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Risk factor for phlebitis in a patient with peripheral intravenous catheters: a cohort study

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ABSTRACT

Phlebitis is one of the nosocomial infections that frequently occurred in hospitals. Phlebitis is mainly related to infusion and therapy. Many risk factors can cause phlebitis. This study aimed to predict the prevalence of phlebitis in patients based on the causal factors in Banyumas Regional Hospital. This study's design was an analytic survey of the cohort approach, with a sample of 218 by using consecutive sampling. The study was conducted from November to December 2019 using the checklist of observation sheets. The results demonstrates 5 phlebitis risk factors associated with the occurrence of phlebitis, namely the type of fluid (p=0.011), nutritional status (p=0.001), catheter size (p=0.002), injection therapy (p=0.027) and comorbidities (p=0.003). The probability of 5 risk factors for the occurrence of phlebitis (88.28%) with the nutritional status being the dominant factor (β=3.928) with a probability of (13.48%). To minimize phlebitis prevalence, the medical personnel may conduct initial phlebitis screening to determine accurate and appropriate preventive measures.

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1. INTRODUCTION

Infections occurred while in the hospital are called nosocomial infections. The occurrence of nosocomial infection becomes one of the indicators in hospital minimum service standards. It is a benchmark of hospital service quality that is closely related to patient safety. One of the nosocomial infections that often occur in hospitals is phlebitis. According to data from the Ministry of Health of Indonesia in 2013, phlebitis in Indonesia reached 50.11% for general hospitals and 32.70% for private hospitals. Banyumas Regional Hospital is a hospital-owned by the Banyumas Regional Government; from the results of a survey in 2018, it was found that the incidence of phlebitis reached 6.1%, the figure is above the applied benchmark, which is 5%. A study conducted by Ghali shows several risk factors for phlebitis, such as mechanical factors, hydrolytic injection, poor venous conditions, infusion care, and the patient's age [1]. In addition to these factors, there are still several other factors included in internal and external factors. Several preceding studies have analyzed the risk factors for phlebitis. However, it is still limited to finding the relationship of risk factors with the occurrence of phlebitis or looking for dominant factors, research that analyzes the probability or predicts the incidence of phlebitis based on existing factors is still limited. Therefore researchers are interested in analyzing the probability (prediction) of phlebitis based on existing risk factors.

2. RESEARCH METHOD

The design of this study used an analytic survey model with a cohort study approach. The study was conducted at the Banyumas Regional Hospital in the emergency department and seven inpatient wards. Sampling is conducted from November to December 2019 for one month. The research population was all patients who were first infused at the emergency room in Banyumas Regional Hospital. The research sample was part of the population that met the study inclusion criteria, namely patients aged 20 - 60 years, willing to

be respondents, infusions attached, compos mentis awareness, and no mental disorders. Sampling was carried out by a consecutive sampling method totaling 218 samples. The instruments used in this research were observation sheets in checklists filled out by the researchers or the research assistants.

The dependent variable of the study was the occurrence of phlebitis. In contrast, this study's independent variables were gender, nutritional status, comorbidities, insertion techniques, catheter size, catheter material, location of insertion veins, type of dressing, type of fluid, type of injection therapy, number of insertions, and length of time installation. Data analysis was performed by a computer using SPSS version 20. Respondent characteristics using frequency and percentage distribution, chi-square analysis, and fisher-exact test were used to find the correlation between phlebitis factors and multivariate using logistic regression backward methods and probability formula phlebitis prevalence based on existing causal factors.

3. RESULTS AND DISCUSSIONS

Table 1. Correlation between phlebitis factors and the prevalence of phlebitis in Banyumas Regional Hospital

Variables	Prevalence				p-value	RR	CI 95%	
	Phlebitis		Non-Phlebitis					
	f	%	f	%			Lower	Upper
Sex								
Female	19	17.9	87	82.1	1.000	0.96	0.55	1.67
Male	21	18.8	91	81.2				
Insertion veins location								
Distal	19	26.4	53	73.6	0.490	1.83	1.06	3.19
Proximal	21	14.4	125	85.6				
Catheter size								
No < 20	14	37.8	23	62.2	0.002	2.63	1.52	4.54
No 20	26	14.4	155	85.6				
Types of infusion Dressing								
Bandage/Covermed	1	9.1	10	90.9	0.367	0.48	0.73	3.19
Transparent	39	18.8	168	81.2				
Number of punctures								
Twice or more	2	28.6	5	71.4	0.378	1.59	0.47	5.30
Once	38	18.0	173	82.0				
Types of Infusion Fluid								
Hypertonic	9	39.1	14	50.9	0.011	2.46	1.35	4.50
Isotonic	31	15.9	164	84.1				
Nutritional Status								
Malnutrition	28	35.9	50	64.1	0.001	4.19	2.26	7.76
Normal	12	8.6	128	91.4				
Types of Injection Therapy								
Antibiotic	24	25.5	70	74.5	0.027	1.98	1.12	3.51
Non-Antibiotic	16	12.9	108	87.1				
Comorbidities/ Complication								
Yes	15	35.7	27	64.3	0.003	2.51	1.46	4.33
None	25	14.2	151	85.8				

As exposed in table 1 were the results of the study indicated five risk factors for phlebitis associated with the prevalence of phlebitis in Banyumas Regional Hospital, they are catheter size (p=0.002), type of infusion fluid (p=0.011), nutritional status (p=0.001), type of injection therapy (0.027) and comorbidities/complications (0.003).

Table 2. Results of Logistic Regression of Phlebitis Factors

Variable	Coefficient (β)	p-value	Exp(β)	95% CI Exp (β)	
				Lower	Upper
Catheter Size	0.972	0.030	2.643	1.100	6.353
Types of Infusion Fluids	1.169	0.033	3.217	1.101	9.405
Nutritional Status	1.368	0.001	3.928	1.753	8.805
Types of Injection Therapeutic	0.943	0.021	2.568	1.151	5.729
Comorbidities	0.795	0.070	2.216	0.937	5,236
Constant	-3,227	0.001	0.040		

As revealed in table 2, the five factors partially affected the prevalence of phlebitis patients in Banyumas Regional Hospital. The most dominant variable influencing phlebitis' occurrence is the nutritional status, where the β value of the nutritional status variable was more significant than the other variables (β = 3.928). Conversely, the comorbidity factor was the least influencing factor for phlebitis (β = 2.216).

Table 3. Calculation Results of the Probability of Phlebitis Patients for Each Risk Factor

Catheter Size < No.20	Types of Hypertonic Fluid	Nutritional Status Malnutrition	Antibiotic Injection Therapy	Comorbidities	Probability
+	-	-	-	-	0.094919
-	+	-	-	-	0.113246
-	-	+	-	-	0.134819
-	-	-	+	-	0.092456
-	-	-	-	+	0.080764
Total					0.882881

Based on table 3, it is identified that the probability of infused patients with a catheter size less than No. 20, isotonic fluid attached, good nutritional status, does not receive the antibiotic injection, and no comorbidity is 9.4919%. The probability of infused patients with number 20 receives hypertonic fluid; good nutritional status did not receive the antibiotic injection, and no comorbidities are 11.3246%. The probability of a patient having IV number 20, isotonic fluid, experiencing malnutrition, not receiving an antibiotic injection, and no comorbidities is at 13.4819%. The probability of a patient attached to IV No. 20 is given isotonic fluid, good nutritional status, received the antibiotic injection, and had no comorbidities is 9.2456%. The probability of infused patients with number 20, isotonic fluid, good nutritional status, does not receive the antibiotic injection, but there are comorbidities or complications of 8.0764%.

Phlebitis may occur due to mechanical, chemical, or bacterial irritation. Mechanical irritation that occurs is usually related to the process of installing an infusion performed by a nurse. Chemical irritation occurs because of intravenous fluids and injection therapy given during treatment. At the same time, biological irritation is usually associated with bacterial colonization in the area of infusion or contained in the patient's bloodstream. Phlebitis can be caused by two factors, namely internal and external factors. Internal phlebitis factors originate from the patient, such as age, sex, nutritional status, and comorbidities. External factors originate from outside of the patient or the environment around the patient, such as mechanical, chemical, and bacterial factors. Based on the above research results, several factors are associated with phlebitis incidence, i.e., catheter size, type of fluid, nutritional status, type of injection therapy, and comorbidities.

According to the study results, 39.6% of patients with malnutrition have experienced phlebitis with a significant value (p=0.001; RR=4.19), which meant a significant correlation between nutritional status and the prevalence of phlebitis. Following Akbar & Isfandiari's research, 31 malnourished patients (68.90%) have developed phlebitis (p= 0.01; OR 4.01) [2]. At this point, nutritional status is a depiction or condition of nutrient intake balance with its usage. Normal nutritional status indicates that nutritional intake is by a person's nutritional needs based on age and gender. In adults, nutritional status can be influenced by several things such as work, physical activity, and the desire to maintain ideal body weight. Nutritional status can affect the body's resistance or immunity related to susceptibility to infections, diseases, and fragility and elasticity of blood

vessels to become a risk of phlebitis. The immune system helps prevent infection by producing antibodies to fight bacteria and viruses by finding and damaging invaders that harm the human body [3]. For a person who has low nutritional status or malnutrition, to reduce the number of phlebitides, nutritional status can be recovered or improved during treatment by providing parenteral nutrition and encouraging nutritious food as much as possible. However, parenteral nutrition should be noted related to the type of liquid, including liquid with high osmolality that is at risk of developing phlebitis if the administration is inappropriate.

In addition to nutritional status, the comorbidities factor is an internal factor that cannot be altered where the patient is carrying it before being treated at the hospital. According to the data, the results indicated that 52.7% of patients with comorbidities and 14.2% without comorbidities had developed phlebitis (p=0.003; RR = 2.51), demonstrating a significant correlation between comorbidities with the occurrence of phlebitis. The data are in line with the results of previous studies by Lubis and Widiastuti, where 51.8% of respondents with comorbidities have experienced phlebitis with a p-value of 0.018 [4] Diseases suffered by patients can affect the occurrence of phlebitides such as diseases related to blood vessels and components, in addition to several other diseases such as diabetes mellitus, hypertension, kidney failure, HIV, cardiovascular disease, digestion, nerve disease, history of surgery, history of burns and malignancy as well have a risk of phlebitis due to the problem of fluid balance, electrolytes, and acid-base which usually appears [5].

In people with diabetes with atherosclerosis, it will result in a reduced bloodstream to the periphery. If an injury occurs, it will be susceptible to infection. It can be assumed that endothelial damage can be a predisposing factor and triggers inflammation in the venous wall resulting in phlebitis [6]. Association with kidney failure is often related to the position of infusion, where infusion is performed in the forearm area; patients with kidney failure have a greater risk because the location is often used for venous artery fistula (AV shunt) placement in hemodialysis [7]. Several other diseases are closely related to the immune system that affects fragility, the elasticity of blood vessels as well as the body's response to infection; when the body recognizes an infection, pyrogen will stimulate the bone marrow to release large numbers of leukocytes and gather in the infected part so that a phenomenon of inflammation occurs. When a person has low immunity, the body will be slow in responding to infectious agents. Moreover, the body, in this case, the bone marrow, cannot produce many leukocytes, which means the body's ability to cope with infection is reduced. Besides, low body resistance will affect the permeability, fragility, and elasticity of blood vessels. Increased permeability will push the protein and intravascular fluid into the interstitial to appear swollen at the injection site. In contrast, the lack of elasticity will cause blood vessels' stiffness, making it easier for injuries to occur when getting mechanical or chemical manipulation. Comorbidity factor cannot be manipulated; therefore, medical personnel must pay attention to this internal factor in deciding on therapy or action to reduce phlebitis in patients.

Other external factors that are at risk of phlebitis are catheter size, type of fluid, and type of intravenous therapy; in this case, the administration of antibiotics. Based on the research results, most phlebitis occurred in the installation of catheter no 20, 37.8% with a significant value of (p= 0.002; RR= 2.63), which meant a significant correlation between the size of the catheter with the incidence of phlebitis. Similar to the results of previous studies by Suswitha, which revealed as many as 58.3% of respondents with large cannulas had developed phlebitis and 22.6% with small cannulas (p= 0.15) [8]. The outcomes were similar to Herlina's research results, which indicated 12.5% of phlebitis with catheter no. 20 with p= 0,0001, which meant a significant correlation because the size of the intravenous catheter installed did not match the patient's vein's size. It was easy to undergo friction that causes venous inflammation [9]. The size of the catheter here was the infusion catheter number 20 attached to the patient's vein. The choice of catheter size affects the success of therapeutic administration. However, if the size does not match the vein's size, it can damage the blood vessels, which will cause inflammation as the body's response to infection wound or blood vessel damage [10]. According to INS (2000) standard in choosing catheter size, it is recommended to use a smaller size catheter and the shortest length to maintain blood flow and accommodate therapeutic administration. However, the selection of a small catheter size has the disadvantage of being more easily blocked by particles or blood clots due to small lumen holes, which can inhibit the flow of intravenous fluids [11]. To reduce the risk of phlebitis it can be done by selecting the size of the catheter under the size of the vein that is also adapted to the purpose of the given therapy but can also be manipulated by making an intense fixation on the venous catheter, so it is not easily shifted when moved.

According to the study results, 39.1% of patients who received hypertonic fluid experienced phlebitis with the value of (p= 0.011; RR= 2.46), which meant a significant correlation between the type of fluid the prevalence of phlebitis. According to Rizky's research, 54% of respondents who received hypertonic fluid have developed phlebitis with a value of p<0.001 [6]. Similarly, Aesthetica's research results demonstrated a significant correlation with 67% of phlebitis in patients given hypertonic fluid [12]. The type of fluid is related to the osmolality level that existed in each type of intravenous fluid. Osmolality is the concentration of a solution or the number of particles dissolved in a solution. The higher the osmolality of a liquid, the risk of

phlebitis increases. That is because the administration of hypertonic fluid in the tunica intima wall will experience trauma and irritation, especially in the provision of rapid droplets in small veins [13]. Besides, hypertonic fluid has the property of attracting water from intracellular to extracellular compartments, which causes cells to contract [12]. To reduce the risk of phlebitis in administering hypertonic fluid it can be manipulated by administering isotonic fluid between the hypertonic fluid administrations.

The study results indicated the occurrence of phlebitis in the administration of antibiotic therapy by 25.5% with a significance value of (p= 0.027; RR= 1.98), which meant that there was a significant correlation between the types of therapy (antibiotics) with the occurrence of phlebitis. Like Nurinda, research results demonstrated that 55.56% of patients with antibiotics had developed phlebitis, and 52.68% of patients were not given antibiotics and had phlebitis [14]. The preferred type of therapy is the administration of antibiotics or non-antibiotic therapy given intravenously. The administration of antibiotic therapy intravenously has the disadvantage that toxic effects occur quickly due to high levels of the drug immediately reach the blood and tissues. The antibiotic drug ingredients are ingredients that can cause irritation from the endothelium and stimulate intravascular inflammatory reactions. Particles of material formed from liquids or imperfect mixing of drugs may also be a risk of phlebitis. To minimize phlebitis risk due to particles of liquid material and the drug filters can be applied on infusion sets with sizes of 1 to 5 microns. The drug dispensing process must be appropriately administered and maintain sterility both during the dispensing process and drug injection [4].

4. CONCLUSION

Based on the study results and discussion, the researchers concluded as follows: The percentage of phlebitis occurrence was 18.3% of the total study sample. There was a significant correlation between catheter size, type of infusion fluid, nutritional status, type of injection therapy, and comorbidities with phlebitis prevalence in Banyumas General Hospital. The most dominant risk factor associated with the prevalence of phlebitis was nutritional status. The probability of the occurrence of phlebitis with five risk factors, namely catheter no 20, hypertonic fluid, malnutrition, antibiotic therapy, and comorbidities, was 88.2881%. To minimize the occurrence of phlebitis, the medical personnel may conduct initial phlebitis screening so that they will be able to determine the precise and appropriate preventive measures.

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