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Analysis of direct medical costs in inpatient treatment of diabetic foot ulcers at Nhan Dan Gia Dinh Hospital in 2024 - 2025

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ABSTRACT

Introduction: Diabetic foot ulcer (DFU) is one of the most serious and common complications in patients with diabetes mellitus Its treatment is typically is prolonged, complex, and costly. Identifying direct medical costs (DMC) is essential for effective financial planning and healthcare resource management. Methods: A cross-sectional descriptive study was conducted using retrospective data extracted from medical records and treatment cost statements of patients with diabetic foot ulcers (DFUs) who met the sampling criteria at Nhan Dan Gia Dinh Hospital during the 2024 - 2025 period. Results: A total of 143 inpatient DFU treatment episodes were included. The male-to-female ratio was 1.04:1 and the majority of patients were elderly (83.9%). The average DMC was 24,319,384 VND (95% CI: 17,981,415 - 30,657,353 VND), with health insurance most of the cost (71.39%) and medication costs accounted for the highest proportion (43.10%). The multivariate regression model demonstrated significant associations between DMC and related factors, expressed as (Adjusted $R^2 = 0.650$; $p < 0.001$): LogDMC = 0.709 × "length of stay" + 0.154 × "chronic kidney disease" - 0.131 × "amputation" + 0.123 × "ulcer severity" + 6.784. Conclusions: During 2024 - 2025, the average DMC for a DFU inpatient episode at Nhan Dan Gia Dinh Hospital was 24.3 million VND (450% of the 2024 average monthly income), with health insurance coverage and medication costs representing the largest proportions. The study identified length of hospital stay as the strongest predictor of treatment costs; therefore, healthcare facilities should prioritize strategies to shorten hospitalization through optimized treatment regimens, enhanced clinical management, and improved care processes to achieve more effective cost control.

Keywords: *direct medical cost, diabetic foot ulcer, inpatient treatment, Nhan Dan Gia Dinh Hospital*

1. INTRODUCTION

Diabetic foot ulcer (DFU) is one of the most severe and prevalent complications of diabetes mellitus (DM), with a global annual incidence of approximately 2.4 - 2.6% and a prevalence of 4 - 10%, according to systematic reviews and data compiled by the International Diabetes Federation (IDF) in 2022 and the American Diabetes Association (ADA) in 2023 [1, 2]. In Vietnam, according to data from the Ministry of Health, there are currently about 7 million people living with DM, of which more than 55% have developed complications [3]. DFU is becoming one of the leading causes of hospitalization, with the approximate inpatient admission rate due to DFU of 20% [4]. DFU is a serious chronic complication, requiring prolonged, complicated, and costly treatment, placing a significant economic burden on both the healthcare system and patients. A study conducted in the United Kingdom estimated that the healthcare costs associated with DFU and lower-limb amputation ranged from £837 million to £962 million, accounting for 0.8% to 0.9% of the National Health Service (NHS) budget [5]. In China, the total cost per patient increased from ¥15,535.58 in 2014 to ¥42,040.60 in 2020, with an average of ¥21,826.91 [6]. In Vietnam, research on the topic of direct medical cost (DMC) related to inpatient treatment of DFU remain limited. Given

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the increasing prevalence of the condition and its serious health and financial consequences, analyzing treatment costs is necessary to provide a clearer and more comprehensive understanding of the economic burden that patients, families, and the healthcare system must face. This study was specifically conducted with the following objectives:

- To analyze the direct medical cost in the inpatient treatment of diabetic foot ulcers at Nhan Dan Gia Dinh Hospital during the 2024 - 2025 period.
- To analyze factors associated with treatment costs in the inpatient management of diabetic foot ulcers at Nhan Dan Gia Dinh Hospital during the 2024 - 2025 period.

2. SUBJECTS AND METHODS

2.1. Study subjects

DMC and related factors in the inpatient treatment of diabetic foot ulcers at Nhan Dan Gia Dinh Hospital during the 2024 - 2025 period.

2.2. Study methods

2.2.1. Study design

A cross-sectional descriptive study based on retrospective data collected from medical records and treatment cost statements of patients with DFU who met the sampling criteria at Nhan Dan Gia Dinh Hospital during January 2024 - Octorber 2025.

2.2.2. Study sample

Sample size

All samples that met the inclusion criteria during 2024 - 2025.

Sampling criteria

The inclusion and exclusion criteria applied at Nhan Dan Gia Dinh Hospital during 2024 - 2025 are presented in Table 1.

Table 1. Sampling criteria

Inclusion criteria	Exclusion criteria
- Patients treated for diabetic foot ulcers with ICD-10 codes: E11.621; E10.621. - Patients aged 18 years and older	- Incomplete medical records lacking essential data for the study - Patients who discontinued treatment due to death or transfer to another facility

Study variables

The study collected data on patient characteristics, treatment costs, and relevant clinical variables as follows:

- Patients characteristics: Age, gender, place of residence, type of health insurance coverage, and insurance reimbursement rate.
- Clinical characteristics: Length of stay, number of comorbidities, reason for admission, ulcer severity, presence of comorbid conditions, and amputation status.
- Cost analysis: Average direct medical cost per inpatient episode by cost component and source of payment.
- Analysis of associated factors: Correlations between sample characteristics and costs were assessed through appropriate statistical tests (Pearson/Spearman correlation, T-test/Mann - Whitney, ANOVA/Kruskal - Wallis) to test the hypotheses H0 and Hx.

2.3. Data processing and analysis

Data were compiled and analyzed using Microsoft Excel 2010 and SPSS. The distribution of DMC was tested using the Kolmogorov - Smirnov test to assess normality. If the DMC data did not follow a normal distribution, they were log-transformed (log10) for statistical analysis. A multivariate linear regression model using the Forward Linear Regression method was applied to identify independent factors influencing treatment costs. During the variable selection process, the model began with no variables and gradually added statistically significant predictors ($p < 0.05$). Assumptions of linear regression - including linearity, normal distribution of residuals, and absence of multicollinearity - were verified to ensure the reliability of the results.

2.4. Research ethics

The study was approved by the Ethics Committee of Hong Bang International University under the code YĐ.SĐH.TC18.TCQLD.007. The study ensured the confidentiality of patient information included in the research sample.

3. RESULTS

A total of 183 patients were enrolled in the study. Of these, 143 patients met the inclusion criteria

and were included in the final analysis. Forty patients were excluded due to incomplete data.

3.1. Determination of direct medical costs in the inpatient treatment of diabetic foot ulcers at Nhan Dan Gia Dinh Hospital during 2024 - 2025

3.1.1. Patient characteristics

The study analyzed 143 inpatient treatment episodes of DFU patients at Nhan Dan Gia Dinh Hospital during the 2024 - 2025 period. The patient characteristics are presented in Table 2.

According to Table 2, the male-to-female ratio was 1.04:1. The majority of patients were elderly, with 83.92% aged over 60 years and 10.49% aged 50 - 59 years. A total of 93.71% of patients were covered by health insurance, most of whom had an 80% coverage rate (60.84%) or 100% coverage (25.17%). Additionally, 73.43% of patients resided in Ho Chi Minh City.

The study included 143 inpatient treatment episodes for DFU at Nhan Dan Gia Dinh Hospital. The clinical characteristics are summarized in Table 3.

Table 2. Patient characteristics (n = 143)

Variable		Frequency	Percentage
Gender	Male	73	51.05
	Female	70	48.95
Age group	18 - 39	3	2.10
	40 - 49	5	3.50
	50 - 59	15	10.49
	> 60	120	83.92
Health insurance participation	Yes	134	93.71
	No	9	6.29
Insurance coverage rate	No Insurance	9	6.9
	80%	87	60.84
	95%	11	7.69
	100%	36	25.17
Place of residence	Outside Ho Chi Minh City	38	26.57
	Ho Chi Minh City	105	73.43

Note: SD - Standard Deviation; CI - Confidence Interval

Table 3. Clinical characteristics (n = 143)

Characteristic		Frequency / Mean (SD)	Percentage / 95% CI
Length of hospital stay (days)		10.00 (6.65)	8.90 - 11.10
Number of comorbidities		3.49 (1.26)	3.28 - 3.70
Reason for admission	Referred correctly	135	94.41
	Referred incorrectly	8	5.59
Ulcer severity*	Grade 0	26	18.18
	Grade 1	32	22.38
	Grade 2	11	7.69
	Grade 3	11	7.69
	Grade 4	28	19.58
	Grade 5	35	24.48
Comorbidities	Hypertension	111	77.62
	Dyslipidemia	73	51.05
	Peripheral arterial disease	50	34.97
	Chronic kidney disease	33	23.08

Characteristic		Frequency / Mean (SD)	Percentage / 95% CI
	Others	105	73.43
Amputation	Yes	51	35.66
	No	92	64.34

*Note: SD - Standard Deviation; CI - Confidence Interval; * Ulcer severity was classified according to the Meggitt-Wagner system[4]*

The study found that the mean length of hospital stay was 10.00 days (95% CI: 8.90 - 11.10 days), and the average number of comorbidities per patient was 3.49 (95% CI: 3.28 - 3.70). Most patients (94.41%) were admitted through appropriate referral pathways, with the highest ulcer severity group being those with deep, extensive necrosis (24.48%). Hypertension (77.62%) and dyslipidemia (51.05%) were the most common comorbidities, and 35.66% of patients required amputation.

3.1.2. Determination of direct medical costs

The study recorded the direct medical costs per inpatient episode results, classified by cost components and sources of payment, as presented in Table 4.

Table 4. Direct medical costs for inpatient treatment by cost components and sources of payment (unit: Thousand VND)

Cost category	Mean value	95% CI	Proportion (%)
By component			
Medication	10,482	5,812 - 15,151	43.10
Blood/blood products	674	241 - 1,106	2.77
Laboratory tests	4,081	3,253 - 4,909	16.78
Hospital bed - days	4,786	3,814 - 5,758	19.68
Medical supplies	55	18 - 93	0.23
Procedures	3,720	393 - 650	15.30
Meals	521		2.14
Total	24,319	17,981 - 30,657	100
By source of payment			
Covered by health insurance	17,361	11,830 - 22,892	71.39
Paid by patients	6,957	5,424 - 8,491	28.61
Total	24,319	17,981 - 30,657	100

According to Table 4, the average direct medical cost per inpatient episode was 24,319 thousand VND (95% CI: 17,981 - 30,657 thousand VND), ranging from 1,644 thousand VND to 315,357 thousand VND. Medication costs were the largest component, averaging 10,482 thousand VND and accounting for 43.10% of total cost, while health insurance covered the majority of overall costs (71.39%).

3.2. Analysis of factors associated with direct medical costs in inpatient treatment of diabetic foot ulcers at Nhan Dan Gia Dinh Hospital during 2024 - 2025

The study tested the normality of 143 DMC values using the Kolmogorov-Smirnov test, histogram, and Normal Q-Q plots before analyzing correlations with associated factors. The results indicated that DMC values were not normally distributed ($p = 0.000 < 0.050$). Therefore, DMC values were log-transformed (base 10) to obtain LogDMC, outliers were excluded, and the data were re-tested for normality using the same methods. The LogDMC values were found to follow a normal distribution ($p = 0.200 > 0.050$). Consequently, T-tests, One-way ANOVA, and Pearson correlation tests were applied to analyze the relationship between associated factors and LogDMC per inpatient episode with a 95% confidence level.

The results of the analysis of factors associated with inpatient treatment costs are presented in Table 5.

Table 5. Factors associated with DMC

Variable	Type of variable	Mean logDMC (95% CI)	p-value
Ulcer severity	Grade 0	6.98	< 0.050
	Grade 1	6.96	
	Grade 2	7.18	
	Grade 3	7.09	
	Grade 4	7.06	
	Grade 5	7.23	
Chronic kidney disease	Yes	7.18	< 0.050
	No	7.04	
Amputation	Yes	7.20	< 0.050
	No	7.00	
Correlation coefficient			
Length of hospital stay (days)		0.780	< 0.050

Note: CI - Confidence Interval. The T-test was used for dichotomous variables, ANOVA for categorical variables with ≥ 3 groups, and Pearson's correlation for continuous variables; # the difference in mean LogDMC between grade 5 and grade 0 was 0.250 (95% CI: 0.015 - 0.485, p = 0.027); between grade 5 and grade 1 was 0.266 (95% CI: 0.048 - 0.484, p = 0.006)

According to Table 5, the study identified factors associated with the patients' LogDMC, including the length of hospital stay, ulcer severity, chronic kidney disease, and amputation. To examine the relationships between the dependent variable and each independent variable, as well as among the independent variables themselves, a correlation matrix was constructed. In this model, the dependent variable was LogDMC, while the independent variables included length of hospital stay, ulcer severity, chronic kidney disease, and amputation.

The study found that all four independent variables, length of hospital stay, ulcer severity, chronic kidney disease, and amputation, were significantly correlated with LogDMC ($p < 0.050$). Therefore, these variables were included in the regression model. A stepwise method was used, in which independent variables were entered and removed sequentially based on their p-values, to analyze their multivariable linear regression relationships. For each variable entered into the model, an F-test was performed; a variable was retained if its entry F-value had $p \leq 0.050$. The results of the final model are presented in Table 6.

Table 6. Multivariable regression model (Adjusted $R^2 = 0.650$; $p < 0.050$)

Dependent variable	Constant / Independent variable	Unstandardized coefficient		Standardized coefficient	t	Sig.	VIF
		β	SE	βk			
Log	Constant	6.784	0.087		77.635	< 0.001	
	LHS	0.037	0.003	0.709	13.058	< 0.001	1.097
	Amputation	-0.082	0.039	-0.131	-2.093	0.038	1.446
	CKD	0.110	0.039	0.154	2.842	0.005	1.098
	US	0.019	0.010	0.123	1.997	0.048	1.417

According to Table 6, LogDMC was most strongly influenced by the independent variable "length of hospital stay" ($|\beta k| = 0.709$), followed by "chronic kidney disease" ($|\beta k| = 0.154$), "amputation" ($|\beta k| = 0.131$), and "ulcer severity" ($|\beta k| = 0.123$). Among these, "length of hospital stay," "chronic kidney disease," and "ulcer severity" were positively correlated with LogDMC ($\beta k > 0$), whereas "amputation" showed a negative correlation ($\beta k < 0$). The multivariable regression model describing the relationship between LogDMC and related factors was expressed as (Adjusted $R^2 = 0.650$; $p < 0.001$): LogDMC = 0.709*"length of hospital stay" + 0.154*"chronic kidney disease" - 0.131*"amputation" + 0.123*"ulcer severity" + 6.7.

4. DISCUSSION

The demographic profile of patients in this study, with a predominance of older adults and a nearly equal gender distribution, aligns with previous reports. Lae Bouphakham et al. (2024) observed a

comparable male-to-female ratio (1.05:1) and a predominance of patients aged 60 years and older (73.33%), while Bui The Long et al. (2022) similarly reported that 85.59% of DFU patients were in the ≥ 60 age group [7, 8]. These consistent findings highlight the vulnerability of elderly populations to DFU and reinforce the need for targeted prevention strategies.

The average DMC per inpatient episode for diabetic foot ulcers was 24,319,384 VND (95% CI: 17,981,415 - 30,657,353 VND), ranging from 1,644,606 VND to 315,357,343 VND. This value was lower than that reported by J. Bradford Rice et al. (2014) in the United States, where annual DMCs ranged from 304 to 317 million VND, but higher than the findings of Huy Tuan Kiet Pham et al. (2020) in Vietnam, who reported an average of 11.47 ± 21.33 million VND among diabetic patients with complications [9, 10]. The exceptionally wide cost range (1.6 million to 315 million VND) can be attributed to substantial heterogeneity in clinical severity, presence of complications, need for surgical or intensive interventions, and prolonged hospitalization among certain patients. The cost structure in our study was dominated by drug expenses (43.10%), followed by bed-days, laboratory tests, and procedures. This differs from Prompers et al. (2008), who found hospital bed-days to be the largest component (34%), with lower proportions for antibiotics, procedures, and laboratory tests [11]. Such differences may reflect variations in treatment protocols, resource use, and insurance coverage across healthcare system.

Health insurance played a crucial role in reducing patients' financial burden, covering 71.39% of total costs. However, patients still faced substantial out-of-pocket payments for non-reimbursed items such as medications, consumables, and high-tech services. This contrasts with Nguyen Thi Thu Huong et al. (2024), who reported that insurance covered 92.8% of costs, leaving patients to pay only 7.2% –[12]. The discrepancy may be explained by differences in clinical characteristics and the scope of insurance coverage, as DFU patients often require prolonged hospitalization, advanced wound care, and interventions such as amputation or revascularization, many of which are not fully reimbursed.

Regression analysis further demonstrated that treatment costs were primarily driven by clinical severity, with length of hospital stay, chronic kidney disease, amputation, and ulcer severity emerging as significant predictors. The multivariable model explained 65% of the variation in LogDMC (adjusted $R^2 = 0.650$, $p < 0.001$), which is relatively high given the complexity of medical cost data, often influenced by patient-specific and institutional factors [13]. These findings emphasize the importance of early detection, effective management of comorbidities, and timely interventions to reduce both clinical severity and economic burden.

Taken together, this study provides valuable insights into cost structures and payment sources for DFU in Vietnam, offering an empirical foundation for health management and policy interventions. The results support the development of chronic disease management strategies and inform health technology assessment and cost-effectiveness analyses. Nevertheless, limitations remain, including the single-center design, short study period, incomplete documentation of key clinical variables, and the exclusion of indirect and non-medical costs. As such, the findings primarily reflect the financial burden within hospital settings and do not fully capture the broader socioeconomic impact of DFU.

5. CONCLUSION

During 2024 - 2025, the average DMC for a DFU inpatient episode at Nhan Dan Gia Dinh Hospital was 24.3 million VND (450% of the 2024 average monthly income), with health insurance coverage and medication costs representing the largest proportions. The study identified length of hospital stay as the strongest predictor of treatment costs; therefore, healthcare facilities should prioritize strategies to shorten hospitalization through optimized treatment regimens, enhanced clinical management, and improved care processes to achieve more effective cost control.

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Phân tích chi phí trực tiếp y tế trong điều trị nội trú viêm loét bàn chân đái tháo đường tại Bệnh viện Nhân dân Gia Định giai đoạn 2024 - 2025

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TÓM TẮT

Giới thiệu: Viêm loét bàn chân (VLBC) do đái tháo đường (ĐTĐ) là một trong những biến chứng nghiêm trọng và phổ biến ở người bệnh ĐTĐ, với quá trình điều trị kéo dài, phức tạp và đòi hỏi chi phí cao, việc xác

định chi phí trực tiếp y tế (CPTTYT) là điều hết sức cần thiết. Phương pháp: Mô tả cắt ngang dựa trên hồi cứu dữ liệu thu thập được từ hồ sơ bệnh án, bảng kê chi phí điều trị của người bệnh VLBC ĐTĐ thỏa tiêu chí chọn mẫu tại Bệnh viện Nhân dân Gia Định giai đoạn 2024 - 2025. Kết quả: Khảo sát 143 đợt điều trị nội trú VLBC ĐTĐ tại Bệnh viện Nhân dân Gia Định (BVNDGĐ) giai đoạn 2024 - 2025 với tỉ lệ nam:nữ có giá trị 1,04:1, đa số người bệnh thuộc nhóm người cao tuổi (83.9%); CPTTYT trung bình 24.319.384 VND (KTC 95%: 17.981.415 - 30.657.353 VND) với bảo hiểm y tế chi trả phần lớn (chiếm 71.39%), và chi phí thuốc có tỉ trọng cao nhất (43,10%). Phương trình hồi quy đa biến thể hiện mối quan hệ giữa CPTTYT với các yếu tố liên quan có dạng (R^2 hiệu chỉnh = 0.650; p < 0.001): LogDMC = 0.709"số ngày điều trị" + 0.154*"bệnh thận mạn" - 0.131*"cắt cụt" + 0.123*"mức độ loét bàn chân" + 6.784. Kết luận: Trong giai đoạn 2024 - 2025, chi phí y tế trực tiếp trung bình cho một lượt điều trị nội trú loét bàn chân đái tháo đường tại Bệnh viện Nhân dân Gia Định là 24.3 triệu VND (tương đương 450% thu nhập bình quân tháng năm 2024), trong đó chi trả từ bảo hiểm y tế và chi phí thuốc chiếm tỷ trọng lớn nhất. Nghiên cứu xác định thời gian nằm viện là yếu tố dự báo chi phí mạnh nhất; do đó, các cơ sở y tế cần ưu tiên các chiến lược rút ngắn thời gian điều trị thông qua tối ưu hóa phác đồ, tăng cường quản lý lâm sàng và cải thiện quy trình chăm sóc nhằm kiểm soát chi phí hiệu quả hơn.*

Từ khóa: *chi phí trực tiếp y tế, viêm loét bàn chân đái tháo đường, điều trị nội trú, Bệnh viện Nhân dân Gia Định*

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