

Patient Safety in Inpatient Wards: Sample of a University Hospital

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ABSTRACT

The aim of this study was to evaluate the patient safety in inpatient wards of an educational hospital affiliated with Tehran University of Medical Sciences from the viewpoint of nursing staff using the six sigma methodology. This was a cross-sectional descriptive analytical study, carried out in an educational hospital affiliated with Tehran University of Medical Sciences in 2010. The study was performed using a researcher-devised questionnaire. From among the hospital nurses, 42 nurses (three from each ward) were randomly selected and were asked to fill out the questionnaire. We used the opinions of faculty members and experts of the field to determine content validity of the questionnaire. Furthermore, to confirm the questionnaire reliability, the value of Cronbach's alpha was calculated and it was determined as 0.81. Data analysis was performed using SPSS and Microsoft Excel software. According to the results, the levels of physical environment and installation safety and safety training were medium (59.8, 60.2 and 64.6%, respectively), while safety of patients' beds, health and management of incidents were at desirable level (70.6, 76.6 and 77.2%, respectively). In general, safety of inpatient wards of the hospital was at the medium level. From the view point of nursing staff, the wards Urology 2 and Orthopedic Surgery 1 had the best and worst status with the mean score of 91.23 and 58.52, respectively.

Keywords: Safety, Six Sigma Model, Nursing Staff, Teaching Hospital

1. INTRODUCTION

Hospitals are among the most important health care providing organizations (Farzianpour *et al.*, 2011a). Hospital have sophisticated and advanced facilities and instruments and specialized and semi-specialized workforce to provide, maintain and support one of the basic needs of human (Nishizaki *et al.*, 2010). Before providing any services, hospitals should provide an appropriate space and safe environment for their clients. Moreover, hospitals should have facilities and equipment required for dealing with emergency conditions, since

irreparable physical and human loss may occur due to unexpected events (Stone *et al.*, 2007).

Before dealing with their responsibilities, level of safety in hospitals should be evaluated and some measures be adopted to improve the safety levels (JC, 2011). This is because although patients should receive care in hospitals, hospitals are responsible for the referred individuals and visitors and incidents should be controlled (JCI, 2011).

Safety in health care organizations is a set of measures adopted for protection of physical assets of the organization and the individuals interact with the

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organization and its surrounding environment (Rogers *et al.*, 2004).

Protection and safety are adopted to reduce the risk of harms and loss and does not exclusively eliminate the risks (Decker, 2012; Greenwald *et al.*, 2010). Safety is not a static concept and is always variable. What seems safe today may not be safe tomorrow. Safety is a phenomenon, which requires periodical evaluations. Presence of a safety plan in hospitals is an important item. Safety plans may save people's life, prevent the harms and finally reduce the hospital costs. Design and employment of safety plans in hospitals is an effective and appropriate task (JCAH, 2011). In fact, safety is a word, which is effective and real just when it is accompanied by specialized programming, checking, presence of safety plan, training and exercise of dealing with incidence, continuous goal-oriented health programs and required trainings (Coughlin *et al.*, 2012).

In the recent decade, the six sigma model has received attention as a robust systematic approach in improvement of health care services, reduction of the costs, improvement of patient safety, increasing the efficiency of resources and overcoming the challenges (Koning *et al.*, 2006; Bisgaard and Freiesleben, 2004).

Considering the effectiveness of the six sigma method in reducing pitfalls of the health care system and the importance of patient safety and since patient safety is a major concern in the health care system, the authors attempted to evaluate patient safety level in inpatients wards of the university Hospital using the six sigma models.

2. MATERIALS AND METHODS

This is a cross-sectional descriptive analytical study, carried out in an educational hospital affiliated with Tehran University of Medical Sciences in 2009. A questionnaire was prepared by the author according to literature review and the guides provided by faculty members and research consultant of the Department of Health Management. Then, after obtaining the required permissions from the hospital manager and educational supervisor, the questionnaires were distributed among the nurses. The hospital has 14 wards and we randomly selected three nurses from each ward; thus, 42 questionnaires were handed in and one day later the participants were asked to return completed questionnaires. To determine the questionnaire validity, the questionnaire was reviewed by some faculty members and they confirmed its validity. To confirm the questionnaire reliability, the value of Cronbach's alpha was determined as 0.81 using SPSS software. The data was analyzed using SPSS and Microsoft Excel software.

Firstly, the items were scored on a five-point Likert scale (none/never/no, few/once in a while, some/sometimes, most/most of the time, all/always/yes). Then, the items of the questionnaire were classified into the following six categories; safety of physical environment, safety of patients' beds, installations, health, safety training and management of incidents. After summing up the scores and calculation of mean and mean percentage for each ward and the hospital in general, scores above 70, 40-70 and below 30 were considered as desirable, medium and poor, respectively. Then, the standard deviation, Upper Specification Limit (USL) and Lower Specification Limit (LSL) values for each category of items in each ward and all the wards were calculated. In the following, using the six sigma method, the wards with the specification interval larger than that calculated for the hospital was specified. The reason for this larger interval was the higher dispersion of the responses.

3. RESULTS

We evaluated 14 wards and in each ward, three nurses were randomly selected and were asked to fill out the questionnaire on patient safety in inpatient wards of the hospital. From among the nurses participated in the study, 33.3% were supervisors and 97.6% of the participants were female. With regard to the age group, the highest (11.9%) and lowest (2.4%) frequency was observed in 36-38 and below 23 age groups, respectively. In addition, all participants had B. Sc. of nursing.

The findings of the study for each ward were as follows.

3.1. CCU Ward

In this ward, safety of patients' beds, installations, health, safety training and management of incidents were in the desirable level, while safety of physical environment was medium.

3.2. Men's Internal Medicine Ward

Health and management of incidents in this ward were in the desirable level, while safety of physical environment, installations and safety training were in the medium level.

3.3. Women's Internal Medicine Ward

In this ward, safety of physical environment, health, safety training and management of incidents were in the desirable level and safety of patients' beds and installations were in the medium level.

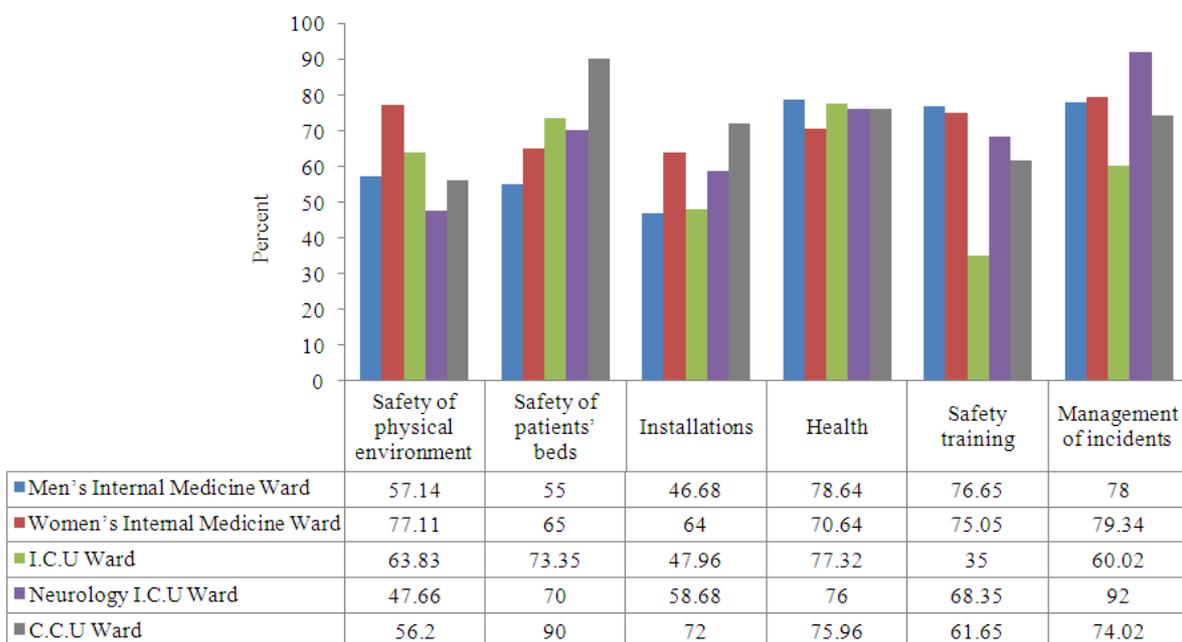


Fig. 1. Safety status inpatient wards, a teaching hospital in the Tehran University of Medical Sciences-2010

3.4. ICU Ward

Safety of patients' beds, health and safety training were desirable, while safety of physical environment, installations and management of incidents were in the medium level in this ward.

3.5. Neurology ICU Ward

Considering safety of patients' beds, health, safety training and management of incidents, the ward was in a desirable state, while safety of physical environment and installations were in medium level (**Fig. 1**).

3.6. Men's Neurosurgery Ward

In this ward, health, safety training and management of incidents were in the desirable level; and safety of physical environment, safety of patients' beds and installations were in medium level.

In this ward, the USL-LSL interval for all categories of items lied within the normal range of the hospital.

3.7. Women's Neurosurgery Ward

In this ward, safety of patients' beds, health, safety training and management of incidents were in the

desirable level; and safety of physical environment and installations were in the medium level.

3.8. Men's Surgery Ward

In this ward, safety of patients' beds, safety training and management of incidents were in the desirable level, while safety of physical environment, installations and health were in the medium level.

3.9. Urology Ward 1

Level of safety in this ward was found to be desirable with regard to safety of patients' beds, health, safety training and management of incidents, while safety of the physical environment and installations were found to be medium.

3.10. Urology Ward 2

Considering safety of physical environment, safety of patients' beds, installations, health, safety training and management of incidents, the ward had a desirable safety level.

3.11. Men's Neurology Ward

Safety of patients' beds, health, safety training and management of incidents were in the desirable level, while safety of physical environment and installations were medium.

Table 1. Safety Status inpatient wards, a teaching hospital in the Tehran university of medical sciences-2010

Dimensions safety wards	Mean	Percentage of mean	SD	USL	LSL
1-Neurosurgery men					
SPE	2.71	54.29	1.31	6.64	--1.49
SPB	3.34	66.70	1.61	8.17	-2.81
I	3.20	64.00	2.01	9.23	-1.51
H	2.87	57.36	1.46	7.25	-1.16
ST	2.08	41.65	1.08	5.32	0.78
MI	3.94	78.64	1.05	7.08	1.22
2-Neurosurgery women					
SPE	2.79	49.49	1.44	6.79	-1.85
SPB	3.50	70.00	1.73	8.69	-1.69
I	2.60	52.00	2.03	8.69	-3.49
H	4.80	96.00	0.56	6.64	3.12
ST	2.00	41.65	1.78	7.42	-3.26
MI	4.30	86.02	0.99	7.27	1.35
3-General surgery women					
SPE	2.71	54.29	1.31	6.64	-1.22
SPB	3.34	66.70	1.61	8.17	-1.49
I	3.20	64.00	2.01	9.23	-2.81
H	2.87	57.36	1.46	7.25	-1.51
ST	2.08	41.65	1.08	5.32	-1.16
MI	3.93	78.64	1.05	7.08	0.78
4-urethra 1					
SPE	3.09	61.89	1.64	8.01	-1.83
SPB	3.83	76.65	1.8	9.23	-1.57
I	2.33	46.68	1.95	8.18	-3.52
H	3.80	75.96	1.57	8.51	-0.91
ST	4.25	85.00	1.14	7.67	0.83
MI	4.10	82.00	0.88	6.74	1.46
5-urethra 2					
SPE	3.95	79.03	0.67	5.96	1.94
SPB	4.92	98.35	0.29	5.79	4.05
I	4.13	82.68	1.64	9.05	-0.79
H	5.00	100.0	0.00	5.00	5.00
ST	5.00	100.0	0.00	5.00	5.00
MI	4.37	87.34	1.25	8.12	0.62
6-Safety neurology men					
SPE	2.76	55.23	1.55	7.41	-1.89
SPB	3.50	70.00	1.73	8.69	-1.69
I	3.40	68.00	2.03	9.49	-2.69
H	4.60	92.04	1.06	7.78	1.42
ST	3.83	76.60	1.40	8.03	-0.37
MI	4.00	80.00	1.26	7.78	0.22
7-Neurology women					
SPE	3.19	63.83	1.47	7.6	-1.22
SPB	3.33	66.65	1.67	8.34	-1.68
I	2.73	54.68	1.79	8.1	-2.64
H	3.07	61.32	1.62	7.93	-1.79
ST	3.00	60.00	1.28	6.84	-0.84
MI	3.00	60.00	0.98	5.94	0.06
8-Orthopedics1					
SPE	2.24	44.77	1.37	6.36	-1.88
SPB	3.09	61.70	1.88	8.73	-2.55
I	2.80	56.00	2.01	8.82	-3.22
H	3.60	72.00	1.55	8.25	-1.05
ST	2.17	43.35	1.27	5.97	-1.63
MI	3.67	73.32	1.35	7.71	-0.37
9-Orthopedics2					
SPE	3.33	66.66	1.28	7.17	-0.51
SPB	3.33	66.66	1.67	8.34	-1.68
I	2.73	54.64	1.98	8.67	-3.21
H	3.27	65.36	1.49	6.73	-2.19
ST	2.92	58.35	1.24	6.64	-0.80

MI	3.67	73.32	1.30	7.56	-0.22
Safety of physical environment = SPE Safety of patients' beds = SPB Installations = I Health = H Safety training = ST Management of incidents = MI					

Table 2. Mean and mean percent patient safety in inpatient wards of a University Hospital; Viewpoints of Nursing Staff, 2010

Dimension of safety total wards	M	Percentage of M	SD	USL	LSL
Safety of physical environment	2.99	59.8	1.49	7.45	-1.48
Safety of patients' beds	3.53	70.6	1.64	8.46	-1.40
Installations	3.01	60.2	1.94	8.83	-2.81
Health	3.83	76.6	1.50	8.34	-0.67
Safety training	3.23	64.4	1.59	8.00	-1.55
Management of incidents	3.86	77.2	1.18	7.41	0.31

3.12. Women's Neurology Ward

Considering all the items of safety of physical environment, safety of patients' beds, installations, health, safety training and management of incidents, the ward was medium.

3.13. Orthopedic Surgery Ward 1

Level of safety of the ward with regard to health and management of incidents was desirable, while it was medium for safety of physical environment, safety of patients' beds, installations and safety training.

3.14. Orthopedic Surgery Ward 2

Safety level of the ward considering safety training and management of incidents was desirable, while safety of physical environment, safety of patients' beds, installations and health were.

Three standard deviations on either side of the mean in all inpatient wards were -1.48 to 7.45, -1.40 to 8.46, -2.81 to 8.83, -0.67 to 8.34, -1.55 to 8 and 0.31 to 7.41 for safety of physical environment, safety of patients' beds, installations, health, safety training and management of incidents, respectively.

The specification interval larger than that calculated for the hospital indicates the dispersion of the responses of the participants.

The USL-LSL interval of safety of physical environment, safety of patients' beds, installations, health, safety training and management of incidents for the inpatient wards, which were larger than those of the hospital are provided in the following:

- Safety of physical environment: ICU, Urology 1 and Men's Neurology wards
- Safety of patients' beds: Women's Internal Medicine, ICU, Neurology ICU, Women's

Neurosurgery, Urology 1, Men's Neurology Women's Neurology, Orthopedic Surgery 1 and Orthopedic Surgery 2 wards

- Installations: ICU, Women's Neurology, Men's Surgery, Urology 1, Men's Neurology, Orthopedic Surgery 1 and Orthopedic Surgery 2 wards
- Health: Women's Internal Medicine, ICU, Urology 1, Women's Neurology and Orthopedic Surgery 1 wards
- Safety training: Neurology ICU, Urology 1, Women's Neurology and Orthopedic Surgery 1 wards
- Management of incidents: ICU, Urology 2, Men's Neurology and Orthopedic Surgery 1 (**Table 1 and 2**)

4. DISCUSSION

In this study, patient safety in hospitals was defined in six categories of safety of physical environment, safety of patients' beds, installations, health, safety training and management of incidents. Then, using the questionnaire, measurements were carried out according to the definitions. The results were as follows.

With regard to safety of physical environment, the inpatient wards were medium with the mean score of 59.8% and only the Women's Internal Medicine and Urology 2 wards were in a desirable state.

The highest and lowest mean scores for safety of physical environment were 79 and 44.77%, which were respectively obtained for Urology 1 and Orthopedic Surgery wards.

In our literature review, we could not find papers on evaluation of hospital safety using the six sigma model. Thus, we could not compare our results with similar studies. However, we elaborate on the factors interfering with the safety and also how to develop safety in this educational hospital.

Lack of window guards, inappropriate flooring, not using isolated rooms when required and lack of air conditioning system are the factors that affect patient safety in these wards. All windows in inpatient wards should be equipped with guards and the flooring should be waterproof to provide patient safety and comfort (Cunningham *et al.*, 2012; Farzianpour *et al.*, 2011b).

Flooring of patients' rooms and ward corridors should be made from non-slip materials. Synthetic materials are preferred for this purpose (Neuhausen *et al.*, 2012; JCI, 2011).

Flooring of the baths should be made from specific materials, such that nurses could have enough control over the patients. Covering of the stairways should always be kept clean and be made from non-slip materials and also minimize the noise as much as possible (Greenwald *et al.*, 2010; JCI, 2011).

The buildings should regularly be checked from cracks.

The walls in all wards should be normal, without any cracks and be in light colors and be washable up to the height of 1.8 m. The ceilings in all parts of the hospital should be smooth and without cracks and be painted in light colors.

Each ward should have appropriate full-time ventilation to provide clean air with proper temperature and a comfortable space for the patients (JCAH, 2011).

Isolation of patients is performed to separate the patients from other individuals and nurses. In fact, this is a cautious measure to prevent dissemination and intra-ward spread of infectious pathogens among patients, staff and visitors of the wards.

Ventilation is considered as a technique for disinfection of the environment. The roles of the ventilation system in hospitals are maintaining the temperature of inner spaces and reduction of microbial load, dusts and smells in the air. The ventilation systems should be designed such that appropriate setting of the inward and outward air flow volume maintains the air flow in the desirable direction.

With regard to the safety of patients' beds, the results indicated that the mean score was 70.6% and it was in a desirable level.

The best and worst results for safety of patients' beds were obtained for the Urology 2 and Men's Internal Medicine wards, with the mean scores of 98.35% and 55%, respectively.

Lack of bedside nurse call system in most wards and absence of footstep beside the beds in some wards may endanger the patients.

An option for patients' beds is the possibility of attaching the bedside safety rails to avoid falls

(Rogers *et al.*, 2004). Falls from hospital beds is the major cause of injury of patients, especially in older age groups; such that more than 70% of victims of the falls leading to death are patients above 65. Falls from hospital beds is apparently the most frequent and troublesome accident. Physical control (tying arms and legs) is not desirable and welcomed in most cases. Furthermore, 24-h direct observation and nursing except for few cases is very costly and impossible. Therefore, such problems should be separately analyzed for each patient and decisions about the approach should be made according to the case characteristics.

At the bedside of all patients, an appropriate communication tool (such as phone for external and nurse call button for internal communications) should be available.

Hospital footstep (single step at the bedside) is a basic equipment of inpatient wards (Leibrock and Harris, 2011; JCAH, 2011).

With regard to installations, the results indicated that installations of the inpatient wards was medium with the mean score of 60.2% and only the three wards of CCU, Men's Neurosurgery and Urology 2 were in a desirable state in this respect.

The highest score of installations was obtained for the Urology 2 ward, with the mean score of 82.68%, while the lowest score was obtained for Men's Internal Medicine and Urology 2 wards with the mean score of 46.68%.

The improper status of half of electrical sockets and lack of emergency power supply in most wards and not having the possibility of taking emergency exit steps would cause some risks for patients.

All electrical equipment such as sockets and switches should be installed according to safety regulations with protective earth contact. Emergency power supply and energy facilities should be installed in the nurses' station of the wards (Aspden *et al.*, 2004).

Emergency power supply is necessary for hospitals. After failure of central electrical system, the emergency power supply should be automatically started maximally within 10 sec.

Fire extinguishing systems should be applied properly and proportionate to the range of activities of the ward.

Fire accidents are caused by severe burning of flammable materials, either intentionally or unintentionally. The accidents harm men, buildings, instruments and facilities. Considering the potential of fire accidents in hospitals and presence of different flammable materials in hospital wards, preventive measures and predictions should be adopted in hospitals.

For each ward, exit facilities (escape steps) should separately be applied for unpredictable events.

In crises, emergency exits and standard stairways, which were built according to the national regulations of buildings, would play an important role in safety of individuals and timely evacuation of the buildings (Verni, 2012).

To avoid falls of people, the staircases should have appropriate support and fences and stable shelters with suitable height. Moreover, other details considered in the national regulations of buildings should be completely taken into account when designing hospital buildings.

Regarding the health status, the inpatient wards were in a desirable state with the mean score of 76.6% and only the three wards of Men's Surgery, Women's Neurology and Orthopedic Surgery 2 were medium in this respect.

The best and worst wards with regard to health scores were Urology 2 and Women's Neurology with the mean scores of 100 and 61.3%, respectively.

Absence of garbage chute system, washing and disinfection of bedpans and urinals and irregular collection of garbage in some wards is dangerous for patients owing to the risk of infection.

The floor of all rooms and corridors should be cleaned and disinfected regularly on a daily basis (Leibroch and Harris, 2011; JCAH, 2011).

The facilities required for automatic evacuation, washing and disinfection of the bedpans and urinals without requiring manual efforts should be applied. Washing and disinfection of bedpan.

Proportionate to the increase in admission of inpatient and outpatient cases, hospital wastes would increase. Although the effect of hospital wastes on safety and health is not measurable, without proper management, the infectious wastes lead to contamination of materials, furniture, instruments, patients and staff. Therefore, this is considered a very hazardous source for patients, health care providers and visitors (Woods, 2010).

Hospital infections have negative impacts on patients and the hospital. Because of hospital infections, the patients would stay longer in hospitals. This leads to higher hospital costs. Furthermore, due to losing of qualitative effectiveness of hospital beds, the hospitals would experience loss.

Considering the safety training, the results indicated that the wards were medium with the mean score of 64.4%.

The best ward in this respect was Urology 2 with the mean score of 100%, while ICU was the worst with the mean score of 35%.

Lack of training for using fire extinguishers and lack of safety training for staff endanger patients in some wards, owing to not following the safety regulations by staff.

All staff should be trained for reporting of incidents to those in charge.

The role of training as the foundation of progress and evolution in different aspects of reducing the incidents is of great importance.

Analyzing the statistics of incidence demonstrate that the rate of incidents by staff not having adequate safety training was 25% higher than that by their trained colleagues.

Safety training addresses three main topics and the courses on safety should include these three items (Ross *et al.*, 2011; Leibrock and Harris, 2011; JCAH, 2011):

- Improvement of knowledge of individuals about the significance of safety and health in development of the country. In other words, the individuals should be thoroughly familiar with theoretical and practical methods of avoiding occupational incidents that are expected and consider "safety first, then work"
- Enhancement of knowledge of individuals about the abilities of preventing events; and
- Improvement of individuals' skills in employment of safety systems and equipment during their work

5. CONCLUSION

All health centers should set up continuous programs on patient safety and train their staff in this regard to make safety as a culture among the staff. The programs should be designed such that they can identify the system problems and the underlying causes.

A program on hospital incidents would be successful only if staff members completely participate in it.

Safety training programs should be delivered to the patients and their family.

Considering management of incidents, our results demonstrated that the wards were in a desirable state with the mean score of 77.2%.

The highest and lowest scores on management of incidents were obtained for Neurology ICU and Women's Neurology with the mean scores of 92 and 60%, respectively. The score on putting forward suggestions by the staff was medium. This is while their

suggestions could minimize the future risk of incidences and even eliminate it.

The studies have shown that the events in general did not have a single underlying cause and they resulted from technical and human reasons. The causes depend on the type, environment, conditions of the working environment and the tools and could be categorized into two types of direct and indirect causes.

The main goal for evaluation of an incidence is collection of information required for defining the principles required for prevention of similar events.

Another measure for modification of individuals and systems is punishment of people who were guilty and abdicate their legal and human responsibilities. The punishment should be used as a tool to prevent repeating a non-feasible and illegal action, such that it modifies the individuals' behavior and the person can play an effective role. A nurse is responsible for the nursing actions and judgments that are performed in relation to individuals. Taking responsibility has been determined as a promotion factor for health care staff, both as a personal factor and as a factor related to the performance. Therefore, following the above-mentioned items would enhance the safety of patients and the hospital.

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