# Factors Contribute to Neonatal Nurses Pitfalls during Application of Pulse Oximeter in Neonatal Intensive Care Unit

# Mohamed B.A.<sup>1</sup>, Refaat H.T<sup>2</sup>, Amin M.M.<sup>3</sup>

B.Sc. Nursing 2010, Professor of Pediatric Nursing, Emetraus Professor of Pediatric Nursing, Faculty of Nursing, Ain Shams University

# Abstract

Background: Pulse oximeter is an essential monitoring and useful tool used in the intensive care unit although it has some pitfalls in it use. Aim: This study aimed to assess the factors contributing to neonatal nurses pitfalls during apply of pulse oximeter in neonatal intensive care unit. Design: A descriptive design was used in this study. Setting: The study was conducted at neonatal intensive care units affiliated to Ain Shams University Hospitals and Zagazig University Hospital. Subject: A purposive sample composed of 80 nurses(50 nurses work at Ain Shams University Hospital and 30 nurses' worke at Zagazig University Hospital who provid care to neonates with puls oximeter. Tools of data collection: Involved A structured Interview Questionnaire sheet and Observational checklist to assess the nurses practices used pulse oximeter in Neonatal intensive care unit. Results: revealed that, less than half of studied sample had good knowledge and less than one quarter of them had poor knowledge regarding to care of puls oximeter, while approximately more than half of studied sample had competent practice regarding to care of pulse oximeter. Illustrated a positive correlation between total knowledge of the studied neonatal nurses and their total practice regarding care of pulse oximeter. Conclusion: Based on results of the current study, it concluded that, factors contribute to neonatal nurse's pitfalls during application of pulse oximeter in neonatal intensive care unit the lack of studied nurse's knowledge about regarding care of pulse oximeter as well as lack of practice (incompetent) contributes to pitfulls. Recommendations: An orientation program should be prepared to help newly appointed nurses to acquire, develop their knowledge and practice to deal with neonatal nurse's care during application of pulse oximetry in neonatal intensive care unit

Keywords: Nurses, Neonates, Pulse oximeter, Performance.Introductionthe need for frequent blood samples (Vallet, etA neonatal period includes the first 28al., 2013).

A neonatal period includes the first 28 days (4 weeks) of life. During this period, following the cutting of the umbilical cord, the neonate establishes independent respiration and circulation and makes many more adjustment, such as feeding and weight gain (Gupte, 2016).

Pulse oximeter is noninvasive test for measuring oxygen saturation. It utilize probe that usually clipped around feet toes, hand fingers, forehead and ear lope Normal reading at pulse oximeter is 95 %to 100% (Duke & Keech, 2016).

Pulse oximeter a small, U-shaped device that uses a light sensor to measure neonates blood-oxygen level and heart rate. This painless device, which is wrapped around neonates toe or hand, and secured with a stretchy bandage, allows for monitoring of blood oxygen without Pulse oximeter are very useful in the following neonatal cases with respiratory failure, sever bronchial asthma, mechanical ventilation, obstructive, sleep apnea, emergency room and weaning from supplemental oxygen. (Golian, 2014).

Pulse oximetry has limitations and affected by physiological and technical factors are: It does not provide information regarding ventilation. Also, because pulse oximeter rely pulse tile blood flow to determine oxygen saturation, physiological states associated with decreased plasticity, such as shock, sever vasoconstriction and low cardiac output, may result in spurious pulse oximetry reading, nail polish on finger nails decrease tissue penetrance of probe emitted light and obscures pulse oximetry readings. Finally, increased level of an abnormal hemoglobin variants such as methamphetamine and carboxyhemoglobin are associated with in accurate pulse oximetry values and decreased peripheral perfusion as hypothermia or hypotension. Technical factors are excessive motions and incorrect place (Weiss & Fleisher, 2015).

Injuries associated with the usage of pulse oximeter because pulse oximeter is noninvasive, they are considered a safe medical technology. While the sensor emits a small amount of heat into the skin, testing indicates that the sensors are considered safe up to a temperature of 43°C on well perfused skin for up to 8 hours. However, indicate that cases have sustained injuries from this modality. There have been at least eight occurrences of skin integrity problems including: cuts/lacerations, discoloration. blanched skin pressure areas/necrosis, induration, burns, and blisters (Lu, et al., 2013).

Nursing quality alert and role for neonates with pulse oximeter are: Brings the oximeter and sensor and set the parameters for the alarm on continuous measuring, avoid placing the probe on an extremity with arterial line, blood pressure cuff or intravenous (IV) line in place, finger nails polish will need to be removed before placing the sensor and clean, Don't work the sensor to tightly as to prevent venous flow and cause inaccurate reading, to teach the skin condition, remove the sensor from the site at least every 2 hours to prevent allot of complications such as injury, ischemia and second, third degree of burn and clean the sensor with cleaning solution (James & Nelson, 2013).

# Significance of the Study:

Pulse oximeter is an essential monitoring and useful tool used in the intensive care unit although it has some pitfalls in it use. Therefore this study should be dealt with the factors contribute to neonatal nurses pitfalls during apply of pulse oximeter in neonatal intensive care unit.

## Aim of the study

The aim of the study was to assess factors contributing to neonatal nurses pitfalls during applies of pulse oximeter in neonatal intensive care unit.

### **Research Question:**

What are the factors contributing to neonatal nurses pitfalls during apply of pulse oximeter in neonatal intensive care unit?

#### Subjects and methods

The subject and methods of the current study was portayed under the following main four designs: I. Technical Design II. Operational Design III. Administrative Design IV. Statistical Design

### I. Technical Design:

It Included research design, study settings, subject and tools of data collection.

## **Research Design:**

A descriptive design was used to conduct this study.

# Technical Design. Research Settings:

The study was conducted at neonatal intensive care units affiliated to Ain Shams University Hospitals and Zagazig University Hospital.

#### Subjects

A purposive sample composed of 80 nurses (50 nurses work at Ain Shams University Hospital and 30 nurses work at Zagazig University Hospital who provide care to neonates with pulse oximeter.

# Tools of the study:

Two tools were used in this study;

I- A structured Interviewing questionnaire Sheet:

It was developed by the researcher after reviewing the related national and international

literature. It was written in a simple Arabic language to suit the understanding level of the study subject.

It was included two parts:

## Part 1:

- Neonatal nurses' characteristics as name, sex, age, educational level and year of experience.

- Neonatal characteristics such as: sex, gestational age, birth weight, duration of hospitalization, diagnosis and complication.

# Part 2:

Neonatal nurses' knowledge about care of puls oxmieter during application in neonatal intensive care unit, the questioner consisted of 14 closed ended questions in form Multiple Choice Question (MCQ) It was adapted by the researcher based on Cheong et al., 2017; Lissauer & Steer, 2013.

It consists of knowledge about (definition, indication, advantage and complication).

# **\*** Scoring system:

A scoring system was followed to assess nurses' knowledge according to pulse oximeter. The Questionnaire was contained of 14 questions, the total scores of the questionnaire were 14 grades, the right answer was scored as a single point and the wrong answer was scored as a zero point. These scores were summed and were converted into a percent score.

It was classified into 3 categories:

- Good knowledge if score >85%.
- Average knowledge if score from 70 < 85%.
- Poor knowledge if score <70%.

# II. Observational checklist:

It was adapted by the researcher based on Harvard, (2012) & Michigan, (2015); it revised by supervisors and it was used to assess nurse's competency for neonates with pulse oximeter at NICU.

#### **\*** Scoring system:

A scoring system was followed to assess nurses' practice; each competency skill was assigned a score according to sub-items. The total score of nurses' practices were 14 grades, each item was evaluated as "competent" was taken one score and "not competent" was taken zero score. These scores were summed up and were converted into a percentage score.

It was classified into 2 categories:

- Competent if score  $\geq$  95%.

- Incompetent if score < 95%.

# **II. Operational Designed**

It included operational design for this study consisted of four phases, namely preparatory phase, ethical considerations, pilot study, and fieldwork.

### **Preparatory Phase**

This phase included reviewing of literature related to nurses' knowledge about factors contributing to neonatal nurses pitfalls during apply of pulse oximeter in neonatal intensive care unit. This served to develop the study tools for data collection. During this phase, the researcher also visited the selected places to get acquainted with the personnel and the study settings. Development of the tools was under supervisors' guidance and experts' opinions were considered.

# **Ethical Considerations**

Ethical approval was obtained from the Scientific Ethical Committee, Faculty of Nursing, Ain Shams University for neonatal nurse's work in the previously mentioned settings. The nurse were informed that they are allowed to choose to participate or not in the study and they have the right to withdrawal from the study at any time. Ethics, values, culture and beliefs were respected.

# **Pilot Study**

Carried out on 8 nurses those represent 10% of neonatal nurses at the neonatal intensive care units affiliated to Ain Shams University Hospitals and Zagazig University Hospital. In order to test the applicability of the constructed tools and the clarity of the included questions related to nurses' knowledge factors contributing to neonatal nurses pitfalls during apply of pulse oximeter in neonatal intensive care unit. The pilot has also served to estimate the time needed for each subject to fill in the questions. According to the results of the pilot, some corrections and omissions of items were performed so the pilot nurses were not included in the main study sample.

# Fieldwork

An approval was obtained from the Medical Director of Maternity and Pediatric Hospital affiliated to Ain Shams University Hospitals and the Medical Director of Maternity and Pediatric Hospital affiliated to General Zagazig Hospital. A letter was issued to them from the Faculty of Nursing, Ain-Shams University, explaining the aim of the study in order to obtain their permission and cooperation.

The researcher first met with the neonatal nurses worked at the previously mentioned settings, explained the purpose of the study after introducing hiself. The study was carried out from the first of April 2018 up to November 2018 (7 month) the researcher was visiting the study setting 2days weekly at morning shift (11a.m-1p.m) to collect data. The questioner for knowledge was filled by nursing staff which take 15-25 minutes; while the observational checklist for assessing nurses' practice regarding pulse oximeter was filled by the researcher in 40-60 minutes while nurses given care for neonates at NICU.

# III. Administrative Designed

An official permission to conduct the study obtained from the medical director of pediatric hospitals affiliated to Ain Shams University Hospitals and the medical director of pediatric hospitals affiliated to General Zagazig Hospital. The researcher met the hospital director and explained the purpose and the methods of the data collection.

# IV. Statistical Analysis

Data collected from the studied sample was revised, coded and entered using Personal Computer (PC). Computerized data entry and Statistical analysis were fulfilled using the Statistical Package for Social Sciences (SPSS) version 22. Data were presented using descriptive statistics in the form of frequencies, percentages. Chi-square test  $(X^2)$  was used for comparisons between qualitative variables. Spearman correlation measures the strength and direction of association between two ranked variables.

# Significance of the results:

- Highly significant at p-value <0.001.
- Statistically significant was considered at p-value <0.05
- Non-significant at p-value>0.0

# **Results:**

**Table (1):** shows that, more than half (56.3%) of the neonatal nurses were in the age group 20 < 30 years with mean age  $28.94\pm5.27$  years, more than two fifth 45% of them were studied at technical health institute, more than one third 34.8% had experience less than 5 years

**Table (2):** shows that 58.8% of neonates were female, age of 51.3% of neonates were 1 < 10days, weight at delivery of 45% of neonates were 1.5-2 k.g, gestational age of 35% was 30 < 33weeks, actual weight of 36.2% were 1.5 < 2k.g and 57.5% were appropriate weight according to gestational age.

**Table (3):** shows that, 42.5% of neonates were diagnosed respiratory distress, 62.4% spent 1 < 10 days at NICU, 66.3% connected with pulse oximeter within 1 < 10 days and 66.2% had no signs of defect in circulation.

**Figure (1):** shows that 49% of neonatal nurses had good knowledge while 32% had average knowledge and 19% had poor knowledge regarding care for pulse oximeter.

**Figure (2):** shows that, more than half (54%) of neonatal nurses were competent while 46% was incompetent at care for pulse oximeter.

**Table (4):** Distribution of the neonatal nurses according their practice regarding to care for pulse oximeter (No=80)

 Table (5): illustrates positive correlation

 between total knowledge of the neonatal nurses

and their total practice regarding care of pulse oximeter.

<b>Table (1):</b> Distribution of the Studied Nurses according to their Characteristics ( $N=60$ ).
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Characteristics	No	%
Age		
20 < 30	45	56.3
30 < 40	24	30
40 or more	11	13.7
Mean±S.D 28.94±5.27		
Qualification		
Diplome	25	31.3
Technical Health Institutes	36	45
Bachelor	19	23.7
Years of Experience		
< 5 years	35	34.8
5 - 10 years	19	23.8
10 - 15 years	13	16.2
>15 years	13	16.2
Mean±S.D 9.88±4.13		

Table (2): Distribution of the Neonates acco	ording to their Characteristic	s (N=60)
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Neonatal Characteristics	No	%
Sex		
Male	33	41.3
Female	47	58.8
Age		
1 < 10days	41	51.3
10 < 20days	17	21.3
20 < 30days	12	15
30 days or more	10	12.5
Mean±S.D 13.71 ±3.96		
Weight at delivery		
less than 1 k.g	11	13.8
1 < 1.5 k.g	13	16.2
1.5 < 2  k.g	36	45
more than 2k.g	20	25
Mean±S.D 1.84±0.72		
Gestational Age		
30 < 33 weeks	28	35
33 < 35 weeks	21	26.3
35 < 38 weeks	20	25
Other	11	13.8
Mean±S.D 35.84±4.03		
Actual Weight		
less than 1k.g	11	13.8
1 < 1.5  k.g	16	20
1.5 < 2  k.g	29	36.2
more than 2k.g	24	30
Mean±S.D 1.99±0.81		
Weight according to Gestational age		
Large	16	20
Small	18	22.5
Appropriate	46	57.5

Table (3): Distribution of the Neonates According to their Health status	(n=80).	
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Health status of Neonate	No	%
Diagnosis		
Respiratory distress	34	42.5
Jaundice	22	27.5
Premature	12	15
congenital cardiac disease	5	6.2
Sepsis	7	8.8
Duration of residence at NICU		
1 < 10days	50	62.4
10 < 20days	15	18.8
20 < 30days	8	10
30 days or more	7	8.8
Mean±S.D 7.93±5.84		
Duration of contact with the probe		
1 < 10days	53	66.3
10 < 20days	12	15
20 < 30days	10	12.5
30days or more	5	6.2
Mean±S.D 7.66±4.19		
Signs of defect in circulation		
Yes	27	33.8
No	53	66.2



Figure (1): Distribution of the neonatal nurses according their total knowledge score (No= 80).

pulse oximeter ( $NO = 80$ ).				
Steps	Competent		Incompeten	t
	No	%	No	%
Review health record for any health problem	37	46.3	43	53.7
Perform hand washing & Identify the neonates	63	78.8	17	21.2
Select an adequate site for application of the sensor	39	48.7	41	51.3
Use appropriate size of pulse oximeter	64	80	16	20
Prepare the monitoring site	65	81.2	15	18.2
Cleans the selected area with the alcohol wipe or disposable	39	8.8	41	51.2
cleaning cloth				
Attach probe securely to skin	58	72.5	22	27.5
Make sure that the emitting sensor and the light receiving sensor	61	76.3	19	23.7
are aligned apposite each other				
Set alarm of pulse oximeter	38	47.5	42	52.5
Check manufactures alarm limits for high and low pulse rate		62.5	30	37.5
sittings				
Check oxygen saturation at regular interval	39	48.8	41	51.2
Check for skin irritation or signs of pressure (every 2 hours or 4		38.8	49	61.2
hours for spring tension)				
Clean none disposable sensor according to the manufacture's	34	42.5	46	57.5
direction				
Perform hand washing and documentation	34	42.5	46	57.5
Total	43	54	37	46

Table (4): Distribution of the neonatal nurses according their practice regarding to care for se oximeter (No=80).



Figure (2): Distribution of the neonatal nurses according their total practice score (No= 80).

 Table (5): Correlation between total knowledge of the neonatal nurses and their total practice (N=80).

Item	Total Practice			
	Calculated r	P value	Tabulated r	
Total Knowledge	0.620**	0.01	0.283	

# Discussion

The human eye is not very trustworthy when it comes to detecting hypoxemia. The traditional sign of circumoral cyanosis is a late indicator of decreased oxygenation and is subjective, depending on the experience and eyesight of the observer, as well as the ambient lighting and the patient's skin pigmentation. Pulse oximetry is an objective measurement of oxygenation and is simple, reliable, and accurate when used appropriately. Pulse oximetry is a useful tool in the evaluation of a patient's oxygenation status and may be used routinely in many areas of clinical practice (Barker, 2015).

Through pulse oximetry, use of oxygenation can be monitored easily and noninvasivelv. Advances microprocessor in technology, along with improvements in lightemitting diodes and photoelectric sensors, have improved the accuracy and reliability of pulse oximetry. However, because of the inherent limitations of noninvasive technology, it is important to know how to interpret the information received from oximetry and also to understand the pitfalls through using these devices (Davidson and Hosie, 2010).

Pulse oximetry has gained wide clinical acceptance in many areas. Small portable systems are available for use virtually anywhere. Almost every neonate that has oxygen or mechanical ventilation requirements would benefit from clinical monitoring of their oxygen status by pulse oximetry (Hill and Stoneham, 2011).

The current study aimed to assess the factors contributing to neonatal nurses pitfalls during applies of pulse oximeter in neonatal intensive care unit.

The current study clarified that, more than half of the studied group were 20-30 years old and were living at village, about three quarters of them were married, more than one third of them studied at technical health institute with experience less than 5 years and more than half of the studied sample attended training courses.

This was in accordance with (Hakemi and Bender, 2014) who conducted an assessment of neonatal nurses understanding of pulse oximetry, advantages, and limitations, showed that about three quarters of the studied sample were married and more than half of them were with mean age 25 years old.

The current work showed that more than half of the neonates were females, half of them were 1-10 days old, the weight of less than half of them was 1.5-2k.g at the time of delivery, meanwhile the actual weight of more than one third of them was 1.5-2k.g according to gestational age.

This was not in accordance with (Walsh, et al., 2015), who studied "Oxygen delivery through nasal cannulae to preterm infants ", found that more than half of the studied group were males and were weighing 2.5 - 3.5kg at the time of delivery.

As regards the health status of the neonates, the current study mentioned that, more than one third of them were diagnosed with respiratory distress, two thirds of them spent (1-10) days at NICU and were connected to pulse oximeter with no signs of circulatory defect (table 3). This was supported by (Anderson, et al., 2014), who made a study about "Retinopathy and pulse oximetry ", clarified that one third of the neonates were diagnosed with respiratory distress and spent (3-10) days at NICU.

Respiratory distress is a common emergency in neonatal period. Prolonged distress leads to hypoxaemia, hypercarbia and acidosis. These changes lead to pulmonary vasoconstriction and persistence of foetal circulation with right to left shunting which leads to multi system organ dysfunction. Monitoring oxygen saturation is important to the newborns receiving supplemental oxygen so to decrease the incidence of exposure to hyperoxemia and the risk of potential deleterious effects of radical oxygen species (Mathai, et al., 2017).

The pulse oximeter remains a valuable tool in the care of intensive care patients. Pulse oximetry arterial oxygen saturation (SpO2) has become the fifth vital sign in the examination of every newborn and infant with respiratory system presentation (Castillo, et al., 2013).

As regards the knowledge of the studied group about the concept of the pulse oximeter, the current study mentioned that, about three quarters of them selected the pulse oximeter as a tool used for detecting oxygen level at tissue, less than half of them selected (fingers of the hand, earlobe and toes) as sites of placing the pulse oximeter on the body of neonates, more than one third of them selected the pulse oximeter as a tool used for detecting oxygen level at tissue and pulse assessment and half of them selected (easy to transport, easy to use and clean, not invasive and not annoying) as advantages of the pulse oximeter.

This was in agreement with (Hutton and Clutton-Brock, 2013), who conducted a study about the benefits and pitfalls of pulse oximetry, found that, more than one third of the studied group used the pulse oximeter as a tool for detecting oxygen level at tissues and pulse assessment, half of them clarified that the advantages of using pulse oximeter were (easy to transport and use) and the sites used for placing it were (fingers of the hand and toes).

Regarding dealing with pulse oximeter, the current work showed that, the entire studied sample used the device before, more than two thirds of them selected (improper position) as a cause of wrong indicator for the pulse oximeter and selected (decrease oxygen saturation) as a cause of alarm of pulse oximeter. Meanwhile less than half of them selected (send a steady pulse prompt) as an indicator for working well and selected (defect of circulation) as a cause of the inability of the device to evaluate oxygen saturation (table 5). This was not in agreement with (Luis, et al., 2014), who made a study about "neonatal nursing staff 's knowledge of pulse oximetry", showed that, three quarters of the studied group used the device before and about one third of them identified that (excessive movement) as a cause of wrong indicator of the device.

The current study showed that, more than three quarters of the studied group knew the complications of using the pulse oximeter, more than half of them selected (skin ulcers) as a complication of using it and didn't approve that thickness of the skin and size of pulse oximeter would affect the accuracy of the device and less than half of them selected (continuous change site of it, daily clean at site of pulse oximeter and decrease friction of skin) as ways for prevention.

This was in agreement with the study of (Fanconi, 2009), which was about pulse oximetry for hypoxemia: a warning to users ", showed that, about three quarters of the studied sample knew the complications of using the pulse oximeter and less than half of them selected (continuous changing of the site of pulse oximeter and daily cleaning of it) as ways of prevention.

As regards care for pulse oximeter the current study, clarified that, less than half of the studied sample had good knowledge, about one third of them had average knowledge and less than one quarter of them had poor knowledge. The study of **(Hakemi and Bender, 2014)**, which was about an assessment of neonatal nurses understanding of pulse oximetry, advantages, and limitations, showed that, about one third of the studied sample had an average knowledge.

The current work, showed that, the practice of more than half of the studied group were competent regarding care for pulse oximeter. This was supported by (Louw, et al., 2016), who conducted a study about accuracy of pulse oximetry in the neonatal intensive care unit, showed that half of the studied group were

competent regarding caring practices of the pulse oximeter

Regarding the relation between characteristics of the neonatal nurses and their practice regarding care of pulse oximeter, the current study showed that, there was statistically significant difference between the qualification of the neonatal nurses and their total practice with (p value =0.005), and there was high statistically significant difference between the training course of the neonatal nurses and their total knowledge.

Also the current study clarified that there was statistically significant difference between (the age, residence and years of experience) of the neonatal nurses and their total knowledge regarding care of pulse oximeter, and there was high statistically significant difference between the qualification of the neonatal nurses and their total knowledge.

This was in accordance with (Hakemi and Bender, 2014) who conducted an assessment of neonatal nurses understanding of pulse oximetry, advantages, and limitations, showed that there was high statistically significant difference between(the age and years of experience) of the neonatal nurses and their total knowledge regarding care of pulse oximeter.

The current work illustrated that there was a positive correlation between total knowledge of the neonatal nurses and their total practice regarding care of pulse oximeter. This was in agreement with (Luis, et al., 2014), who made a study about "neonatal nursing staff's knowledge of pulse oximetry", showed that there was a direct correlation between neonatal nurses knowledge and their practice with high statistically significant difference between them with (p value =0.001).

The pulse oximeter remains a valuable tool in the care of intensive care pediatric patients. Pulse oximetry arterial oxygen saturation (SpO2) has become the fifth vital sign in the examination of every newborn and infant, so further studies are recommended to study the neonatal nurses pitfalls of applying of pulse oximeter in neonatal intensive care unit (knowledge and practices).

# Conclusion

Based on results of the current study, it concluded that, factors contribute to neonatal nurse's pitfalls during application of pulse oximeter in neonatal intensive care unit the lack of studied nurse's knowledge about regarding care of pulse oximeter as well as lack of practice (incompetent) contributes to pitfulls.

# Recommendations

In	the light	of	the	finding	gs of	the
current	study,		th	e	follov	ving
recommendations are suggested:						

- An orientation program should be prepared to help newly appointed nurses to acquire, develop their knowledge and practice to deal with neonatal nurse's care during application of pulse oximetry in neonatal intensive care unit.
- Developing continuous educational programs including evidence based guidelines based on need's assessment for nurses to improve their performance and quality of care regarding care of neonatal during application of pals oximeter in neonatal intensive care unit.
- Developing educational program self-learning packaging (SLP) for neonatal nurses' about care during application of pulse oximetern in neonatal intensive care unit.
- Developing and availability a simplified and comprehensive educational, guidelines and booklet about nursing management of neonatal nurse's during application of pulse oximeter in neonatal intensive care unit

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