 (4.44%)	0.315†
LOS in Index Admission (Days), Mean± SD	4.46 ± 2.86	4.29 ± 2.69	4.89 ± 3.23	0.235
Prior NIV Use	70 (43.75%)	51 (44.35%)	19 (42.22%)	0.860†
Reason for NIV				
Dyspnea	15 (9.38%)	10 (8.70%)	5 (11.11%)	0.616†
Hypercapnic Failure	128 (80.00%)	94 (81.74%)	34 (75.56%)	
Hypoxic Failure	17 (10.63%)	11 (9.57%)	6 (13.33%)	
No. of FU After Index Admission, Median(IQR)	1.00 (1.00 – 2.00)	1.00 (0.00 – 2.00)	2.00 (1.00 – 3.00)	0.001‡

Figure 1

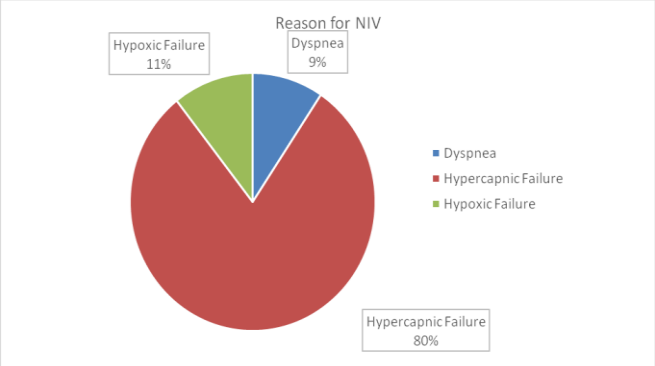

Figure 2

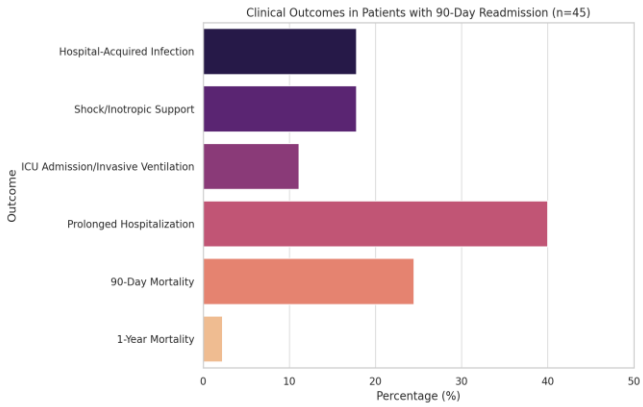

Table 2

Clinical Outcomes in Home NIV Patients with 90-Day Readmission

Characteristics	90-Day Readmission (*n*=45)
Length of Stay (Days), Mean ± SD	4.66 ± 3.88
Hospital Acquired Infection	8 (17.78%)
Shock/Inotropic Support	8 (17.78%)
Invasive Ventilation/ICU Admission	5 (11.11%)
Prolonged Hospitalization	18 (40.00%)
90-Day Mortality	11 (24.44%)
1-Year Mortality	1 (2.22%)

Abbreviations: NIV, Non-Invasive Ventilation; SD, Standard Deviation; and ICU, Intensive Care Unit

Out of the 45 patients readmitted within 90 days, 17.8 percent had hospital-acquired infections, 17.8 percent were given inotropic support, and 11.1 percent needed an invasive mechanical ventilator and admission to the ICU. In 40 percent of the cases, there was prolonged hospitalization. The 90-day mortality rate in the readmitted group was 24.4%, and 1-year mortality was also recorded to be 2.2%. Table 3. Univariate and Multivariate Logistic Regression Analyses Used to Identify Prognostic Factors of 90-Day Readmission in Home NIV Patients.

Table 3

Characteristics		Univariate Logistic Regression Analysis		Multivariate Logistic Regression Analysis	
		Odds Ratio (95% CI)	*P* value	Odds Ratio (95% CI)	*P* value
Age (Years), Mean ± SD		1.01 (0.98 – 1.04)	0.441	-	-
Gender	Female	Reference		-	-
	Male	1.22 (0.61 – 2.47)	0.573		
Comorbidities	DM	1.10 (0.55 – 2.19)	0.784	-	-
	HTN	1.42 (0.67 – 2.99)	0.362	-	-
	IHD	2.00 (0.85 – 4.73)	0.114	-	-
	CKD	0.35 (0.04 – 2.93)	0.334	-	-
	Asthma	0.91 (0.37 – 2.24)	0.844	-	-
	COPD	0.96 (0.47 – 1.97)	0.909	-	-
	ILD	1.45 (0.50 – 4.20)	0.489	-	-
	OSA/OHS	0.41 (0.19 – 0.88)	0.022	0.69 (0.28 – 1.71)	0.421
	Bronchiectasis	4.76 (1.46 – 15.45)	0.009	5.18 (1.26 – 21.30)	0.023
Smoking Status	Never	Reference		-	-
	Ex-Smoker	1.12 (0.51 – 2.44)	0.774		
	Current Smoker	0.45 (0.10 – 2.17)	0.323		
WHO Functional Class	I	Reference		-	-
	II	0.67 (0.12 – 3.80)	0.651		
	III	1.33 (0.24 – 7.39)	0.742		
	IV	1.11 (0.15 – 8.37)	0.919		
Admitting Diagnosis	Asthma Exacerbation	1.03 (0.37 – 2.83)	0.961	-	-
	Bronchiectasis Exacerbation	3.47 (0.89 – 13.56)	0.074		
	COPD Exacerbation	0.74 (0.34 – 1.59)	0.435		
	ILD Exacerbation	1.62 (0.55 – 4.74)	0.383		
	OSA/OHS Exacerbation	0.35 (0.11 – 1.07)	0.067		
	Pneumonia with Sepsis	1.08 (0.47 – 2.50)	0.851		
	Parapneumonic Effusion	2.59 (0.16 – 42.33)	0.504		
	Decompensated CHF	1.98 (0.43 – 9.23)	0.383		
	NMD with Respiratory Failure	2.63 (0.36 – 19.25)	0.342		
LOS in Index Admission (Days), Mean± SD		1.07 (0.96 – 1.20)	0.237	-	-
Prior NIV Use		0.92 (0.46 – 1.84)	0.807	-	-
No. of Admissions in Last 1 Year, Median (IQR)		2.30 (1.56 – 3.38)	<0.0001	2.66 (1.72 – 4.12)	<0.0001
Reason for NIV	Dyspnea	Reference		-	-
	Hypercapnic Failure	0.72 (0.23 – 2.27)	0.579		
	Hypoxic Failure	1.09 (0.25 – 4.71)	0.907		
No. of FU After Index Admission, Median(IQR)		1.48 (1.18 – 1.86)	0.001	1.60 (1.22 – 2.09)	0.001

Bronchiectasis was strongly linked with a substantially higher likelihood of readmission within 90 days (OR: 4.76; 95% CI: 1.4615.45, p = 0.009), whereas OSA/OHS indicated a possible protective role (OR: 0.41; 95% CI: 0.190.88; p = 0.022) in a univariate logistic regression analysis. They were also supported in multivariate analysis where bronchiectasis was a powerful independent predictor (OR: 5.18;95% CI: 1.2621.30; p =

0.023). Also, the presence of hospital admission of the previous year (OR: 2.66; 95% CI: 1.724.12; p < 0.0001) and after-discharge follow-up visits (OR: 1.60; 95% CI: 1.222.09; p = 0.001) proved to be significant predictors of readmission. All other variables, such as age, gender, and comorbidities (DM, HTN, IHD, CKD, asthma, COPD), admitting diagnosis, functional status, prior NIV utilization, index LOS, and others, were not statistically significant predictors in the multivariate model.

DISCUSSION

This retrospective cohort study examined the 90-day readmission rate among patients who left Aga Khan University Hospital in Karachi between January 1, 2023, and August 31, 2023, who used home non-invasive ventilation (NIMV). This research concluded that 28.1 percent of patients (45 out of 160) were readmitted within 90 days, which is a significant issue in managing such patients (1). The results correspond to the literature where the authors found that patients in chronic hypercapnic respiratory failure (i.e., patients with chronic obstructive pulmonary disease [COPD], obstructive sleep apnea [OSA], or obesity hypoventilation syndrome [OHS]) are at high risk of frequent hospitalizations caused by exacerbations and adverse events of the disease (2,3).

The following readmission rate indicates the difficulty of treating patients at home on NIMV. Bronchiectasis was the most significant independent predictor of readmission, with a multivariate odd ratio (OR) of 5.18 (95% CI: 1.26-21.30; p = 0.023), consistent with its effects in causing respiratory infections and airway obstruction (4,5). This observation indicates that, despite this study, bronchiectasis patients might need specific measures to reduce readmission risk, e.g., an improved method of airway clearance or prophylactic antibiotics (6). On the other hand, OSA/OHS was potentially protective during univariate analysis (OR: 0.41; 95% CI: 0.19-0.88; p=0.022), but not in the multivariate analysis (7). This can be an indication of improved responsiveness to NIMV in OSA/OHS patients, because in such cases, airway obstruction can be easily managed with positive airway pressure (8).

The pre-existing hospitalizations (OR: 2.66; 95% CI: 1.72-4.12; p < 0.0001) and follow-up in post-discharge care (OR: 1.60; 95% CI: 1.22-2.09; p = 0.001) also positively affected readmission (9,10). All of this is probably a sign of clinical instability and increased disease load because patients who were frequently admitted in the past potentially have worse or poorly managed diagnoses (11). The fact that it comes with follow-up visits implies that, although follow-up is vital, those who are prone to frequent follow-ups might already be at risk, as they still experience symptoms or have complications (12). This highlights the need for uniform follow-up plans to optimize NIMV settings and mitigate modifiable risk factors at the initial stages (13).

Clinical indicators of the readmitted population were also alarming, with 40 percent having longer stays at the hospital, 17.8 percent having hospital-adverse events, and 24.4 percent facing 90-day mortality (14). These findings suggest that readmissions have serious repercussions, especially among patients with bronchiectasis or those who had previously experienced a lot of hospitalizations and are candidates for intensive outpatient clinics (15). The absence of a critical correlation with readmission and other variables, including age, gender, diabetes, and hypertension, unlike some previous studies, may be explained by either the small sample size of the studied population or local differences in patient demographic proportions (16).

The results provided by the study imply the following clinical implications. Better patient instructions regarding the use of NIMV, such as mask fitting and compliance, may help mitigate challenges like ventilation failure (17). Additionally, multidisciplinary follow-up between respiratory therapists and pulmonologists is possibly better associated with outcomes because they have the potential to counsel individuals on the specific requirements of the types of diseases distributed, specifically bronchiectasis patients (18). By directly measuring NIMV compliance and respiratory values, supporting the telemonitoring technologies, could further decrease readmissions, since it would make prompt intervention possible (1,2).

The one-center design and retrospective nature of the present study lead to bias (3), selection bias, and the generalizability of the study is limited. A small sample size of the readmission cohort (n = 45) decreased statistical power in subgroup analyses, and confounding factors, including adherence to medications and socioeconomic status, were not measured (4). The lack of standardization regarding follow-up patterns and sparsely reported outcomes after 90 days also limits the results (5). It is noted that further, consistent studies should be incorporated that are multicenter, prospective in nature, with a large sample size, a uniform follow-up schedule, and stratification of specific indications of NIMV, to better determine the risk factors of readmission (6,7). These initiatives can result in patient-specific interventions that would reduce readmissions and enhance longer-term patient outcomes in terms of those treated with home NIMV.

CONCLUSION

The results revealed that 14.4 percent of the patients in a 160 patient retrospective cohort of in-hospital patients who had been administered non-invasive ventilation (NIMV) and discharged experienced a readmission within 90 days of hospital stay, making it one of the problematic aspects of dealing with chronic hypercapnic respiratory failure. The highest independent risk factor was bronchiectasis, having a multivariate odd ratio of 5.18 (95% CI: 1.26-21.30; p=0.023). Other factors previously predicted to contribute to readmission included prior hospitalizations and frequent follow-up visits. On the other hand, OSA/OHS had the potential for a protective effect. The outcomes of readmitted patients were severe, with 40 percent being readmitted and protracted in the hospital, 17.8 percent acquiring hospital infections, and a 24.4 percent mortality rate within 90 days. These results raise questions about the necessity of specialized intervention, especially in the case of bronchiectasis patients, through improved airway control and a uniform surveillance plan. This could further decrease

readmissions through improved patient education and improved telemonitoring. The limitations to be addressed by future research, such as a small sample size and non-standardized follow-ups, should be discussed in multicenter prospective studies, which can enhance the results for this vulnerable population.

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