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Health-care associated infections in the two university hospitals of southern Tunisia: a point prevalence survey

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Keywords

Healthcare associated infections • Prevalence • Factors

Summary

Introduction. *Despite advances in the prevention of healthcare-associated infections (HAI) in recent decades, this once-almost-usual adverse event remains relatively common and still has a definite impact on patients and public health. In light of this, this study aimed to determine the HAI prevalence, to describe their main specificities and to identify their associated factors, in Southern Tunisia.*
Methods. *We conducted a cross-sectional study to assess HAI point prevalence in two university hospitals in southern Tunisia. The study was started on February 20th to March 13th, 2023.*
Results. *There were 1.028 patients included in the survey and (47.3%) of them were women (n=486). The median age was 48 years (Interquartile Range (IQR)=[30-65]) years. We noted 86 HAI in the two establishments visited, with a global HAI prevalence of 8.4%. Multivariate analyses showed that independent factors of HAI were immune suppression (AOR=2.5; p=0.004), hospital stay duration ≥ 6 (AOR=4.5; p<0.001), surgery 30 days prior to the study date (AOR=1.9; p=0.021), having central vascular catheter (AOR=2.44; p=0.032) and having intubation or endotracheal tube (AOR=3.5; p=0.002).*
Conclusions. *This study highlighted a relatively high prevalence of HAI in southern Tunisia. Therefore, urgent and ongoing corrective measures should be implemented, maintained and re-evaluated continuously in order to control HAI and promote care safety.*

Introduction

Despite advances in the prevention of healthcare-associated infections (HAI) in recent decades, this once-almost-usual adverse event remains relatively common and still has a definite impact on patients and public health. Undoubtedly, this complication requires efforts to control it at best [1]. HAI are responsible of an increased and a sup-er added morbidity, mortality and healthcare costs as well [2]. In addition to these consequences, HAI are widely known as a factor of prolonged hospital stay, long-term disability and increased antimicrobial resistance [3]. Although all methods and strategies are implemented across the world to prevent and to control HAI, they remain to represent a challenge for the modern medicine [4]. Moreover, fighting this scourge becomes a quality and safety indicator of healthcare in health establishments. Clinically, and according to the diagnosis and the interventions received for patients, HAI most frequent sites were bloodstream infections, urinary tract infections, respiratory tract infections, and surgical site infections [5]. The responsible agent of HAI could be bacterial, viral, or parasitical [6]. Furthermore, the most considerable particularity of HAI was that they are increasingly caused by resistant microorganisms such as *Methicillin-Resistant Staphylococcus Aureus and Carbapenemase-Producing Enterobacteria*. Also, it was estimated that about the one-third of these infections were caused by an antibiotic-resistant bacterium [7].

HAI as previously described, are a global health phenomenon but with unequal distribution depending on the country's development level. In fact, according to the World Health Organization (WHO) out of every 100 patients in acute-care hospitals, seven patients in high-income countries and 15 patients in low- and middle-income countries will acquire at least one HAI during their hospital stay and on average, 1 in every 10 affected patients will die from their infection [8]. Considering the gravity and the importance of this problem, prevention is the most effective strategy to fight HAI complications and repercussions. One of the pillars of this prevention is having an effective surveillance of HAI in order to characterize and to quantify this problem and to reduce it [9]. HAI prevalence was about 5.9% in 28 European countries and about 10% in low-income countries (10.1%) [10]. In Tunisia, the latest surveys dated from 2005 and 2012 where the HAI prevalence was ranged from 6 to 7% [11]. At a regional level, there was local point prevalence surveys conducted in the center east and in the southern regions of the country where the reported HAI prevalence was 17.7% and 9.02% [12-13]. Given this, the evaluation of HAI frequency remains a mandatory and a crucial step before any control action.

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The point prevalence studies of this type of infections are of a major interest in epidemiological surveillance in hospitals given their easily implementation and low cost.
In light of this, this study aimed to determine the HAI prevalence, to describe their main specificities and to identify their associated factors, in Southern Tunisia.

Methods

Study design and settings

We conducted a cross-sectional study to assess HAI point prevalence in the two university hospitals of southern Tunisia. These two referral hospitals of southern Tunisia have complementarity activities. In fact, the first one was a teaching hospital with almost a medical vocation with a maximum capacity of 1000 beds, while the second one has an almost surgical aptitude hosted 562 beds. These two university hospitals are housing patients from Sfax and from neighboring regions in the southern Tunisia.
The study was started in February 20th to March 13th, 2023. The protocol of the world health organization prevalence survey was assumed and validated by a national committee in hygiene and preventive health in order to standardized prevalence surveys between region [14]. All departments in the two hospitals that had a patient hospitalization unit were included. Totally, 21 departments of the medical vocation university hospital and 16 departments of the surgical hospital were eligible. It was a one-day visit per department and the whole prevalence survey lasted for 19 days.

Study population and case definition

All patients of any age hospitalized in the two hospitals were included in the morning on the day of the survey. An exhaustive and updated patients' list was obtained at this time in each department. HAI were defined according to the Center for Disease Control (CDC) criteria as a hospital acquired infections that are typically not present or might be incubating at the time of admission and manifest 48 hours after admission. They are infections acquired during hospital care, which are not present, or incubating at the time of admission [15, 16].

Data collection and study tool

The study tool used was a pretested, structured, uniformed and validated fact-sheet written in English. The investigation was done by pre-trained medical epidemiologist after discussing with the nursing staff and physicians if needed.
Different parameters were collected from patient medical files such as nursing notes, medical notes, temperature charts, drug charts, electronic prescribing systems, surgical notes, laboratory reports, and other relevant charts.
Collected data included sociodemographic and clinical information such as age, gender, ward type, admission date, length of hospital stays, medical history and criteria to investigate different infections. We also noted if the patient had an invasive device, surgical intervention within 30 days, or antibiotic treatment on the day of the survey.
We used the McCabe scale to classify patients according to the severity of their underlying conditions. The McCabe scale provides an objective and structured method to classify the severity of comorbidities. In our study, using this scale allows for a clear categorization of patients, which can help understand how the burden of comorbidities interacts with other risk factors for HAIs. This scale was composed of 3 categories: nonfatal disease (expected survival > 5 years), ultimately fatal disease (expected survival 1-4 years), and rapidly fatal disease (expected death within 1 year) [17]. As for patients that had been operated in the last 30 days, and based on the American Society of Anesthesiologists (ASA) and to the to the surgical wound class patients were classed into grades that ranged from 1-4, and to (clean, clean/contaminated, contaminated and dirty), accordingly [18]. The data were checked for both completeness and accuracy to rule out missing or inconsistent data.

Statistical analysis

For the entry and the statistical analysis, we used SPSS Statistics software version 26. According to the variables type, continuous variables were presented as mean ± standard deviation or median and interquartile range (IQR) giving to the normality distribution tested. As for categorical variables, they were described as numbers and percentages. We used the chi square test in independent samples to assess association between categorical variables. The crude odds ratio (COR) was assessed as well as its 95% confidence interval (CI). Variables statistically associated with HAI were then entered into a multivariate logistic binary regression model backward stepwise, in order to determine HAI independent factors (adjusted odds ratio (AOR) and 95%). A p value < 0.05 was considered as statistically significant.

Results

Description of the study population

There were 1028 patients included in the survey and (47.3%) of them were women (n = 486). The median age was 48 years (Interquartile Range (IQR) =[30-65]) years. In total, 694 participants (67.5%) were hospitalized in the medical vocation hospital. As for patients' main clinical characteristics, 523 patients (50.9%) were hosted for more than 6 days, 154 patients (15%) had previous hospitalization in the last 3 months, and 42 patients (4.1%) were transferred from another hospital (Tab. I).

Characteristics of healthcare associated infections

We noted 86 HAI in the two establishments visited,

Tab. I. Description of the study population.

Characteristics	Number	Percentage
Gender		
Males	542	52.7
Females	486	47.3
Age groups		
Neonates	69	11.1
≤ 2 years	160	15.6
]2-60[years	553	53.8
≥ 60 years	307	29.9
Hospital		
Hedi Chaker University Hospital	694	67.5
Habib Bourguiba University Hospital	334	32.5
Hospital stay duration		
< 6	505	49.1
≥ 6	523	50.9
Previous hospitalization in the last 3 months	154	15
Transfer from another hospital	42	4.1
Ward type		
Medical	631	61.4
Surgical	307	29.9
Intensive care unit	90	8.8
Tobacco use	150	14.6
Alcohol use	57	5.5
Drug use	26	2.5
Medical history		
Surgery since admission		
No surgery	356	68.3
Minimal invasive surgery or non-NHSH surgery	66	12.7
NHSN surgery	95	18.2
Unknown	4	0.8
Surgery in the last 30 days	164	16
ASA score		
1	86	59.7
2	33	22.9
3	19	13.2
4	6	4.2
Surgical wound class		
Clean	96	59.3
Clean contaminated	25	15.4
Contaminated	26	16
Dirty	15	1.5
Antimicrobial preoperative prophylaxis	108	10.5
Comorbidities		
Immunosuppression	106	10.3
Neutropenia	25	2.4
Obesity	69	6.7
High blood pressure	194	18.9
Diabetes	217	21.1
Dyslipidemia	106	10.3
Malnutrition	27	2.6
McCabe Index		
Non-fatal disease	845	82.2
Ultimately fatal disease	144	14
Rapidly fatal disease	39	3.8
Invasive devices in place on the survey date		
Central vascular catheter	49	4.8
Peripheral vascular catheter	573	55.7
Urinary catheter	100	9.7
Intubation or endotracheal tube	64	6.2
Antibiotics prescription	389	45.4

ASA score: American Society of Anesthesiologists.

with a global HAI prevalence of 8.4%. The prevalence of HAI was of 7.6% in the medical vocation hospital, and the department had the highest prevalence was the hematology department (39.3%) (n = 11). As for the surgical vocation hospital, the prevalence was 9.8% and the highest prevalence was noted in the intensive care units (24.1%) (n = 14) (Tab. II).
According to the anatomic site of HAI noted, the most frequent site was the respiratory tract infection (32 cases; (37.2%)), followed by blood stream infections (21 cases; (24.4%)). We noted that in 46.5% of cases a microorganism was isolated (n = 40). Among which, the pathogen isolated was *Klebsiella pneumoniae* in 22.5% of cases (n = 9) (Tab. III).

Associated factors of healthcare associated infections

Results of univariate analysis

For patients' relative risk factors univariate analyses showed that age between less than 2 years or ≥ 60 years was statistically associated with HAI. For comorbidities, immune suppression and neutropenia were statistically associated with HAI. High blood pressure was statistically associated with HAI. Patients with rapidly fatal disease and those with an ASA score ≥ 2 were statistically more frequently affected by HAI.
For extrinsic risk factors, hospital stay duration ≥ 6 days, previous hospitalization in the last 3 months, Surgery 30 days prior to the study date and dirty Surgical Wound Class were statistically associated with HAI. Also, we found that devices statistically associated with HAI were central vascular catheter, peripheral vascular catheter, urinary catheter and intubation or endotracheal tube (Tab. IV).

Results of multivariate analysis

Multivariate analyses showed that independent factors of HAI were immune suppression (AOR = 2.5; p = 0.004), hospital stay duration ≥ 6 (AOR = 4.5; p< 0.001), surgery 30 days prior to the study date (AOR = 1.9; p = 0.021), having central vascular catheter (AOR = 2.44; p = 0.032) and having intubation or endotracheal tube (AOR = 3.5; p = 0.002) (Tab. IV).

Tab. II. Healthcare associated infections according to ward specialty and university hospital.

University hospital/ward specialty	All enrolled patients	Number of HAI	Prevalence of HAI (%)
Total patients	102,8	86	8.4
Medical vocation hospital (total)	694	53	7.6
Adult departments	487	30	6.2
General medicine	290	28	9.7
Hematology	28	11	39.3
Other general medicine departments	262	17	6.5
Genecology and obstetrics	103	0	0
Adult psychiatric unit	94	2	2.1
Pediatric departments	207	23	11.1
General medicine	150	18	12
Neonatology	40	5	12.5
Neuro-pediatrics	3	0	0
Pediatric surgery	12	0	0
Pedopsychiatric	2	0	0
Surgical vocation hospital (total)	334	33	9.8
Surgery	240	17	7.1
Intensive care	58	14	24.1
General medicine (neurology, oncology, radiotherapy)	36	2	5.5

HAI: healthcare associated infections; %: Percentage.

Tab. III. Health-care-associated infections anatomical site and isolated micro-organisms.

HAI site	HAI (N = 86) (n, %)	Micro-organism in question (N = 40) (n, %)										
		Total MO isolated	E.c	K.p	E.f	Other E.	S.a	A.b	P.a	C.N.S	C.a	P.m	Others
All HAI	86 (8.4)	40 (46.5)	3 (7.5)	9 (22.5)	1 (2.5)	3 (7.5)	2 (5)	1 (2.5)	8 (20)	2 (5)	4 (10)	3 (7.5)	4 (10)
Urinary tract	11 (12.8)	9 (81.8)	2 (22.2)	3 (33.3)	1 (11.1)	-	-	-	1 (11.1)	-	1 (11.1)	-	1 (11.1)
Respiratory tract	32 (37.2)	5 (15.6)	-	2 (40)	-	1 (20)	-	-	2 (40)	-	-	-	-
Bloodstream	21 (24.4)	15 (71.4)	-	3 (20)	-	1 (6.6)	1 (6.6)	1 (6.6)	2 (13.3)	1 (6.6)	2 (13.3)	3 (20)	1 (6.6)
Surgical site	11 (12.8)	8 (72.7)	1 (12.5)	1 (12.5)	-	1 (12.5)	1 (12.5)	-	3 (37.5)	-	-	-	1 (12.5)
Eye, ear, nose, throat and mouth	11 (12.8)	3 (27.3)	-	-	-	-	-	-	-	1 (33.3)	1 (33.3)	-	1 (33.3)

* N,n: number; HAI: Health-care associated infections, Pr: prevalence of HAI; E.c: Escherichia coli; K.p: Klebsiella pneumoniae; A.b: Acinetobacter baumannii; P.a: Pseudomonas aeruginosa; S.a.: staphylococcus aureus; E.f.: Enterococcus faecali; Other E: other enterobacteria; C.N.S: coagulase negative staphylococcus; C.a.: Candida albicans; P.m: Proteus Mirabilis.

Discussion

This study pointed-up HAI prevalence and its associated risk factors in tertiary care hospitals in southern Tunisia. Evaluating this indicator was a key outcome in healthcare systems because of the huge impact of HAI on patients and healthcare systems. This study illustrated a global HAI prevalence of 8.4%. This prevalence was slightly lower from two previous studies conducted in our region in 2017 (10.9%) and 2019 (9.02%) [12]. This decrease could be explained by the effectiveness of the corrective measures taken by the preventive medicine and hygiene department in order to fight HAI notably continuous training sessions for healthcare professionals about standard precautions. This percentage was about 17.7% in a center-east Tunisian region with two university hospitals [19]. These findings could be explained by the complexity and invasive interventions administered for patients. By comparing with previous literature from other developing countries, we found a relative disparity between countries and globally HAI frequencies reported were more important than our findings. They were about 11% in Nepal [20] and about 30% in India [21]. In contrast, recent studies conducted in European developed countries reported a HAI prevalence rate ranging from 4.6% to 9.3% [22]. The high prevalence of HAI in low and middle outcomes countries could be reported to the lack of really active HAI prevention and control committee in hospitals. They could be related to the lack of respect of standard precautions given the huge workload and to the lack of financial resources [23].

It was worthy to know that the most important prevalence was noted in the hematology and the intensive care departments. This finding was in accordance with previous similar study [24]. An eventual explanation of this fact could be the invasive interventions delivered

Tab. IV. Factors associated with healthcare-associated infections: results of univariate and multivariate analysis.

	Univariate analysis				Multivariate analysis	
Variables	HAI		COR (95% CI)	p	AOR (95% CI)	p
	No (N,%)	Yes (N,%)				
Patients' relative risk factors						
Gender						
Male	488 (90)	54 (10)	1	0.051		
Female	454 (93.4)	32 (6.6)	0.6 [0.4-1.1]			
Age groups						
[2–60] years	523 (93.2)	38 (6.8)	1			
< 2 years or ≥ 60	419 (89.7)	48 (10.3)	1.6 [1.1-2.5]	0.043		
Habits						
Tobacco use						
No	800 (91.1)	78 (8.9)	1	0.147		
Yes	142 (94.7)	8 (5.3)	0.5 [0.2-1.2]			
Alcohol use						
No	889 (91.6)	82 (8.4)	1	0.705		
Yes	53 (93)	4 (7)	0.8 [0.3-2.3]			
Drug use						
No	918 (91.6)	84 (8.4)	1	0.900		
Yes	24 (92.3)	2 (7.7)	0.9 [0.2-3.9]			
Comorbidities						
Immunosuppression						
No	857 (93)	85 (80.2)	1		1	0.004
Yes	65 (7)	21 (19.8)	3.3 [1.9-5.6]	< 0.001	2.5 [1.3-4.5]	
Neutropenia						
No	923 (92)	80 (8)	1	0.004		
Yes	19 (76)	6 (24)	3.6 [1.4-9.4]			
Obesity						
No	878 (91.6)	81 (8.4)	1	0.728		
Yes	64 (92.8)	5 (7.2)	0.8 [0.3-2.2]			
Hypertension						
No	776 (93)	166 (85.6)	1	0.001		
Yes	58 (7)	28 (14.4)	2.3 [1.4-3.6]			
Diabetes						
No	748 (92.2)	63 (7.8)	1	0.181		
Yes	194 (89.4)	23 (10.6)	1.4 [0.8-2.3]			
Dyslipidemia						
No	847 (91.9)	75 (8.1)	1	0.430		
Yes	95 (89.6)	11 (10.4)	1.3 [0.6-2.5]			
McCabe Index						
Non-fatal disease	783 (92.7)	62 (7.3)	1	0.009		
Ultimately fatal disease	128 (88.9)	16 (11.1)	1.6 [0.8-2.8]	0.123		
Rapidly fatal disease	31 (79.5)	8 (20.5)	3.2 [1.4-7.4]	0.005		
ASA score ≥ 2						
No	79 (91.9)	7 (8.1)	1			
Yes	45 (77.6)	13 (22.4)	3.3 [1.2-8.8]	0.015		
External risk factors						
Admission ward type						
Medical	581 (92.1)	50 (7.9)	1	<0.001		
Surgical	289 (94.1)	18 (5.9)	0.7 [0.4-1.2]			
Intensive care unit	72 (80)	18 (20)	2.9 [1.6-5.2]			
Hospital stay duration						
< 6	488 (96.6)	17 (3.4)	1	<0.001	1	<0.001
≥ 6	454 (86.8)	69 (13.2)	4.4 [2.5-7.5]		4.5 [2.6-8.1]	
Previous hospitalization in the last 3 months						
No	819 (93.7)	55 (6.3)	1	<0.001	1	0.001
Yes	123 (79.9)	31 (20.1)	3.7 [2.3-6.1]		2.6 [1.5-4.4]	

▶

Tab. IV (*follows*). Factors associated with healthcare-associated infections: results of univariate and multivariate analysis.

Variables	Univariate analysis				Multivariate analysis	
	HAI		COR (95% CI)	p	AOR (95% CI)	p
	No (N,%)	Yes (N,%)				
Transfer from another hospital						
No	902 (91.5)	84 (8.5)	1	0.389		
Yes	40 (95.2)	2 (4.8)	0.54 [0.1-2.3]			
Surgery 30 days prior to the study date						
No	800 (92.7)	63 (7.3)	1	0.004	1	0.021
Yes	141 (86)	23 (14)	2.1 [1.3-3.4]		1.9 [1.1-3.4]	
Surgical wound class						
Clean	86 (89.6)	10 (10.4)	1	0.150		
Clean contaminated	22 (88)	3 (12)	1.2 [0.2-4.6]	0.820		
Contaminated	22 (84.6)	4 (15.4)	1.5 [0.4-5.4]	0.484		
Dirty	10 (66.7)	5 (33.3)	4.3 [1.2-15.1]	0.023		
Invasive devices in place on the survey date						
Central vascular catheter						
No	911 (93.1)	68 (6.9)	1	<0.001	1	0.032
Yes	31 (63.3)	18 (36.7)	7.8 [4.1-14.6]		2.44 [1.1-5.5]	
Peripheral vascular catheter						
No	432 (94.9)	23 (5.1)	1	0.001		
Yes	510 (89)	63 (11)	2.3 [1.4-3.8]			
Urinary catheter						
No	863 (93)	65 (7)	1	<0.001		
Yes	79 (79)	21 (21)	3.5 [2.1-6.1]			
Intubation or endotracheal tube						
No	896 (92.9)	46 (71.9)	1	<0.001	1	0.002
Yes	68 (7.1)	18 (28.1)	5.2 [2.8-9.4]		3.5 [1.6-7.4]	

* N: Number; %: Percentage; COR: Crude Odds Ratio; CI: Confidence interval; AOR: Adjusted Odds Ratio; HAI: Healthcare associated infection; ASA: American Society of Anesthesiologist.

and the immunodepression of patients hospitalized in these units.

By anatomic site, the most frequent HAI site was respiratory tract infection. This fact could be related to the change in the emergence of the COVID-19 pandemic. In fact, it was reported that during this pandemic there was a reduction of respiratory tract infections worldwide due to social distancing and the use of barrier gestures [25]. Besides, in the post-pandemic era, a possible increase in the incidence of respiratory infections was expected in the whole world due to the lack of adherence to preventive and distancing measures, the irrational and abusive abuse of antibiotics during the pandemic era, and emergence of multi-resistant respiratory strains [26].

According to the microorganism type the most frequent bacteria isolated was the Klebsiella pneumoniae followed by the Pseudomonas aeruginosa. This result was in line with previous data [12-27]. In fact, these pathogens are the most common isolated pathogens in HAI in the literature (over than 40% of cases) [27, 28].

As for HAI predictive factors, our study showed that the only patients' relative risk factor was immune suppression. In fact, it could be considered as evidence that immunocompromised patients are the mostly at risk to have HAI [29].

For extrinsic predictors, we found that hospital stay duration ≥ 6, surgery 30 days prior to the study date, having central vascular catheter and having intubation or endotracheal tube were independently associated with HAI. Our findings were in accordance with previous studies [11-12-30]. All previous factors cited could be a source of germs transmission for hospitalized patients via direct or indirect route. Invasive devices, such as central catheter and intervention could be an entry point for germs via a direct route by breakage of the skin barrier or closed cavities.

This original study is the first one enlightening magnitude of HAI in south Tunisian university hospitals after the COVID-19 era. The exhaustivity of the data collection gives a clear and exact idea about HAI burden in our region. In addition, the validated protocol used give an added value to the survey. Nevertheless, there were some limitations. Firstly, it was a cross-sectional study which illustrated only association between facts but did not approve the causality. Secondly, other factors apart from the listed could have influenced risk for HAI such as healthcare professional adherence to preventive measures and availability of financial resources in hospitals evaluated. Finally, it was a regional study that should be completed by other researches in different regions of the country in order to dressed HAI profile at a national scale that to be able to control it.

Preventing healthcare-associated infections (HAIs) requires a robust infection control strategy that prioritizes consistent hand hygiene, appropriate use of personal protective equipment (PPE), and regular cleaning and disinfection of frequently touched surfaces. Healthcare facilities should also emphasize antimicrobial stewardship to combat resistance, ensure the safe management of invasive devices, and perform ongoing surveillance to promptly identify and address infection trends. Continuous training for healthcare workers and patient education on infection prevention are crucial in minimizing HAI risks and enhancing overall patient safety.

Conclusions

This study highlighted a relatively high prevalence of HAI in southern Tunisia. Multiple factors were predictive of HAI specifically invasive devices, surgery, length of hospital stay and fragility of patients.
Considering this, health authorities, hospital direction and healthcare professionals must be aware about the HAI alarming rates. Therefore, urgent and ongoing corrective measures should be implemented, maintained and re-evaluated continuously in order to control HAI and promote care safety.

Acknowledgments

None.

Human Ethics and Consent to Participate declarations

Not applicable.

Data Availability Declaration

Not available.

Conflicts of interest statement

None.

Authors' contributions

MB, MBH, HBAM and MBJ: developed the study design and were responsible for the organization and coordination of the study. MB: was the chief investigator and responsible for the data analysis. All authors contributed to the writing of the final manuscript. All members of the healthcare associated infections in the two university hospitals of southern Tunisia: a point prevalence survey contributed to the management or administration of the study.

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