ORIGINAL ARTICLES

Direct medical costs among patients with type 2 diabetes mellitus with complications at Thieu Hoa District General Hospital, Thanh Hoa province, Vietnam in 2023

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ABSTRACT

Objective: Analyze direct medical costs of type 2 diabetes mellitus patients with complications treated at Thieu Hoa District General Hospital in 2023 and some related factors.

Research method: A cross-sectional study was collected from Electronic medical records of 1,793 outpatients with type 2 diabetes mellitus with complications receiving treatment at the Thieu Hoa District General Hospital, Thanh Hoa province, Vietnam from January 1st, 2023 to December 31st, 2023. Data were collected using Excel software and processed using STATA software.

Results: The average age of patients with type 2 diabetes mellitus with complications is 66.6±11.1; female accounted for 55.4%. The percentage of patients had one complication (30.9%). Direct medical costs were 7,243,111,304 VND, of which health insurance paid 92.8% and patients co-paid 7.2%. Renal complications and eye complications had large payment components even though the number of patients was small. Factors directly rerlating to increased direct medical costs in patients with type 2 diabetes mellitus with complications were increased age, male, more number of examinations per year, and more number of complications.

Conclusion: The study provides insight into the disease state and direct medical costs for treating type 2 diabetes mellitus with complications showing high costs for medicine components and testing. Interventions are needed to effectively manage and treat type II diabetes mellitus patients with complications in the future.

Keywords: *Type 2 diabetes mellitus, complications, direct medical costs, Thieu Hoa General Hospital.*

INTRODUCTION

Type II Diabetes mellitus (T2DM) is one of the chronic, non-communicable metabolic diseases with an increasing trend globally. According to a report by the World Diabetes Federation (IDF) in 2021, there are about 537 million adults (20-79 years old) in the world living with T2DM and every year about 4 million people die from its complications (1). In Vietnam, according to a report from the Ministry of Health, more than 55% of patients with T2DM have complications, of which 34% are cardiovascular complications; 39.5% had eye complications and neurological complications; 24% of kidney complications (2).

The increase in dibetes and its complications is a global problem in the world and also cause negative impacts on the economy and

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quality of life of patients. Total medical costs related to T2DM globally amount to nearly 970 billion USD, estimated to be 1.03 trillion USD by 2030 and 1.06 trillion USD by 2045. The medical costs related to T2DM that each patient must pay is nearly 1,900 USD (3). On average, people with diabetes have medical expenses that are about 2.3 times higher than those of people without the disease (4). In 2021, Vietnam's total health spending related to diabetes is 1,670 million USD and the average cost for treatment per patient is 418.1 USD/ year (5). According to research by author Pham Huy Tuan Kiet on 1,395,204 people identified as having T2DM, the total direct medical costs are 435 million USD, of which 24% are spent on hospitalization, 20% on outpatient care. outpatient care, 7% for emergency care, 36% for non-diabetic drugs, and 13% for hypoglycemic drugs. Approximately 70% of total direct medical costs are due to diabetes-related complications (6).

In Vietnam, there are not many studies on the direct costs of T2DM patients with complications, especially research at the grassroots health level such as district general hospitals. Management of T2DM treatment at primary health care facilities plays a pivotal role and is the key to success in treatment. Thieu Hoa District General Hospital has deployed a software system to manage the treatment of diabetic patients in the form of electronic medical records. All patient treatment information and medical treatment costs for each visit are stored on the software and information can be extracted. Therefore, in order to better understand the direct medical costs of people with T2DM with complications, collect necessary information for the planning process and deploy effective information for the planning process. we conduct research with the following research objectives: ***"Analyzing direct medical costs for patients with type 2 diabetes mellitus with complications at Thieu Hoa District General Hospital in 2023 and its related factors."***

METHODS

Study design: A cross-sectional study.

Study subjects: Electronic medical records of T2DM with complications undergoing outpatient treatment at the Thieu Hoa District General Hospital during the period from January 1st 2023 to December 31st 2023. Electronic medical records contain all patient treatment information and medical treatment costs for each visit are stored on the software and information can be extracted.

Study site and time: Research period is from November 2023 - June 2024 at Thieu Hoa District General Hospital.

Selection criteria: T2DM patients diagnosed by a doctor when discharged from the hospital have the code for diabetes with complications: E11.1; E11.2; E11.3; E11.4; E11.5; E11.6; E11.7; E11.8. When examining in the hospital, the doctor diagnosed the patient with T2DM code E11, with diagnosis codes being complications of the disease that appeared after the patient had diabetes.

Exclusion criteria: Medical records are incomplete information on treatment and costs.

Sample size and sampling method: Select all records with the code for T2DM with complications that meet the research criteria, the patient's data matches the selection criteria, and are treated at the hospital. Thieu Hoa District General Hospital in 2023. A total of 1,793 patients were included in the analysis in the study.

Research variables: Includes groups of variables about:

- General characteristics of research subjects: age, gender, health insurance payment level. Direct costs are the costs incurred by the health care system, the community, and the patient's family in directly dealing with the

illness. Direct costs are divided into two categories: direct osts for health care (also known as direct medical costs) and direct costs outside of treatment. The perspective used in this study is the health care sector, direct medical costs of type 2 diabetes patients with complications: including medicine; cost of diagnostic imaging; testing cost; minor and major surgery cost; medical supplies; and examination.

- Some characteristics related to treatment include number of medical examinations/ year; Number and type of complications of type 2 diabetes: eye complications, neurological complications, renal complication, coronary complications, cerebrovascular complications, peripheral vascular complications.

Tools and methods of data collection:

The tool used in the research is a collection form designed according to a pre-written structure. The toolkit includes 3 following parts: 1. General information about patient demographics; 2. Information about the patient's treatment characteristics; 3. Information about direct medical costs.

The form is designed on Excel software to extract information from the hospital's patient management software.

On the hospital's treatment management software, we extracted the list of T2DM patients currently receiving outpatient treatment at the hospital. Then, we selected T2DM patients with complications as defined in the patient selection criteria. Next, we extracted the medical records of the visits from January 1, 2023 to December 31, 2023 of T2DM patients with complications, a total of 12,069 examination visits were collected. Because patients had multiple visits during the year, we merged the data of visits of the same patient together to calculate the cost per patient. We used health insurance code, which is unique for each patents. In total, there were 1793 outpatients treated for T2DM with complications.

Processing and analyzing data: Data are managed using Excel software, then data are cleaned, analyzed and processed on statistical software STATA. Descriptive statistics include mean, standard deviation, median, interquartile range for direct medical cost, and percentages for variables gender, agegroup, health insurance payment level. To determine the relationship between some factors and direct medical costs of T2DM with complications, linear regression models were used for analysis. A statistical significance level of $\alpha = 0.05$ was applied.

Research ethics: The study was approved by the Reseach Council of Hanoi Medical University according to Decision No. 221/ QD-DHYHN on January 26, 2024. The information provided by subjects is only for research purposes and is kept confidential.

RESULT

Some general information of research subjects (n=1793)

Table 1. General information of people with type II diabetes mellitus with complications at Thieu Hoa District General Hospital (n=1,793)

Characteristic	Frequency (n)	Percentage (%)
Gender		
Male	800	44.6
Female	993	55.4
Age group		
≤45	59	3.3
56-55	213	11.9
56-65	524	29.2
66-80	822	45.8
≥81	175	9.8
Health insurance payment level		
100%	619	34.5
95%	208	11.6
80%	966	53.9

Table 1 shows that out of a total of 1,793 T2DM patients with complications, 55.4% were female patients and 44.6% were male patients. The age group is most concentrated at 56-80 years old. 100% percent of patients had health insurance, in which the patients with health insurance payment level 80% with 53.9%

Some characteristics of complications of type II diabetes mellitus with complications

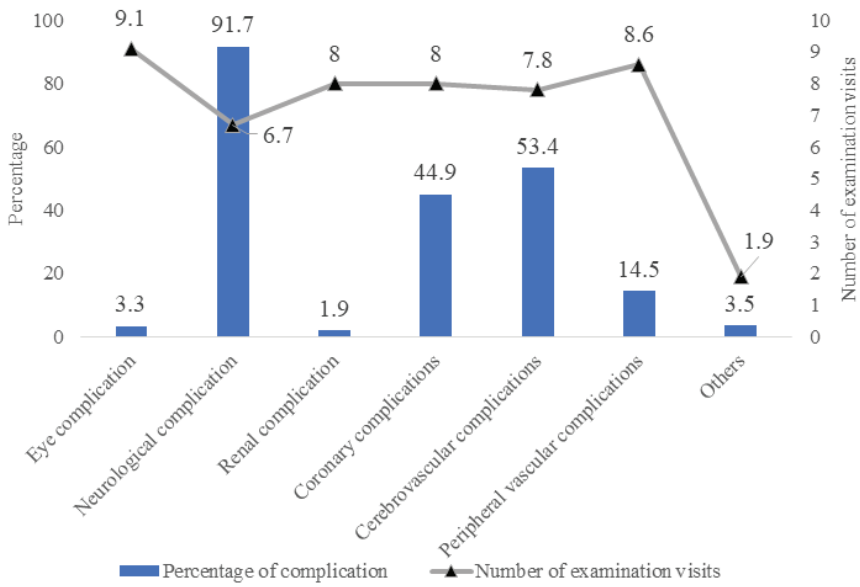

Figure 1. Distribution of patient rate and number of examination visits according to types of complications (n = 1,793)

The average number of complications was 2.4 complications/patient. 30.9 % of patients had one single complication and 69.1% of patients had from 2 and above complications during treatment. The most common complications were neurological complications (91.7%), coronary complication (44.9%), cerebrovascular complications (53.4%) and peripheral vascular complications (14.5%).

The mean of examinations for eye complications was 9.1 times. And then, the peripheral vascular complications (8.6 times), renal complications (8.0 times), coronary complications (8.0 times), and cerebrovascular complications (7.8 times) and at least neurological complications (6.7 times).

Direct medical costs of people with type 2 diabetes mellitus with complications

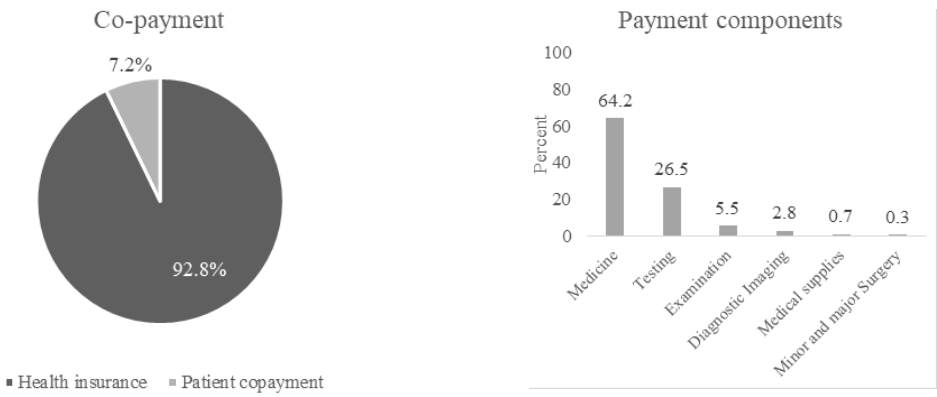

Figure 2. Total cost of diabetes treatment (7,243,111,304 VND)

Figure 2 shows that the amount of health insurance payments accounted for 92.8%. Total drug costs accounted for the highest percentage at 64.2%, less than testing costs 26.5%, examination costs 5.5%, diagnostic imaging 2.8%, medical supplies 0, 7% and the lowest was surgical procedure cost 0.3%.

Table 2. Direct costs per year for a patient of type II diabetes mellitus patients according to complications

**Unit: Thousand VND*

Type of compication	Mean	Standard deviation	Median	Interquartile range
Eye complications	7,584.96	4,189.99	7,036.85	4,394.88- 10,821.64
Neurological complications	4,269.50	3,119.98	3,768.10	1,800.21 -5,769.53
Renal complication	6,175.62	4,144.09	5,987.95	3,125.59 – 8,792.93
Coronary complications	5,492.99	3,166.60	4,980.77	3,263.85 – 7,063.95
Cerebrovascular complications	5,038.70	3,055.52	4,540.05	2,943.08 - 6,391.09
Peripheral vascular complications	6,558.89	3,481.47	6,035.96	3,771.65 – 8,502.88
Other complications	694.48	2,194.71	34.50	34.50 – 69

Table 2 shows that the total mean of cost that patients paid for eye complications is the highest (7,584.96 ± 4,189.99 thousand VND), the mean of cost that patients paid for other complications is the lowest (694.48 ± 2,194.71 thousand VND).

Table 3. Components of treatment costs for a patient with type 2 diabetes mellitus with complications in 2023

**Unit: Thousand VND*

Expense	n	Mean	Standard deviation	Median	Interquartile range
Medicine	1,740	2,671.92	2,489.04	2,034.10	886.35 – 3,510.65
Diagnostic Imaging	990	201.94	168.97	153.2	65.4 – 265.9
Testing	1,744	1,099.38	654.29	1,108.05	520.2 – 1,617.45
Minor and major Surgery	241	107.41	105.07	41.6	40 - 144
Medical supplies	310	171.31	124.24	137.4	75.72 – 260.52
Examination	1,793	221.83	127.40	210.00	103.50 -348.00

Table 3 shows that among all the components of treatment costs for a patient in 2023, the average medicine cost was the highest at 2,671.92 thousand VND. Next, the cost for the testing which was 1,099.38 thousand VND; The lowest cost is the Minor and major Surgery cost of 107.41 thousand VND.

Some factors related to direct medical costs of people with type 2 diabetes mellitus with complications

Table 4 . Some factors related to the total direct costs of type II diabetes mellitus patients with complications

Variable	Univariate		Multivariate	
	Coef (thousand VND)	95% CI	Coef (thousand VND)	95% CI
Age				
	43.16 ***	30.18 – 56.13	22.74 ***	14.96 – 30.52
Gender				
Male	ref		ref	
Female	-382.30 ***	(-675.33) – (-89.27)	-353.84 ***	(-510.34)–(-197.34)
Health insurance payment level				
100%	ref		ref	
80%	-699.28 ***	(-1,014.27) – (-384.29)	-314.36 **	(-500.54) – (-128.17))
95%	703.18 **	235.52 – 1,170.83	101.82	(-148.84) – (352.47)

Variable	Univariate		Multivariate	
	Coef (thousand VND)	95% CI	Coef (thousand VND)	95% CI
Number of examinations/year				
	725.11 ***	(703.51 - 746.72)	679.32 ***	(653.86 - 704.77)
Number of complications				
	1,375.67***	1.275.88-1475.46	200.98***	(124.90-277.07)
Multivariate model parameters				
			p<0.001	Adjusted R^2=0.727

** p<0.05 ; ** p<0.01; *** p<0.001*

Table 4 shows the multivariate linear regression results, the model was meaningful statistically significant with p<0.001, adjusted R^2 = 0.727 showed that 72.7% of the change in the dependent variable is explained by the independent variables. Factors related to the direct medical cost of T2DM were age, gender, health insurance payment level, number of examinations/year and number of complications the patient experiences (p<0.001). Age was positively correlated with the total direct medical costs of T2DM with complications. When age increases by 1 year, the total cost increases by 22.74 thousand VND (95%CI: 14.96 - 30.52). Similarly, women pay 353.84 thousand VND less than men (95%CI: (-510.34)–(-197.34)). At the health insurance payment level, compared to the 100% payment level, the 80% payment level was less 314.36 thousand VND (95%CI: (-500.54) – (-128.17)). The number of examinations/year was related to the total cost of direct treatment. Specifically, increasing number of examinations by 1, increases the total direct medical cost by 679.31 thousand VND (95%CI: 653.86 - 704.77). The patient's number of complications was related to the cost. An increase in the number of complications by 1 increases the cost by 200.98 thousand VND (95%CI: 124.90-277.07).

DISCUSSION

Direct medical costs of people with type II diabetes mellitus with complications

The results show that the total direct medical costs of T2DM with complications is 7,243,111,304 VND. Of which the majority of the amount paid by health insurance is 6,724,260,603 VND. Patient co-pay is 518,850,701 VND. The total direct medical costs of 1,793 T2DM patients with complications (12,069 examination visits) in 2023 at Thieu Hoa district General Hospital are higher than the total direct medical costs of T2DM patients with health insurance at District 8 hospital in 2019 (4.6 billion VND); 2020 (5.9 billion VND); 2021 (3.9 billion VND) with total of 28,002 examination visits (7). Comparing this on the basis that both hospitals are class II general hospitals, it can be seen that the total costs related to type II diabetes with complications are much higher than for patients with type II diabetes in general.

Among the components, total medicine costs account for the highest percentage at 64.2% , followed by testing costs at 26.5%, and the lowest was minor and major surgical costs at 0.3%. The explanation for this is that drugs are the main method for medical treatment of T2DM. High drug costs show the dependence on pharmacological therapies in managing diabetes complications. In a

study in India, drug costs also accounted for a large portion of the total cost of diabetes treatment (8). Testing costs are the second largest cost component, but are much lower than drug costs. The reason may be that some health insurance policies also lead to a limited number of tests. The cost of testing emphasizes the importance of regular testing to manage and control the disease, to detect early and promptly treat complications. These results are similar to the findings of other studies, suggesting that regular testing is necessary to effectively manage the condition (9). The cost of minor and major surgical costs was lowest because this is an outpatient category, with very little surgical intervention. This may be because surgical interventions are rare or are performed at specialized medical facilities. The Texas study also found that costs associated with diabetes complications were mainly due to routine medical services and not surgery (9).

Eye complications and renal complications had an average cost for components much higher than the remaining groups of complications, although they only account for a very small number of patients. In particular, eye complications, with the highest average costs, indicate that vision problems such as diabetic retinopathy require complex and expensive treatments. This is consistent with international studies, in which the cost of treating diabetic eye complications is often very high due to the need for many therapies such as optical lasers, intraocular drug injections, and even surgery (8,10). The annual cost of treating eye complications varies from country to country, for example the cost of treating cataract complications is estimated to be 1500 USD (~37,500 thousand VND) in China (11). These results highlight the importance of effectively managing the risk factors and complications associated with T2DM. At the same time, it also provides a basis for financial planning and health policy to minimize medical costs for patients and the health system.

Factors related to direct medical costs

Factors related to direct medical costs of T2DM patients with complications include age, gender, health insurance payment level, number of examinations/year and number of complications encountered by each patient. Age is thought to be related to the cost of treatment for T2DM with complications. Obviously age greatly affects the cost of treatment because the older you are, the greater the cost of treatment. These results reflect that older patients often experience more complications and require more medications to manage their condition. Similar studies have also documented that the cost of treating diabetes increases with age due to the increased complexity of the disease and the need for more medications to control complications (11,12). Gender affects the cost of treatment for T2DM with complications (14). The cost of treatment for T2DM with complication in women was higher than those in men. This has been demonstrated by the fact that women are more likely to have diabetes diagnosed later and in worse conditions, receive both diagnostic and therapeutic support to a lesser extent, and ultimately achieve recommended treatment goals. The guide's recommendations are at a low level. Some studies suggest that women show a significantly higher rate of medication non-adherence due to the cost of medication. They tend to quit smoking, take less medication, or ask their doctor to prescribe a lower- cost alternative (15).

Health insurance payment levels also show clear differences; The direct medical cost of patients with 80% payment level shared payment is lower than the total direct cost of patients with 100% payment level, which reflects the optimization in the use of medical services when patients have to pay part of the

costs themselves, as mentioned in the study. Research by Casagrande and colleagues (2017) (16). The number of examinations per year is proportional to the total cost of treatment, consistent with the study of Nuckols et al (2018), where increased disease management and the number of periodic examinations can increase short-term costs. term but reduces long-term complications and costs (16). The more complications a patient has, the more treatment costs such as examinations, tests, diagnostic imaging, medications, etc. Our research shows that for every increase in one complication, treatment costs increase. 200 thousand VND. These findings emphasize the importance of managing patients with T2DM with complications, and adjusting these factors in health policy for effective management.

Strengths and Limitations

Our study has several strengths. Collecting information about patients' direct medical costs extracted from software on the hospital system, so the cost data is highly accurate and reliable. In other studies, direct healthcare costs were estimated using the number of patient visits as the denominator. However, our study was the first to combine individual patient visits by using unique health insurance code's patients to estimate the total cost of all visits to the same patient and use the number of patients as the denominator. In addition, the study has some limitations due to the data extracted from the software, so information about socio-economic characteristics, patient history characteristics, treatment history characteristics, and medical information and clinical symptoms could not be collected in this study. Limitations in cost, time, and resources made interviewing patients to supplement the above information very difficult. Hence, in the regression model, we are limited in including explanatory variables in the model. So the regression model does not have many suitable variable options. Therefore, in future studies, there must be a combination of patient interviews if there are sufficient resource conditions to help collect more comprehensive information.

CONCLUSION

The majority of direct medical costs of people with T2DM with complications are paid by health insurance (92.8%). The medicine cost component accounts for the highest proportion of 64.2%, followed by testing at 26.5% and the lowest was minor and major surgery costs at 0.3%.

Some factors related to increased direct medical costs in patients with T2DM with complications were increased age, male, increased number of visits per year, and increased number of complications. The results demonstrate the importance of glycemic control, regular disease management, and minimizing risk factors to prevent serious complications. Medical costs for the treatment of T2DM with complications in Vietnam show a strong contribution to the cost of medicine and testing, and emphasize the importance of complex and expensive treatments, especially for severe complications such as eyes and kidneys. Interventions are needed to effectively manage and treat T2DM patients with complications in the future.

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