Original Article

Predictor Factors Causing Length of Stay (LOS) in Diabetic Neuropathy Patients

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ABSTRACT

Diabetes mellitus has emerged as a prevalent public health issue, experiencing a steady rise across the globe, in both developed and developing nations. Among the chronic complications frequently observed in diabetic individuals is diabetic neuropathy, characterized by recurrent infections, non-healing ulcers, and the potential for finger or toe amputations. These neuropathic complications often prolong the treatment duration, consequently impacting the length of hospitalization for patients. Neuropathic conditions in Type 2 Diabetes Mellitus (DM) result in a prolonged healing process. This research aims to analyze the predictor factors contributing to the Length of Stay (LOS) in neuropathic DM patients. It employs a quantitative research approach utilizing a descriptive correlation methodology. The research was conducted from October 2023 to February 2024 at Indriati Solo Baru Hospital, with a questionnaire serving as the research instrument. The sample in this research comprised patients with Diabetic Neuropathy (DM Neuropathy) selected using the Purposive Sampling technique and totaled 127 respondents. Data analysis included univariate, bivariate, and multivariate analyses. The outcomes revealed that out of the seven factors examined, only three factors were significantly associated with the Length of Stay (LOS) among neuropathic DM patients: control of blood sugar levels, presence of complications in respondents, and presence of comorbid diseases in respondents. The predictor factor that exerted the greatest influence on the Length of Stay (LOS) level in neuropathic DM patients was the presence of comorbid diseases in respondents. The study primarily focuses on identifying predictor factors for length of stay (LOS) in neuropathic DM patients. However, it did not thoroughly control for potential confounding variables that could influence LOS, such as socioeconomic status, access to healthcare, severity of neuropathy, and presence of other comorbidities aside from diabetes. suggestion to the next research to focus on other variables such as healthcare, the severity of neuropathy, and the presence of other comorbidities aside from diabetes.

Keywords*: DM Neuropathy, Length of Stay, Predictor factors.*

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INTRODUCTION

Diabetes mellitus accompanied by neuropathy complications necessitates an extended treatment duration, thereby increasing the *Length of Stay* (LOS) or duration of hospitalization. The outcomes from the research conducted by Bala et al. (2022) indicate that patients with neuropathy complications undergo treatment for approximately 7.3 days

longer compared to DM patients without complications, who typically require around 5.5 days of treatment. Another factor that can affect the length of hospitalization is the age between 18-40 years with a LOS of 6.7 days. Gender can affect the LOS of DM patients with women taking longer than men, namely 7.5 days in women and 7.2 days in men [1].

Globally, the average hospital stay duration was 7.3 days, which was notably longer for patients diagnosed with type 2 diabetes and specific forms of diabetes compared to those with type 1 diabetes (p<0.001). The length of stay for DM is longer with age (from 5.5 days in those aged 18 to 40 years, 6.7 days in those aged 40 to 65 years, and 8.0 in those aged ≥65 years, p < 0.001) and higher in women than in men (7.5 days vs. 7.2 days, p = 0.002) [2].

Diabetic neuropathy refers to a group of nerve disorders resulting from diabetes. Individuals with diabetes undergo nerve damage across their body gradually. While some may exhibit no symptoms of nerve damage, others may experience sensations like pain, tingling, numbness, and loss of sensation in their hands, arms, legs, and feet. Nerve complications can manifest in various organ systems, including the digestive tract, heart, and reproductive organs [3].

Neuropathy denotes a collection of conditions that impact various types of nerves, including sensory, motor, and autonomic nerves. It predominantly occurs in the peripheral body, commonly referred to as *Diabetic Peripheral Neuropathy* (DPN). Sensory impairment can lead to a loss of sensation or numbness, potentially causing injuries in diabetics to go unnoticed. Motor disorders can cause muscle wasting (atrophy), foot deformities, changes in foot biomechanics, and impaired pressure distribution, which increase the likelihood of ulcers. Autonomic disorders can lead to reduced sweat excretion in the feet, resulting in dry skin, fissures, and the formation of *calluses* [4].

A research conducted by Bala et al. (2022) revealed that individuals with chronic diabetic complications, including diabetic neuropathy, chronic kidney disease, foot ulceration, and cardiovascular disease, experienced longer hospitalization periods (p < 0.05 for all). Conversely, patients with acute diabetic complications had notably shorter mean hospitalization durations compared to those without acute complications (p < 0.001). The length of hospital stay increased from 2015 reaching a maximum in 2016 and decreased thereafter with a minimum duration in 2018 (p = 0.002). A similar evolution was seen in the length of hospital stay in patients with type 2 diabetes, women, middle-aged adults, and patients with diabetic retinopathy (p < 0.05 for all). There was no observed change over time in individuals with type 1 diabetes, specific forms of diabetes, men, young adults, the elderly, patients with diabetic neuropathy, chronic kidney disease, foot ulceration, or cardiovascular disease (CVD) [5].

Neuropathic conditions in Type 2 DM patients will extend the process of care and healing for patients in the hospital. *Length of stay for* Type 2 DM patients will be longer because of the occurrence of new wounds due to neuropathy conditions [6]. *Length of stay* (LOS) is one of the indicators of the *quality* of medical services provided by hospitals to patients (*quality of patient care*). LOS shows how many days a patient is hospitalized in one period of care [7]. Hospitalization entails providing patient services for observation, diagnosis, treatment, medical rehabilitation, and/or other healthcare interventions by staying overnight in a hospital. The unit for measuring the length of stay is days, calculated by determining the difference between the discharge date (whether the patient is discharged alive or deceased) and the admission date to the hospital. Typically, this data is documented in the admission and discharge summary forms within the medical records [8].

Complications of Type 2 diabetes mellitus (DM) that result in neuropathic conditions are prevalent and pose greater risks across all age groups, emphasizing the importance of preventing the exacerbation of Type 2 DM conditions. Prevention efforts should focus on mitigating and minimizing the risk factors associated with neuropathic conditions. Healing neuropathic conditions in Type 2 DM will require an extended duration. The length of the healing process and treatment in the hospital will have an impact on the patient's *Length of Stay in* the hospital. The results of a preliminary research conducted at Indriati Hospital showed that the number of patients with neuropathic diabetes mellitus during April 2022 - May 2023 was 162 patients. The average *length of stay for* neuropathic diabetes mellitus patients is 4-10 days. Based on

this background, the researcher made a research entitled " Predictor Factors Causing *Length of Stay* (LOS) in Neuropathic DM Patients "

METHOD

This research employs a quantitative research approach, specifically utilizing a *descriptive correlation* methodology. The research methodology involves the use of a questionnaire as the measuring instrument. The independent variables considered in this research encompass age, gender, family history of diabetes, duration of diabetes, presence of complications, blood sugar control, and comorbid diseases. While the dependent variable is *Length Of Stay (LOS)*.

The sample in this research amounted to 127 respondents who were DM Neuropathy patients who were admitted to the inpatient ward and willing to become respondents. The sampling technique in this research used *Purposive sampling* technique and totaled 127 respondents. This research was conducted in October 2023-February 2024 at Indriati Solo Baru hospital.

The instrument utilized in the research was a questionnaire comprising demographic data of respondents and the duration of their *Length of Stay.*

To address the research questions, the analyses included univariate, bivariate, and multivariate tests. Univariate tests for sample characteristics were presented as percentage proportions (%), while bivariate test analyses involved normality and correlation tests. The normality test employed the Kolmogorov-Smirnov test (for samples >50), the correlation test utilized Chi-Square, and the multivariate test employed logistic regression. The data analysis used focuses on what variables can influence LOS in diabetic ulcer patients, namely by regression test analysis.

RESULTS

Table 1. Distribution of predictors of *Length of Stay* (LOS) in patients with DM Neuropathy

Gender	Frequency	Percent
Male	47	37,0
Women	80	63,0
Age		
26-35 Years	6	4,7
36-45 Years	11	8,7
46-55 Years	43	33,9
56-65 Years	58	55,7
>65 Years	9	7,1
Family History		
No	51	40,2
Yes	76	59,8
Duration of DM		
1-3 Years	26	20,5
>3 Years	101	79,5
Complications		
No	47	37,0
Yes	80	63,0
GD Control		
1 Time	47	37,0
2 Times	52	40,9
3 Times	17	13,4
>3 Times	11	8,7
Comorbid Diseases		
No	39	30,7
Yes	88	69,3
LOS		
Normal LOS	45	35,4
High LOS	82	64,6

Based on Table 1, the majority of respondents were female, comprising 80 individuals (63%). The age range of most respondents fell between 56 and 65 years old, totaling 58 individuals (55.7%). Furthermore, a significant proportion of respondents had a family history of DM disease, amounting to 76 individuals (59.8%). The most prevalent duration of DM was over 3 years, with 101 individuals (79.5%). Additionally, the majority of respondents experienced complications, accounting for 80 individuals (63%). Regarding blood sugar control, 52 individuals (40.9%) checked their blood sugar twice a day. Additionally, 88 individuals (69.3%) had comorbid diseases. In terms of Length of Stay (LOS) values, the majority of respondents, totaling 82 individuals (64.6%), had a high LOS of ≥ 5 days.

Table 2. Most risky factors in the cause of predictors of *length of stay* (LOS) in patients with DM neuropathy

Variable	p-value	OR	Exp.B
Gender-LOS	0,342	0,671	0,267
Age-LOS	0,427	Unable	0,002
Family History - LOS	0,088	0,549	- 0,206
Duration of DM	0,364	0,413	- 0,295
Complications -LOS	0,023	0,302	0-,650

GD-LOS contro	0,038	Unable	0,245
Comorbid Diseases-LOS	0,000	0,176	-1,525

Based on Table 2, the results of the chi-square test indicate that there are four variables not associated with LOS, as the p-values are greater than 0.05. These variables are gender (p = 0.342), age (p = 0.427), family history (p = 0.088), and DM duration (p = 0.364). On the other hand, three variables showed an association with LOS, with p-values less than 0.05. These variables are complications (p = 0.023), blood sugar control (p = 0.038), and comorbid diseases (p = 0.000). The Odds Ratio value indicates that two variables cannot be determined because Odds Ratio can only be calculated for 2x2 tables, whereas kx2 tables cannot be tested for Odds Ratio. The highest Odds Ratio value was observed for complications, with a value of 0.302.

The results of the logistic regression test reveal that the highest coefficient beta value is observed for comorbid diseases, with a coefficient beta value of -2.579. This indicates that a 1% change in comorbid diseases can affect the Length of Stay (LOS) by 1.525.

Table 3. Multikolinieraity Test

Multikolinerity	VIF	Tolerance
Complication	0,922	1,085
Blood sugar control	0,880	1,137
Comorbid diseases	0,901	1,110

The results of the multicollinearity test show that the complication variable has a VIF value of 0.922, the blood sugar control variable has a VIF value of 0.880 and the comorbid disease variable has a VIF value of 0.901, so that when a variable has a VIF value > 0.1. The tolerance value for the complication variable is 1.085, blood sugar control is 1.137 and comorbid disease is 1.110 so that the three variables have a tolerance value of <10. Based on these results, multicollinearity does not occur.

Table 4. Auto correlation test

Analysis	Durbin Watson
d	1,661
d_l	1,482
d_u	1,604

The results of the Durbin Watson test show a d value of 1.661 with a dl value according to the Durbin Watson table with a population of 127 and independent variable 3, namely 1.482 and a du value of 1.604. Interpretation of the results shows the value d>du>dl which means there is no autocorrelation.

DISCUSSION

Distribution of predictors of *Length of Stay* (LOS) in patients with DM Neuropathy

The outcomes of this research are consistent with those of the research conducted by Mildawati, Diani, & Wahid (2019), which demonstrated that the characteristics of diabetic peripheral neuropathic patients include a majority of female gender, comprising 59 individuals (71.15%), the most common age group being 46-65 years old, totaling 38 individuals (45.85%), and a duration of suffering of 5 years, involving 35 individuals (42.25%) [9].

Women are at a higher risk of experiencing neuropathy complications associated with parity and pregnancy, both of which are risk factors for diabetes mellitus. The research's outcomes indicated that neuropathy complications in diabetic patients were more common among women (63%) compared to men (37%). Female gender tends to be more susceptible to diabetes mellitus due to factors such as a high body mass index, menstrual cycle syndrome, and the onset of menopause, leading to increased fat accumulation and hindrance in the transport of glucose into cells [10].

Furthermore, the outcomes of this research suggest that the risk of neuropathy complications increases with advancing age. However, this does not eliminate the possibility of peripheral neuropathy occurring in younger individuals with diabetes. Neuropathy complications can affect diabetic patients of various age groups. Individuals aged over 30 may undergo physiological changes that can diminish bodily functions[8]. Peripheral neuropathy is frequently identified after an individual reaches the age of 50 years. The research's outcomes indicated that out of 1788 diabetic patients, 90% experienced peripheral neuropathy between the ages of 40 and 79, with an average age of diabetic patients being 55.5 years. This is in accordance with other studies that found the prevalence of DPN (*diabetic peripheral neuropaty*) as much as 47.5% occurred in diabetics aged 50-59 years[9].

According to Kamenov et al., there were no significant sex differences observed in diabetes control measures such as HbA1c and mean plasma glucose. However, the duration of diabetes was found to be longer in women compared to men. Despite the varying durations of diabetes between genders, the prevalence of diabetic neuropathy did not exhibit significant differences based on sex [11]. This is corroborated by research indicating that complications typically manifest after the disease has progressed for 10-15 years. Prolonged suffering from type 2 diabetes mellitus leads to continuous accumulation of glucose in the blood, resulting in the onset of complications. Additionally, outcomes from other studies support the notion that the duration of diabetes mellitus correlates with the emergence of complications. In essence, the longer an individual has diabetes mellitus, the greater the likelihood of experiencing complications [1]. This contradicts research on factors linked to the occurrence of diabetic peripheral neuropathy, which indicates that there is no association between age and the duration of diabetes mellitus [1].

The outcomes indicated that there is a correlation between the duration of suffering and the risk of peripheral neuropathy in patients with type 2 diabetes mellitus (DM). The longer an individual suffers from DM, the higher the risk of developing neuropathy. Prolonged suffering from DM, coupled with elevated blood glucose levels, can weaken and damage the walls of capillaries that supply blood to the nerves, leading to nerve damage, known as neuropathy [12].

The outcomes from the research conducted by Tofure et al. revealed that the majority of respondents, totaling 28 individuals (100%), had comorbidities. In this research, diabetic peripheral neuropathy coexisting with hypertensive disease is attributed to prolonged suffering from DM with hyperglycemia, which affects alterations in the blood vessel wall and blood pressure. Fundamental changes primarily occur in vascular endothelium, vascular smooth muscle cells, and renal mesangial cells, all of which contribute to diabetic vascular complications [13].

High blood sugar levels in the results of blood sugar checks in this research will cause various disorders in the somatosensory (*visual, vestibular, proprioceptive*) and motor (*musculoskeletal*, muscles, soft tissue joints)

systems that can interfere with the balance system and increase the risk of falls [14]. The blood sugar level obtained in the blood glucose test (GDS) is derived from carbohydrate intake and the various processes of gluconeogenesis and glycogenolysis that occur in the body. Blood sugar levels obtained through GDS examination do not entirely reflect the increase in blood sugar levels that occur. Elevated admission GDS levels in research subjects can also be influenced by various conditions, including high carbohydrate intake, low physical activity, and underlying diseases, particularly diabetes mellitus (DM) [14].

The most risky factor in the cause of predictors of *length of stay* (LOS) in patients with DM neuropathy

The outcomes of Lubis & Susilawati's research indicate that factors such as gender (p.958) and age (p.928) do not have an impact on the Length of Stay (LOS) in neuropathic DM. However, complications (p.024) were found to significantly affect the LOS in neuropathic DM [8].

This illustrates that diabetes mellitus (DM) should be regularly controlled, as complications such as hypertension can suddenly arise due to the manifestation of the patient's poor lifestyle, leading to inadequate blood sugar control. The success of treating diabetes mellitus largely relies on the patient. The five key components of successful diabetes mellitus treatment include dietary management, physical activity, regular blood monitoring, medication adherence, and regular medical check-ups [4].

Complications

Complications of diabetes mellitus (DM) can manifest as acute conditions such as hypoglycemia and chronic conditions like heart disease, vascular issues, kidney failure, visual impairment (retinopathy), erectile dysfunction, foot ulcers, and gangrene. According to the International Diabetes Federation, individuals with diabetes are susceptible to complications such as retinopathy, nephropathy, and neuropathy, which can impact their motivation and life expectancy. Psychological factors also influence the length of hospitalization, emphasizing the importance of treatment adherence. Research outcomes demonstrate that non-adherence is linked to deteriorating health

status, increasing the risk of hospitalization and mortality [15].

Complications in diabetic ulcer sufferers can worsen the condition of the wound, due to disruption of the function of blood vascularization to the periphery. Disruption of peripheral vascularization will disrupt the supply of oxygen and nutrients to peripheral tissue so that the process of forming new tissue in the wound becomes hampered. Impaired peripheral vascularization can impact the supply of antibodies to the wound so that the wound healing process is hampered. Complications in diabetic ulcer sufferers will prolong the long wound healing process which will have an impact on the length of hospital stay. The results of Salim, Lubis & Sugeng's research show that there are several complications that can prolong LOS in Diabetic Ulcer patients such as hypertension, neuropathy, coronary heart disease and stroke [16].

The outcomes from the research conducted by Nita et al. (2021) indicate that the factors influencing Length of Stay (LOS) in neuropathic DM include complications (p=0.028) and comorbid diseases (p=0.022). These results were corroborated by Bala et al. (2022), demonstrating that the primary factor affecting LOS in neuropathic DM patients was comorbid disease, with a p-value of <0.001 [14].

Chronic complications associated with diabetes are preventable, and interventions aimed at modifying the risk of these complications constitute strategies in diabetes management that can aid in reducing healthcare costs. Our outcomes indicate that, alongside length of stay and age, chronic complications of diabetes such as cardiovascular disease (CVD), foot ulceration, and chronic kidney disease are the primary contributors to disease costs. Previous studies have similarly identified chronic complications and the duration of diabetes-related hospital stays as key factors driving inpatient medical care costs [17].

In a recent research investigating the cost of hospitalization for individuals with diabetes in Irish public hospitals, age and chronic complicated diabetes emerged as significant factors influencing hospitalization costs [18]. Similar outcomes were also reported in Bulgaria, where 54% and 41% of hospitalizations were attributed to chronic macro- and microvascular complications of

diabetes in patients with type 2 diabetes and type 1 diabetes, respectively [19].

Blood Sugar Control

Blood sugar control is used to observe whether the blood glucose condition is stable or not. Blood sugar control must be carried out regularly because unstable blood sugar conditions will prevent the growth of new cells and tissue in the ulcer [20]. Unstable blood sugar conditions or hyperglycemia will cause blood flow to become obstructed due to blood density levels so that nutrients, antibodies and oxygen are blocked from reaching the wound so that cells are unable to carry out metabolism and are unable to repair damaged cells and inhibit the formation of cells and tissue. new to the wound[21].

Wound conditions that cannot heal quickly due to hyperglycemia will make the treatment process take a long time [22]. The treatment process will focus on two things, namely stabilizing blood glucose levels and treating diabetic ulcers. The treatment process for diabetic ulcers will experience an extended time which has an impact on LOS [7].

The research results of Simbolon & Ibrahim (2020) show that blood glucose levels are an important factor that can influence LOS in diabetic ulcer patients. Unstable blood glucose conditions will worsen the condition of wounds and hinder the wound healing process, because wounds cannot be healed due to poor blood vascularization to the periphery[4].

Research conducted by Darwis et al. revealed that the most influential factors affecting Length of Stay (LOS) in neuropathic DM patients include blood glucose levels (p < 0.001) [23]. Simbolon et al, showed that factors affecting LOS in neuropathic DM include the presence of ulcers (p = 0.034), depth of ulcers (p = 0.003), Hb (p = 0.033), albumin (p = 0.017)[4].

Comorbid Diseases

Comorbid Diseases Accompanying diseases (comorbidities) that coexist with diabetic ulcer sufferers will cause worsening of the wound condition. Accompanying diseases such as hypertension, atherosclerosis, stroke, lung disease and immune system diseases will greatly influence the wound healing process in diabetic ulcers[24,25]. Accompanying diseases will have an impact on the vascularization of blood circulation to the periphery as well as

insufficient oxygen supply due to lung disease. Immune diseases can affect the long wound healing process because the body has to focus on healing itself from infection so that ulcers will be hampered in the wound healing process. Prolonged wound healing will have an impact on lengthening LOS [7].

The results of Nita et al's research show that the factors that influence LOS in DM neuropathy are complications (0.028) and comorbid diseases (0.022). The results of this study were confirmed by Bala et al,[7] who showed that the factor that most influences LOS in neuropathic DM patients is comorbid diseases with a p value <0.001 [14].

The results of Darwis et al's research show that many factors can influence LOS in diabetic ulcers, one of which is comorbid diseases. The presence of comorbid diseases will worsen the condition of diabetic ulcers and the treatment process should not only focus on healing the wound but also focus on the comorbidities [23].

CONCLUSION

Based on the conducted research, it can be concluded that out of the 7 factors examined, only 3 factors are correlated with the Length of Stay (LOS) level in neuropathic DM patients, namely, blood sugar level control, presence of complications, and presence of comorbid diseases. Additionally, the predictor factor that predominantly influences the LOS level in neuropathic DM patients is the presence of comorbid diseases in respondents. Suggestions for future researchers include exploring other potential factors that may contribute to the LOS level in neuropathic DM patients, such as environmental, genetic, or psychosocial factors.

The study primarily focuses on identifying predictor factors for length of stay (LOS) in neuropathic DM patients. However, it not thoroughly control for potential confounding variables that could influence LOS, such as socioeconomic status, access to healthcare, severity of neuropathy, and presence of other comorbidities aside from diabetes. suggestion to next research to focuses in another variable such as healthcare, severity of neuropathy, and presence of other comorbidities aside from diabetes.

This research still has many limitations, such as the data collection process which only uses one place, not being able to control confounding variables, and not being able to carry out modeling analysis to see whether there is a relationship between the independent variables.

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