



Analysis of the Relationship Between Nurses' Knowledge of Infusion Therapy with the Incidence of Phlebitis and Patient Comfort

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Article Info

Article history:

Received 23 January 2024

Received in revised form 13

March 2024

Accepted 20 March 2024

Keywords:

Knowledge

Infusion Therapy

Phlebitis

Comfort

Abstract

Phlebitis is a complication of infusion therapy. The aspect that affects the incidence of phlebitis and comfort is the nurse's skill of infusion therapy in inserting needles in the right location, right fluid, and right standard operating procedure. Nurses' skills in the infusion insertion were influenced mainly by knowledge. The research objective was to determine the relationship the nurse's knowledge of infusion therapy with the incidence of phlebitis and comfort. This type of research-correlational analytic with cross-sectional approach. The number of samples was 60 nurses who worked in inpatients ward and 60 patients who received infusion by a nurse. The results found that 51.7% of respondents had poor knowledge, the incidence of phlebitis was 46%.7, and as much as 48.3% of respondents felt comfortable with the insertion of an infusion done by the nurse. The results of further analysis showed that there is a significant relationship between knowledge of nurses about infusion therapy with incidence of phlebitis ($p = 0.000$), and there is a significant association between knowledge of the nurses and patients' comfort ($p = 0.000$). It was recommended for nurses to improve knowledge and skills so that the infusion complications and discomfort may be prevented.

Introduction

Infusion therapy is one of the procedures most often given to patients undergoing hospitalization as an intravenous (IV) therapy route, administration of drugs, fluids, and administration of blood products, or blood sampling (Alexander et al., 2010). Therefore, this therapy is generally given to patients being treated in hospital, where these patients will have vascular access at several stages of treatment.

Currently, infusion is not only for inpatients, but can be given in home care settings. According to Dellinger et al. (2008) said that this therapy has developed from a measure that was considered extreme, which was only used in critical conditions, to a therapy that is used in almost 90% of hospitalized patients. The number of patients receiving infusion therapy is estimated at around 25 million patients per year in the UK, and they have had various forms of intravenous access devices installed during their treatment (Campbell, 1998). Meanwhile, in Pujasari & Sumarwati (2002) estimates that around 80% of patients admitted to hospital receive infusion therapy.

Along with the development of health technology, various vascular access devices have emerged that can meet the clinical needs of individual patients (Gabriel, 2008; Gabriel et al., 2005). The emergence of a variety of venous access devices, complex service systems, and the provision of very specific treatment modalities to various patient conditions, has major

implications for nursing practice. Nurses are required to have high clinical knowledge and competence so that the provision of infusion therapy will be more guaranteed (Alexander et al., 2010).

The role of nurses in infusion therapy, especially in carrying out delegation tasks, can act as care givers, where they must have knowledge of the field of nursing practice related to assessment, planning, implementation and evaluation in infusion therapy care. According to Gayatri & Handiyani (2007) said that the administration of infusion therapy is instructed by the doctor but the nurse is responsible for administering and maintaining the therapy to the patient. Meanwhile, Scales & Fernandes (2009) explains that the role of nurses in infusion therapy is not only for administering medical agents, but more broadly includes installing IV access devices, maintenance, monitoring, and most importantly, preventing infection.

Infusion therapy is an invasive procedure, therefore nurses must be skilled enough when installing an IV. When a nurse is given the task of providing infusion therapy, the only skill required is to perform a venipuncture correctly and skillfully. Nurses must also have a commitment to providing infusion therapy that is safe, cost-effective, and provides quality infusion care (Alexander et al., 2010).

Infusion therapy provides many benefits for most patients. However, due to improper installation procedures, wrong position, and failure to penetrate the vein, it can cause discomfort to the patient. Comfort is a condition of being free from distress or discomfort as a result of curative strategies from the medical side. Increasing patient comfort is a nursing goal that must be maintained, and in many cases should be able to provide improvement compared to the previous status or condition. Comfort results from physical interventions, one of which is the provision of infusion therapy. Physical comfort is one of many strategies for improving health and secondary to other goals, for example preventing complications (Kumanyika et al., 2008).

Apart from providing a response of discomfort, infusion therapy can also cause complications, both local and systemic. Local complications consist of phlebitis, infiltration, and extravasation; while systemic complications include air embolism, fluid overload, allergic reactions and sepsis (Gabriel, 2008).

Phlebitis is a complication that often occurs in patients receiving infusion therapy. Phlebitis is inflammation of the vein lining caused by mechanical, chemical factors or poor aseptic techniques. Phlebitis is characterized by redness at the puncture site, pain, swelling, hardening or induration, hardening along the vein, and heat (Alexander et al., 2010)

Phlebitis is caused by many factors. The most frequent causes of phlebitis are inappropriate catheter size and vein selection, fluid type (pH and osmolality), lack of aseptic technique during installation, and long cannulation times (Gabriel, 2008 ; Alexander et al., 2010).

The consequences of phlebitis complications in patients are increasing the length of stay in hospital or length of stay (LOS), increasing the length of therapy, and increasing the responsibility of nurses, and can put patients at risk of other health problems (Alexander et al., 2010). As the results of research conducted by Campbell (1998) stated that through the chi square test there was a significant relationship between phlebitis complications and length of stay, which increased patient costs.

The incidence of phlebitis is an indicator of the quality of nursing care obtained from comparing the number of phlebitis incidents with the number of patients receiving infusion therapy (Depkes, 2002; INFEKSI, 2008). Finlay (2008) recommends that the level of phlebitis that should be reported is level 2 or more. Meanwhile, the incidence rate recommended by the Infusion Nurses Society (INS) is 5% or less. And if the incidence of phlebitis is found to be

more than 5%, then the data must be reanalyzed regarding the degree of phlebitis and possible causes to develop a plan to improve nurse performance (Alexander et al., 2010).

Based on a literature review, it states that 5% to 70% of patients who receive intravenous therapy experience phlebitis (Dahlan, 2006; Campbell, 1998). Meanwhile, a study conducted by Campbell (1998) found that the incidence of phlebitis ranged from 20 to 80%.

There are no definite figures for the incidence of phlebitis in Indonesia, this is probably because research related to the incidence of phlebitis and its publications are still rare. Research on phlebitis published in Indonesia includes research conducted by which examined the incidence of phlebitis in a kindergarten hospital. II Udayana found that the incidence of phlebitis was 33.3%. Meanwhile, who conducted research at Husada Utama Hospital in Surabaya, obtained data on the incidence of phlebitis which was quite high, namely 56.25% because in this study level I phlebitis had been declared phlebitis.

The incidence of phlebitis increases with the length of cannulation or installation time. As stated by Gabriel et al. (2005) who said that the incidence of phlebitis increased from 12% to 34% in the first 24 hours after the first day of insertion, followed by an increase in the rate from 35% to 65% after 48 hours of catheter installation. . For this reason, moving the installation location must be done before phlebitis occurs.

Finlay (2008) recommends that peripheral cannulas should be replaced every 72 hours and as soon as possible if contamination is suspected, there are complications, or when therapy has been stopped (Alexander et al., 2010). Meanwhile research conducted by Danski et al. (2015), proves that planned removal of the puncture site every 48 hours significantly reduces the incidence of infusion phlebitis. This is in line with the results of research by Pujasari & Sumarwati (2002) which found that the incidence of phlebitis ranged from one day to three days, with the average incidence being two days. This shows that the time of occurrence of phlebitis can occur before 72 hours. Therefore, it is necessary to consider moving the correct installation location so that the incidence of phlebitis can be reduced.

The rapid development of evidence-based infusion therapy, especially the development of vascular access devices and procedures for administering drugs or fluids via intravenous access, requires nurses to master the theory of infusion therapy management. In other words, nurses must have high knowledge, especially about therapeutic procedures for administering drugs or fluids, reading doses, side effects, personal protection and contraindications.

The involvement of nurses in providing infusion therapy has implications for responsibility in preventing complications of phlebitis and discomfort in patients, especially in terms of skills in installing cannulas aseptically and correctly, thereby reducing the risk of installation failure, in addition to having to master the treatment regimen. Therefore, nurses must have clinical competence in all aspects of infusion therapy. Provides standards regarding the theory and practice of infusion therapy that must be mastered by nurses including: legal and professional aspects of infusion therapy; anatomy and physiology of vascular access; pharmacology of intravenous fluids and medications; local and systemic complications; principles of infection control; use of infusion therapy equipment; infusion procedures; infusion treatments; prevention of complications; management of complications; and specific skills in inserting vascular access devices in special patients, for example neonates, children, and oncology patients.

With this knowledge, nurses are expected to have critical thinking in making decisions regarding their actions. For example, before a nurse carries out an infusion procedure, the first skill the nurse must have is being able to determine the size of the cannula and the location of the vein to be inserted based on the therapy to be given. Considerations that influence these choices include, among others, the type of solution to be given, the expected length of intravenous therapy, and the patient's general condition.

Knowledge or cognitive aspects are a very important domain for the formation of a person's behavior, where behavior is the totality of a person's understanding and activities which is the joint result of internal and external factors. As research conducted by Heeren et al. (2016) found that behavior that is based on knowledge, awareness and positive attitudes, then this behavior will be long lasting. Meanwhile, behavior that is not based on knowledge and awareness will not last long. Based on this statement, nurses who have high knowledge about the management of infusion therapy should be able to display the behavior to follow the correct infusion procedure so as to reduce the risk of complications and discomfort to patients due to incorrect installation procedures.

Apart from knowledge about management, the most important thing that nurses must have is knowledge about patient safety. This knowledge relates to how to prevent harm to patients during treatment and care. One of the patient safety measures in the management of infusion therapy is carrying out the action of installing an infusion based on the established Standard Operating Procedures (SOP). The occurrence of complications of phlebitis, swelling and trauma due to repeated infusions is the result of infusions that do not prioritize patient safety. This causes the patient to be harmed, because the patient's hospitalization time will increase.

The results of a preliminary study conducted by the author in January 2011 showed that the incidence of phlebitis at RSU Royal Prima Marelan was still above the INS standard, namely 6.73%. The phlebitis incident reported was phlebitis at an advanced stage. According to the results of an interview with one of the room heads, data was obtained that the reported incidents of phlebitis were cases of infusion jams with various conditions, for example accompanied by swelling, heat, and the patient had asked to be removed immediately because he felt uncomfortable. It was further stated that in fact the hospital had issued a rule to replace the infusion every 3 days, but in the room it had not been carried out routinely by the nurses on the grounds that there had been no phlebitis complications and the infusion flow was still good, the infusion replacement was actually carried out if phlebitis had occurred or the infusion flow was blocked. .

Based on the results of interviews with 5 nurses about complications of phlebitis, they said they did not know much about phlebitis. What they know is that phlebitis is swelling in the insertion area accompanied by an infusion that cannot flow. They said they did not know the exact degree of phlebitis, because what is usually done in the room is that if the IV is stuck, it must be replaced immediately, and this is reported as a phlebitis incident. Apart from that, they also said that when installing an infusion catheter it was only based on feeling without knowledge of the distance from the joint and choosing the right vein, so what they did was just try not to fail in inserting the vein, without paying attention to the risks that might arise.

Based on the author's observations, a description of the implementation of infusion installation carried out by nurses in the room did not comply with standard operational procedures (SOP). For example, not using gloves, inadequate skin disinfection (sometimes touching skin that has been disinfected again), covering the puncture area with non-aseptic technique, and sometimes covering the insertion site only with plaster.

Currently Royal Prima Marelan General Hospital is making many improvements, especially in an effort to improve the quality of nursing services. One way is to improve the performance of nurses in providing services to patients by carrying out all actions according to standards. This is aimed at achieving patient safety, including patient comfort.

Until now, no research has been conducted on infusion therapy and the incidence of phlebitis, especially related to nurses' knowledge about infusion therapy. Seeing the high incidence of phlebitis, and the importance of nurses in preventing the incidence of phlebitis and increasing patient comfort, prompted the author to conduct research on analyzing nurses' knowledge about infusion (intravenous) therapy with the incidence of phlebitis and patient comfort at RSU Royal

Prima Marelan. This research is the first research as a basis for conducting further research . This study aims to analyze the relationship between nurses' knowledge about infusion therapy with the incidence of phlebitis and patient comfort. The independent variable is the nurse's knowledge about infusion therapy, while the dependent variable is the incidence of phlebitis and patient comfort.

Methods

This research is quantitative research with an *analytic-correlational design* using a *cross-sectional approach*, namely research that aims to find the relationship between independent/free variables and dependent/bound variables by carrying out measurements or research at one time (Sastroasmoro, 2022). According to Franzese & Hays (2007), the main advantages of a *cross-sectional research design* are that it is practical, economical and easy to implement. Meanwhile, the weakness is that because this research is only carried out at one time, it often provides results that do not reflect actual conditions because humans are dynamic and can change at any time. Researchers used a *cross-sectional approach* because this research aims to identify whether there is a relationship between the independent variable and the dependent variable in one measurement . This research was conducted at RSU Royal Prima Marelan which is located on Jl. Marelan Psr. 3 West No.187, Rengas Island, District. Medan Marelan, Medan City, North Sumatra 20255. The sample used in this study consisted of two samples, namely a sample of implementing nurses and patients undergoing infusion therapy who met the inclusion criteria.

Result and Discussion

Results of Data Analysis of Characteristics of Implementing Nurses

Characteristics of implementing nurses based on variables of age, gender, length of work, and employment status. The age categorization of nurses means *the mean value* is the age group < 25.6 years, and the age group > 25.6 years. Likewise, to divide the categories of length of work for nurses, the *mean value is also used* , namely the group of nurses who have worked < 2.4 years, and the group of nurses who have worked > 2.4 years. The results of the analysis are presented in table 1.

Table 1. Distribution of characteristics of executive nurses in adult inpatient rooms at RSU Royal Prima Marelan in November 2023 (n = 60)

Variable	Frequency	Percentage
Age:		
< 25.6 years	34	56.7
> 25.6 years	26	43.3
Type Sex:		
Man	16	26.7
Woman	44	73.3
Level education:		
D III	28	46.7
S1/Nursing	32	53.3
Long Work:		
< 2.4 year	29	48.3
> 2.4 year	31	51.7

Table 1 shows that the number of nurses working in the adult inpatient ward at RSU Royal Prima Marelan based on age group is 56.7 % of respondents belonged to the lower age group 25.6 years, while based on gender, 73.3 % of respondents were women. Based on education level, 53.3 % of respondents had a bachelor's degree/nurse education and with a length of work of 51.7 % of respondents had a length of work of more than 2.4 years .

Results of Patient Characteristics Data Analysis

The characteristics of patients who have an IV installed are presented based on the variables age, gender, type of disease, area of the IV and size of the IV. The division of age groups is based on *the mean* , namely the age group < 50 . 7 years, and age group > 50.7 years. The results of the analysis are presented in table 2.

Table 2. Distribution of characteristics of patients who were given an IV in the adult inpatient room at RSU Royal Prima Marelan November 2023 (n = 60)

Variable	Frequency	Per centage _
Age:		
< 50 . 7 years	29	48.3
> 50 . 7 years	31	51.7
Type Sex:		
Man	18	30
Woman	42	70
History Disease:		
Surgery	21	35
Non Surgery	39	65
Areas installation infusion :		
Wrist _ hand	25	41.7
Back _ hand	35	58.3
Size infusion :		
20	39	65
22	21	35

Based on table 2, it is known that 51.7 % of the respondents who were given an IV in the adult inpatient room at RSU Royal Prima Marelan were in the age group above 50.7 years, and 70 % were female. Based on disease history, 6.5 % of respondents had a history of non-surgical disease, and based on the location of installation, 58.3 % of respondents had IVs installed in the hand bed area . Meanwhile, based on the size of the infusion, 65 % of respondents had a 20 gauge infusion installed .

Results of Data Analysis on Nurses' Knowledge Level

The results of data analysis on the level of nurses' knowledge about infusion therapy are presented in the form of a frequency distribution of categorical data. The categorical data presented consists of two categories, namely good knowledge group and group knowledge is not good. The good knowledge group is the result of combining the high and medium knowledge groups because the high knowledge group has a small number of subjects, namely 3 (three) respondents so it is combined into a good knowledge group. Based on the research results, the distribution of nurses' level of knowledge about infusion therapy can be seen in table 3.

Table 3. Distribution of the level of knowledge of implementing nurses about infusion therapy

In adult inpatient ward Royal Prima Marelan General Hospital November 2023 (n = 60)

Level Knowledge	Frequency	Percentage
Good	29	48.3
No Good	31	51.7
Total	60	100.0

Based on table 3, it is known that the level of knowledge of nurses regarding infusion therapy is 5 1.7 % of respondents have poor knowledge. This result is almost comparable to respondents who have good knowledge.

Phlebitis Incidence Data Analysis

Data on the incidence of *phlebitis* was obtained through observation of the infusion area using an observation sheet for signs of *phlebitis* . It is said that *phlebitis* occurs if at least one sign of *phlebitis is found* , namely redness at the puncture area, pain, swelling, hardening along the cannula or along the vein, and *pyrexia* or fever. Observations were made on the third day of installation. The results of data analysis on the incidence of *phlebitis* are presented in table 4.

Table 4. Distribution of *phlebitis incidence* in adult inpatient rooms at RSU Royal Prima Marelan November 2023 (n = 60)

Incident <i>Phlebitis</i>	Frequency	Percentage
No <i>Phlebitis</i>	3 2	53.3
<i>Phlebitis</i>	2 8	46.7
Total	6 0	100.0

Based on table 4, it is known that the incidence of *phlebitis* in patients who were given an IV drip by the implementing nurse in the adult inpatient room at RSU Royal Prima Medan was 4 6.7 %.

Results of Patient Comfort Data Analysis

The results of the comfort data analysis of patients who were given an IV on the third day based on the scores obtained from the comfort instrument based on the *Kolcaba Comfort Behavior Checklist* , are presented in the form of categorical data. Categorical data is presented to determine the frequency of patient comfort levels. In determining the comfort level, because the data is normally distributed, the mean value is used as *the cut of point* for comfort level, where is the score \geq mean is declared comfortable, and if the score $<$ mean is declared uncomfortable. So if the score is ≥ 83.9 it is said to be comfortable and if the score is < 83.9 it is said to be uncomfortable. The frequency distribution of patient comfort levels can be seen in table 5 .

Table 5. Distribution of comfort level of patients who were installed with an IV on the third day in the adult inpatient room at RSU Royal Prima Marelan November 2023 (n = 60)

Level Comfort	Frequency	Pers entage
Comfortable	29	48.3
No comfortable	3 1	51.7
Total	6 0	100.0

Based on table 5, it is known that as many as 5 1.7 % of respondents felt uncomfortable with the IV installation carried out by the implementing nurse on the third day of installation.

Analysis of the Relationship between Nurse Characteristics and Knowledge

Nurse characteristics include age, education, and length of service. The results of the analysis of the relationship between age, education and length of work of nurses with knowledge carried out using the *Chi square* test can be seen in table 6.

Table 6. Analysis of the relationship between nurse characteristics and level of knowledge at RSU Royal Prima Marelan November 2023 (n = 60)

Variable	Level Knowledge				Total		OR (95% CI)	p value
	Good		No Good					
	n	%	n	%	n	%		

Age:	19	55.9	15	44.1	34	100	2,027	0.281
< 25.6 years	10	38.5	16	61.5	26	100	0.71 – 5.73	
> 25.6 years								
Education:	9	32.1	19	67.9	28	100	0.284	0.037
DIII	20	62.5	12	37.5	32	100	0.09 - 0.82	
S1								
Long Work:	13	44.8	16	55.2	29	100	0.762	0.789
< 2.4 years	16	51.6	15	48.4	31	100	0.27 – 2.10	
> 2.4 years								

The results of the analysis of the relationship between nurse characteristics and level of knowledge showed that as many as 61.5 % of nurses from the age group > 25.6 years had poor knowledge about infusion therapy. The statistical test results obtained a *p value* = 0.281 , so it can be concluded that there is no relationship between age and knowledge.

The results of the analysis between the level of nurse education and knowledge showed that 67.9 % of nurses with DIII education had poor knowledge about infusion therapy. The statistical test results obtained a *p value* = 0.037 , so it can be concluded that there is a relationship between the level of education and knowledge. From the analysis, the OR value is obtained = 0.28 , meaning that a nurse with a Bachelor's degree has a 0.28 times chance of having good knowledge compared to a nurse with a DIII education.

The results of the analysis between the length of work of nurses and the level of knowledge showed that 55.2 % of nurses who had worked less than 2.4 years had poor knowledge. The statistical test results obtained a *p value* = 0.789 , so it can be concluded that there is no relationship between length of work and nurses' knowledge about infusion therapy.

Analysis of the Relationship between Patient Characteristics and *Phlebitis* Incidence

Patient characteristics include age, gender, medical history, insertion area, catheter size and fluid type. The results of the analysis of the relationship between age, gender, history of disease, area of installation and size of infusion with the incidence of *phlebitis* carried out using the *Chi square* test can be seen in table 7.

Table 7. Analysis of the relationship between patient characteristics and the incidence of *phlebitis* at RSU Royal Prima Marelan November 2023 (n = 60)

Incident <i>Phlebitis</i>								
El variable	No <i>Phlebitis</i>		<i>Phlebitis</i>		Total		OR (95% CI)	<i>p value</i>
	n	%	n	%	n	%		
Age:								
< 50.7 years	13	44.8	16	55.2	29	100	0.513	0.308
> 50.7 year	19	61.3	12	38.7	31	100	0.18 – 1.43	–
Type Sex:								
Man	10	55.6	8	44.4	18	100	1.136	1,000
Woman	22	52.4	20	47.6	42	100	0.37 - 3.44	
Disease History:								
Surgery	10	47.6	11	52.4	21	100	0.702	0.704
Non Surgery	22	56.4	17	43.6	39	100	0.242 – 2.03	
Installation area :								
Wrist	14	56.0	11	44.0	25	100	1,202	0.930
Back of the hand	18	51.4	17	48.6	35	100	0.42 – 3.37	

Size Infusion	27	69.2	12	30.8	39	100	7,200	0.002
20	5	23.8	16	76.2	21	100	2.14 - 24.21	-
22								

The results of the analysis of the relationship between patient characteristics and the incidence of *phlebitis* show that the variable associated with the incidence of *phlebitis* is the infusion size variable with $p\text{ value} = 0.002$. Based on the OR value, it was found to be 7.20, which means that patients who used an infusion size of 22 had a 7.20 times chance of developing *phlebitis* compared to patients who used an infusion size of 20. Temporary The variables age, gender, history of disease and installation area were not related to the incidence of *phlebitis* ($p > 0.05$).

Analysis of the Relationship between Nurses' Level of Knowledge about Infusion Therapy and the Incident of *Phlebitis*

The results of the bivariate analysis in this study illustrate the relationship between the level of nurses' knowledge about infusion therapy and the incidence of *phlebitis*. The analysis can be seen in table 8.

Table 8. The relationship between the level of nurses' knowledge about infusion therapy and the incidence of *phlebitis* in the adult inpatient ward at RSU Royal Prima Marelan November 2023 (n = 60)

Level Knowledge	Occurrence of <i>Phlebitis</i>						OR (95% CI)	p value
	No <i>Phlebitis</i>		<i>Phlebitis</i>		Total			
	n	%	n	%	n	%		
Good	23	79.3	6	20.7	29	100	9,370	0,000
No Good	9	29	22	71	31	100	2.8 – 30.7	
Amount	32	53.3	28	46.7	60	100		

The results of the analysis of the relationship between the level of nurses' knowledge about infusion therapy and the incidence of *phlebitis* showed that 71% of patients who received infusions by nurses who had poor knowledge experienced *phlebitis*. The statistical test results obtained a $p\text{ value} = 0.000$, so it can be concluded that the hypothesis failed to be rejected, in other words there is a significant relationship between the level of nurses' knowledge about infusion therapy and the incidence of *phlebitis*. The results of further analysis obtained an OR = 9.37, meaning that nurses who had poor knowledge were 9.37 times more likely to cause *phlebitis* than nurses who had good knowledge.

Analysis of the Relationship between Nurses' Level of Knowledge about Infusion Therapy and Patient Comfort

The relationship between nurses' level of knowledge about infusion therapy and patient comfort can be seen in table 9.

Table 9. Relationship between nurses' level of knowledge about infusion therapy and patient comfort in the adult inpatient room Royal Prima Marelan General Hospital November 2023 (n = 60)

Level Knowledge	Comfort				Total	OR (95% CI)	p value	
	Comfortable		No Comfortable					
	n	%	n	%				
Good	22	75.9	7	24.1	29	100	10.776	0,000

No Good	7	22.6	24	77.4	31	100	3.2 – 35.6	
Amount	29	48.3	31	51.7	60	100		

The results of the analysis of the relationship between the level of nurses' knowledge about infusion therapy and patient comfort showed that 77.4 % of patients who were given an IV by nurses who had poor knowledge about infusion therapy experienced discomfort. The statistical test results obtained a $p\text{ value} = 0.000$, so it can be concluded that the hypothesis failed to be rejected, in other words there is a significant relationship between the level of nurses' knowledge about infusion therapy and patient comfort. The results of the analysis also show that the value of $OR = 10.7$, meaning that nurses who have poor knowledge have a chance of 10.7 times caused discomfort in patients who were placed on an IV on the third day.

Multivariate Analysis Results

The multivariate analysis used in this study was multiple logistic regression. The purpose of using this analysis is to validly estimate the relationship between a dependent variable and an independent variable. The dependent variables are the incidence of *phlebitis* and patient comfort, while the independent variables in this study are the level of knowledge, education level of nurses, length of work of nurses, age of patient, gender of patient, history of illness, area of infusion installation and size of infusion. The stages of multivariate analysis include selecting multivariate candidate variables, model building, interaction analysis, assessing *confounding variables* and preparing the final model. The following presentation will focus on constructing the final model from the multivariate analysis.

Potential Factors *Confounding* the Relationship between Nurses' Knowledge about Infusion Therapy and the Incident of *Phlebitis*

Candidate Selection

Selecting independent variables that are predicted to be associated with the incidence of *phlebitis*. Each independent variable was subjected to bivariate analysis with the dependent variable, namely the incidence of *phlebitis* using a simple logistic regression test. The following are the results of the bivariate test for candidate variables and their p values, which can be seen in table 10.

Table 10. Bivariate test results for potential *confounding factors* in the relationship between nurses' knowledge about infusion therapy and the incidence of *phlebitis* in the inpatient room at RSU Royal Prima Marelan November 2023 (n = 60)

Variable	$p\text{ value}$
Nurse knowledge	0.000 *
Education_nurse	0.012 *
Length of work as a nurse	0.448 *
Age patient	0.204 *
Type sex patient	0.821 *
History of illness	0.516 *
Areas installation infusion	0.726 *
Infusion size	0.001 *

Remarks *: included in the multivariate candidate

Based on table 10, it can be seen that the $p\text{ value}$ of the variable is nurse knowledge ($p = 0.000$), nurse education level ($p = 0.012$), patient age ($p = 0.204$) and infusion size ($p = 0.001$). has a $p\text{ value} < 0.25$ so everything can be entered into multivariate modeling. However, because the aim of the research was to find out whether these eight variables were confounding factors in

the relationship between nurses' knowledge about infusion therapy and the incidence of *phlebitis*, the eight variables were included in the modeling.

Multivariate Modeling

Multivariate modeling uses a logistic regression test with the *Backward LR method*, all candidate variables are tested together. The model preparation of all variables can be seen in table 11.

Table 11. Model I (*full model*) multivariate analysis of potential *confounding factors* The relationship between knowledge and the incidence of *phlebitis* in the RSU Royal inpatient room Prima Marelan November 2023 (n = 60)

Variable	B	Wald	Sig.	OR	CI 95%	
					Min	Max
Knowledge	2.153	8,648	0.003	8,611	2,050	36.160
Education nurse	-0.534	0.526	0.468	0.586	0.139	2.479
Long Work nurse	-0.444	0.312	0.576	0.641	0.135	3,049
Patient's age	-1,300	2,906	0.088	0.273	0.061	1.215
Type sex patient	-0.121	0.017	0.897	0.886	0.142	5,516
History of illness	0.524	0.346	0.556	1,688	0.295	9,667
Installation area	-0.304	0.092	0.762	0.738	0.104	5,245
Size infusion s	2,334	5,831	0.016	10.321	1,552	68,637

Table 11 shows that the variable values included in the final modeling are variables that have a p value < 0.05. Variables that have a p value > 0.05 are removed from the model one by one, starting from the variable that has the highest p value. The variable that has the highest p value is the patient's gender variable (p = 0.897), followed by the installation area variable (p = 0.762), the length of work of the nurse (p = 0.576), disease history (p = 0.556), nurse education (p = 0.468) and patient age (p = 0.088).

After the variables of patient gender, installation area, length of work of the nurse, and history of illness were removed, the OR change in the knowledge variable did not exceed 10%, so these variables were still excluded.

However, for the nurse education variable after being removed from the modeling, there was a change in the OR for the knowledge variable of > 10% (OR = 20.4%), then the nurse education variable is reintroduced into the modeling. Then, when the patient age variable was removed, there was also a change in the OR of the knowledge variable > 10% (OR = 20.7%), so the patient age variable was also reintroduced into the modeling.

Next, after all the variables that have p value > 0.05 is excluded and the result is that the change in the OR of the knowledge variable is no more than 10%, so the final modeling results are in table 12.

Table 12. Final model: multivariate analysis of potential *confounding factors* regarding the relationship between knowledge and the incidence of *phlebitis* in the inpatient room Royal Prima Marelan General Hospital November 2023 (n = 60)

Variable	B	Wald	Sig.	OR	CI 95%	
					Min	Max
Knowledge	2.195	9,070	0.003	8,982	2,152	37,482
Nursing Education	-0.626	0.805	0.369	0.535	0.136	2.099
Patient Age	-1.386	3,593	0.058	0.250	0.060	1.048
Infusion Size	1.818	6,060	0.014	6.160	1.449	26.192

Based on the results of the final model depicted in table 12, it is known that the variables related to the incidence of *phlebitis* are nurse knowledge, nurse education, patient age and infusion size, where the knowledge variable is the variable that is most significantly associated with the incidence of *phlebitis* where the OR obtained is 8.98. Meanwhile, nurse education and patient age is a *confounding factor* in the relationship between nurses' knowledge about infusion therapy and the incidence of *phlebitis* because it has a p value > 0.05.

Nurses' Level of Knowledge about Infusion Therapy

The results of research on the level of nurses' knowledge about infusion therapy showed that as many as 51.7% of nurses had poor knowledge about infusion therapy. Based on these results, it can be seen that almost half of the number of nurses in the adult inpatient room at RSU Royal Prima Marelan were able to answer correctly, around 51.7%.

Based on the research results, it is known that implementing nurses' knowledge about infusion therapy is still low. This can be seen from the number of nurses who received scores that fell into the bad category. This means that most nurses are only able to answer questions about infusion therapy correctly around 50% (the knowledge category is not good if they get a score < 65). This can be seen in the distribution of respondents' answers to the questions asked. It turns out that several important questions that nurses need to know were answered correctly by a small number of nurses. Based on the knowledge categories used in Lourenco and Ohara's research, it is quite ideal because the knowledge that a practitioner must have must have a high standard, because it is related to competence. However, this also depends on which angle the researcher wants to highlight.

A nurse should ideally have a basic knowledge of various theories related to infusion therapy. This will influence their behavior, especially regarding principles relating to implementation protocols and implementation to prevent complications. Therefore, nurses must have in-depth knowledge of the principles of aseptic technique, stability, storage, labeling, interactions, dosage and calculations and appropriate equipment so as to provide infusion therapy safely to patients. Knowledge is an important aspect that a nurse must have because it can influence certain skills. A nurse who will install or administer infusion therapy must have the following knowledge: understanding, objectives and indications for infusion therapy; anatomy and physiology of vascular access; pharmacology of intravenous fluids and medications; local and systemic complications; principles of infection control; use of infusion therapy equipment; infusion procedures; infusion treatments; prevention of complications; and management of complications. This knowledge must be applied in behavior when nurses are installing and maintaining infusions. Many factors influence knowledge, including level of education, experience and age (Heeren et al., 2016; Arikunto, 2010). Education influences a person's ability to receive information, meaning that the higher the education, the more information they will receive so that the higher a person's education, the wider their knowledge will be.

Based on the research results, it was found that the majority (46.7%) of respondents had DIII nursing education. Furthermore, from the results it is known that the data on the level of knowledge based on nurse education is that 69.9% of nurses who have poor knowledge are DIII, while the majority of nurses with bachelor's degrees (62.5%) have good knowledge about infusion therapy. The results of further analysis showed that there was a relationship between education and knowledge ($p < 0.05$). These results are different from research conducted by Grauer et al. (2009) who found that nurses who had a BSc educational qualification. had better knowledge than *General Nursing* (GMN) nursing staff about the concepts, causes, prevention, complications, and management of intravenous therapy ($p < 0.05$).

This difference may be caused by differences in the characteristics of each individual nurse as well as differences in the characteristics of the hospital where the nurse works. In the research carried out by researchers, it was a type C general hospital (RSU), while the place of research

carried out by Grauer et al. (2009) was a teaching hospital from the University of Berhampur. Of course, based on the different types of hospitals, the qualifications of the nurses will also differ. In terms of qualifications, they actually meet the standards for nursing staff. This is in line with the opinion of Heeren et al. (2016) that education is an indicator that someone has taken formal education in a particular field. However, formal education is not an indicator that someone has mastered a particular field of knowledge if that person does not try to learn or seek new knowledge about something from non-formal education.

A person's knowledge about an object basically contains two aspects, namely positive aspects and negative aspects, and these two aspects will ultimately determine a person's attitude towards a particular object. This means that if the implementing nurses at RSU Royal Prima Marelán, the majority of whom have DIII education, but do not try to carry out activities to upgrade *their* knowledge, this can give rise to a negative attitude towards that knowledge.

Experience is a source of knowledge, because with experience, a person will obtain the truth of knowledge by repeating the knowledge gained to solve problems faced in the past. On-the-job learning experiences provide professional knowledge and skills. The results of the study showed that nurses who had work experience > 2.4 years had better knowledge than nurses who had work experience < 2.4 years. As many as 51.6% of nurses who had work experience > 2.4 years had a good level of knowledge. However, the results of further analysis showed that there was no relationship between length of work and knowledge ($p > 0.05$). This means that the nurse's experience is not related to knowledge.

This is not in line with research conducted by Grauer et al. (2009) who concluded that there was a significant relationship between experience and knowledge ($p < 0.01$). In this study, the standard was nurse experience > 10 years and < 10 years. It was concluded that nurses who had > 10 years of experience had better knowledge than nurses who had < 10 years of knowledge. This means that the longer a nurse works, the more experience the nurse should have about an object, so that she has adequate knowledge about an object, thus being able to display good behavior and skills at work. The differences in results may be due to differences in the characteristics of other nurses and the type of hospital. It may also be due to differences in policies from the institutions, which will lead to differences in motivation and performance.

It can be understood that nurses who have long work experience will gain a lot of information and experience which will increase their knowledge. The more often people are exposed to certain information, the more that person will understand the ins and outs of that information, so that their knowledge will increase.

The results of research based on the age characteristics of nurses show that nurses aged < 25.6 years have better knowledge than nurses aged > 25.6 years. From the research results, it was found that 55.9% of nurses from the age group < 25.6 years had good knowledge about infusion therapy. This is not in line with the results of research by Grauer et al. (2009), which found that nursing staff who were more than 40 years old had better knowledge than nurses who were less than 40 years old. Meanwhile, the results of further analysis showed that there was no relationship between nurse age and knowledge ($p > 0.05$). This result is different from Grauer et al. (2019) research which found that there was a significant relationship between age and knowledge ($p < 0.02$).

Based on these results, it can be explained that increasing age does not always increase a person's knowledge. Ideally, as one gets older, it will affect a person's understanding and thinking patterns so that the knowledge gained will improve. However, this is not a guarantee that older people will have better knowledge. This can happen if it is not accompanied by self-development, through the learning process, especially to seek new knowledge or information about certain things. This means that if a nurse is > 30 years old, but does not carry out the learning process about infusion therapy well, then their knowledge will not improve.

Based on the results and explanation above, it can be seen that the implementing nurses' knowledge about infusion therapy is still lacking. This needs to be followed up, especially by the health service institution where the nurse works, in this case the RSU Royal Prima Marelan. According to the author's assumption, this lack of knowledge is because nurses are rarely exposed to the latest information related to infusion therapy. Therefore, it is necessary to hold training and other non-formal education related to infusion therapy material along with *evidence-based results* so that nurses are expected to be able to implement procedures for installing and maintaining infusions properly.

Phlebitis Occurrence

The results of the study showed that the incidence of phlebitis in the adult inpatient room at RSU Royal Prima Marelan was 46.7%. The incidence of phlebitis in this study was quite high compared to the standar, namely 5% or less. The results of this study differ from the statement put forward by Pujasari & Sumarwati (2002) who stated that the incidence of phlebitis in Indonesia is generally around 10%. A different opinion was expressed by Champbell (1998) who said that the incidence of phlebitis ranges from 20 – 80%. Meanwhile, the results of research conducted by Gayatri & Handiyani (2007) found a phlebitis incidence of 35.8%, where in the study grade 1 phlebitis was reported as a phlebitis incident. Meanwhile, the results of research conducted by Jacinto et al. (2014) who conducted research on the effect of four-guide modified intravenous therapy treatment at RSU Cibabat Cimahi showed that the incidence of phlebitis was 5.6% in the control group. However, in this study there were differences in treatment in the installation and maintenance of infusions between the intervention and control groups, so that a tendency for infection to occur in the control group was found.

Phlebitis is an inflammatory reaction that occurs in the veins which is characterized by pain, redness, swelling, induration along the veins, and heat. Phlebitis can be caused by mechanical, chemical or infective factors. Phlebitis is one of the complications of infusion installation which is most often found in the field.

The variation in the incidence of phlebitis found in research may be due to differences in the characteristics of respondents as well as differences in hospital policies and facilities. It could also occur due to a lack of knowledge of nurses, especially in reporting whether phlebitis occurs or not. The phlebitis scale recommended by *the Infusion Nursing Standard of Practice 2006* consists of 5 (five) scales, namely scale 0 to scale 4, where scale 0 indicates no phlebitis occurs while scale 4 indicates the most severe degree of phlebitis. Meanwhile, the incidence of phlebitis that must be reported is on a scale of 2 or more (Abolfotouh et al., 2014).

Plumer (2007) said that to detect the presence of phlebitis, all patients who have an IV installed must be observed for signs of phlebitis at least once every 24 hours. These observations can be made when the nurse administers intravenous medication, changes IV fluids, or checks the speed of the IV drip. Meanwhile, this condition does not occur at RSU Royal Prima Marelan, where nurses rarely observe the IV installation area.

The incidence of phlebitis increases with the length of cannulation time. As stated by Gabriel, et al. (2005) said that the incidence of phlebitis increased from 12% to 34% in the first 24 hours, followed by an increase in the rate from 35% to 65% after 48 hours of installation. As research conducted by Royal College of Surgeons of England (1995) found that moving the installation location regularly every 48 hours was proven to significantly reduce the incidence of phlebitis. This can be explained by the fact that the occurrence of an inflammatory response due to prolonged installation can be reduced by replacement before inflammation develops further. When an intravenous catheter is inserted into the vein, there is a very high risk of inflammation, either due to mechanical factors or chemical factors due to the administration of drugs or fluids that have high osmolality.

Phlebitis can be prevented by using aseptic technique during installation, using an IV catheter size appropriate to the size of the vein, considering the selection of the installation site based on the type of fluid given, and the most important thing is moving the installation site every 72 hours aseptically. In fact, the hospital has determined that the location of the infusion should be moved every three days, but the implementation has not been carried out properly. Changing the installation location is actually done when phlebitis occurs. This requires further intervention, especially increasing awareness to carry out all actions in accordance with procedures.

Based on the results of patient characteristics in table 4.7, data was obtained that the incidence of phlebitis occurred more frequently in female patients (47.6%). This is in accordance with research conducted by Campbell (1998) which showed that patients who experienced phlebitis were more likely to be women (58%) than men. This was also stated by Tully, et al. (1981); Campbell (1998) found that gender has an influence on the incidence of phlebitis, where female gender increases the risk of phlebitis. This may happen because female patients tend to have higher mobility than men. This is what increases the risk of phlebitis in women compared to men.

Based on disease history, data was obtained for 17 patients (43.6%) who experienced phlebitis and had a history of non-surgical disease. The history of existing diseases is a group of diseases that are differentiated based on whether surgery was performed or not. The non-surgical disease group includes diabetes mellitus, kidney disorders, heart problems, lung disorders, digestive disorders, nervous disorders and tropical diseases. This is in accordance with the theory that systemic diseases, especially those related to vasculature, for example diabetes mellitus, will increase the risk of phlebitis because they affect the condition of the blood vessels.

Based on the location of installation, 17 (48.6%) patients experienced phlebitis in the area of the back of the hand. This is the same as the results of research conducted by Pujasari & Sumarwati (2002) who found that phlebitis often occurred in the metacarpal veins or the area of the back of the hand.

The incidence of phlebitis obtained in this study was the incidence of phlebitis which came from observations of the infusion area on the third day (72 hours) after installation. This is in accordance with the results of research conducted by Jacinto et al. (2014) which found that phlebitis most often occurred on the third day (72 hours) after installation. However, in contrast to the results of research by Pujasari & Sumarwati (2002), it was found that the incidence of phlebitis occurred more often after 2 x 24 hours of installation, meaning that the incidence of phlebitis occurred before 72 hours, while the INS recommends replacing the infusion catheter after 3 x 24 hours (72 hours) on the basis of that the growth of bacteria that causes phlebitis occurs in that time period.

The high incidence of phlebitis at RSU Royal Prima Maarelan requires high attention from the management. This is related to hospital accreditation assessments, where the incidence of phlebitis is one of the factors assessing service quality. For this reason, it is necessary to re-evaluate the recording and reporting of phlebitis incidents, especially to socialize the assessment of the phlebitis scale so that it is clear whether what is being reported is really a phlebitis incident or something else.

So far, what is reported as an incident of phlebitis is an advanced degree of phlebitis (usually level 3 or 4), even though there are 4 levels of phlebitis ranging from mild to severe degree of phlebitis. For this reason, it is necessary to evaluate the performance of nurses, especially in terms of installing and maintaining infusions, as well as making efforts to prevent phlebitis, for example by changing cannulas every three days or as early as possible before phlebitis occurs, as well as using *transparent dressings* for the insertion area.

The standard operating procedures (SOP) at RSU Royal Prima Marelan are in accordance with standards, and have been installed in every treatment ward, however, nurses' compliance in installing infusions according to the SOP is still lacking. This can be seen from the lack of awareness of nurses in carrying out infection control, such as installing IV drips that lack asepsis, sometimes re-touching the insertion area that has been disinfected, and administering fluids that are also less aseptic. This needs to get attention from the hospital to improve the performance of nurses, especially in terms of compliance in implementing SOPs. Apart from that, there is no standard SOP regarding infusion care, for example fluid replacement procedures, infusion replacement times, dressing change times, and infusion set replacement times. This must be followed up immediately by preparing an SOP regarding infusion maintenance. Hospitals must also equip facilities and infrastructure, especially related to infusion equipment, so that problems related to efforts to reduce the incidence of phlebitis can run smoothly.

Patient Comfort

The research results showed that 51.7% of patients said they were comfortable with the infusion carried out by the adult inpatient nurse at RSU Royal Prima Marelan, while 48.3% said they were uncomfortable. The comfort score is obtained by carrying out analysis to obtain a mean value as *a cut of point*. In this study, the patient's comfort response was studied, using a questionnaire given on the third day after the infusion was installed. The aspects measured include physical, psychological, social and environmental components. This aspect was developed from Kolcaba's *General Comfort Questionnaire*, but has been modified for patients who have IVs installed.

This is different from research conducted by Widmar (2012) which used the concept of *Orem's Self-Care Deficit* which was used as a framework for assessing the comfort of patients who had an IV installed based on the location of the installation which had an impact on the patient's self-care activities and pain levels. The results of this study found that patients who had IVs installed in their dominant and non-dominant hands had higher pain scores than patients who had IVs installed in the back of their hands. Apart from that, the score for self-care was also lower compared to patients who were placed on the back of the hand.

Discomfort due to installing an IV can be caused by an inappropriate installation area, for example where the IV is placed in the dominant hand. As a result, it can interfere with *self-care* activities. This happens because the dominant hand does more activities than the non-dominant hand. Movement of the hand where the IV is installed can cause a change in the position of the catheter, if the catheter fixation is not strong enough. As a result, it can cause catheter displacement, leakage, or blockage, causing disruption in the administration of intravenous therapy. This factor is a factor that increases the risk of infection.

Physical discomfort is related to the disease process, and the main problem of discomfort is pain. The act of installing an IV itself is an invasive procedure that can cause discomfort. However, the patient can feel comfort if it is done correctly and appropriately. Usually the discomfort caused by installing an IV is caused by an inappropriate installation location, such as if the IV is installed in a joint area which makes it difficult for the patient to move, or if it is installed in the dominant hand so that it interferes with the patient carrying out activities. The number of patients who said they were comfortable with the infusion installation carried out by nurses showed that the patients felt that they were not bothered by the location of the infusion installation. Apart from that, patients think that infusion is part of therapy that must be accepted so that the patient responds positively to this. However, nurses must continue to maintain patient comfort by paying attention to every response given by the patient, as well as carrying out appropriate installations that still maintain patient comfort.

Analysis of the Relationship between the Level of Knowledge about Infusion Therapy and the Incidence of Phlebitis

The results of the study showed that there was a significant relationship between the level of nurses' knowledge about infusion therapy and the incidence of phlebitis. In further analysis, the OR value = 9.37 was obtained, meaning that nurses who had poor knowledge were 9.37 times more likely to cause phlebitis than nurses who had good knowledge. These results indicate that nurses' knowledge about infusion therapy makes a major contribution to the occurrence of phlebitis.

The results of the study differ from the results of research conducted by Mahyuni (2009) which was carried out in the surgical treatment room at the Pambalah Batung Amuntai Regional General Hospital, East Kalimantan, showing that there was no relationship between knowledge and the incidence of nosocomial phlebitis infections ($p \geq 0.05$). This is possible because of the differences in the characteristics of the nurses and patients studied. It is understandable that someone who has low knowledge will tend to behave in ways that are not appropriate to what they should be. As stated by Heeren et al. (2016) who said that behavior will be lasting if it is based on high knowledge. Likewise, nurses who have insufficient knowledge about infusion therapy can cause inappropriate behavior when carrying out infusion installation and maintenance.

Based on Bindra (1978) it is formulated that behavior is a person's response or reaction to a stimulus (stimulus from outside). Human behavior can be grouped into two, namely closed behavior (*covert behavior*) and open behavior (*overt behavior*). Closed behavior occurs if the behavior is still in the form of attention, feelings, perceptions, knowledge and attitudes towards the stimulus in question. Meanwhile, open behavior is in the form of actions or practices that other people can see. If it is related to nurses regarding infusion therapy, it can be seen from the behavior of nurses in installing and carrying out infusion treatment.

The same thing was stated by Plumer (2007) that nurses must have high *skills and knowledge about infusion therapy*. Nurses who have adequate knowledge and skills can apply appropriate infusion settings so that complications can be reduced.

In connection with knowing as early as possible the occurrence of phlebitis, nurses must carry out regular and structured monitoring, for example when administering therapy, when changing fluids, when monitoring droplets, or when measuring vital signs. This monitoring must be carried out on the patient including the cannula, the insertion site, and the surrounding area. Frequent monitoring can provide information about early signs of phlebitis so that it can be treated immediately.

Analysis of the Relationship between Level of Knowledge about Infusion Therapy and Patient Comfort

The results of the study showed that as many as 77.4% of patients who were given IV drips by nurses who had poor knowledge experienced discomfort. Meanwhile, only 24.1% of patients who were installed by nurses who had good knowledge experienced discomfort. The statistical test results obtained $p \text{ value} = 0.0005$, meaning that there is a significant relationship between the level of nurses' knowledge about infusion therapy and patient comfort.

Based on these results, it can be seen that nurses who have good knowledge can reduce discomfort in patients. This can be explained by the fact that if the nurse has good knowledge about infusion therapy, the nurse will perform the installation process carefully so as not to hurt the patient. In accordance with the opinion expressed by Plumer (2007) said that if the nurse has high skills, then when inserting the infusion catheter it will be done carefully and gently into the vein using one-handed technique, where the same hand that performed the cannulation will retract the stylet, then carefully push the cannula into the vein).

Conclusion

More than half of the nurse respondents had poor knowledge about infusion therapy. The incidence of phlebitis at RSU Royal Prima Marelan is very high. More than half of the patient respondents who were given an IV drip by the implementing nurse felt uncomfortable. There is a significant relationship between the level of nurses' knowledge about infusion therapy and the incidence of phlebitis ($p = 0.001$). There is a significant relationship between the level of nurses' knowledge about infusion therapy and comfort ($p = 0.005$). The factor that most influences the incidence of phlebitis is the patient's medical history after controlling for the type of fluid and the nurse's knowledge. Patient age is a *confounding factor* in the incidence of phlebitis. The factor most related to patient comfort is nurse knowledge. Nurse education and medical history are *confounding factors* patient comfort.

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