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RESEARCH ARTICLE

Cost of illness analysis of diabetes mellitus with complications in one hospital in Surabaya

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Abstract

Introduction: The high prevalence and incidence of complications due to diabetes mellitus impose an economic burden on patients and society. **Aim:** To obtain an overview of the cost of diabetes mellitus with complications and identify the factors that affect it. **Methods:** This study was conducted based on the perspective of health care providers. **Results:** The cost of illness for diabetes mellitus with complications was IDR 2,654,047,597 and an average cost of IDR 15,688,528/patient. Diabetes mellitus type 2 with peripheral circulation complications (E11.5) had the highest average cost (IDR 34,135,284/patient). The factors that significantly influenced direct medical costs were the length of stay, class of hospitalisation, and type of complications (Charlson comorbidity index). **Conclusion:** The results of this study indicate that the presence of complications increases the cost of diabetes mellitus treatment.

Introduction

Diabetes mellitus is a global disease affecting low and middle-income countries (International Diabetes Federation, 2019). In 2019, 463 million people had diabetes worldwide. This number is predicted to increase from 578 million to 700 million in 2030 and 2045 (Saeedi *et al.*, 2019). In 2018, Indonesia ranked seventh with 10.7 million people with diabetes mellitus, with 2.6% in East Java. Surabaya was in the third position of cities/districts with the most diabetes sufferers in East Java, reaching 3.5% or ±100,000 people with diabetes (Kementerian Kesehatan Republik Indonesia, 2018).

Diabetes complications are one of the causes of the high percentage of hospitalisations. In 2019, costs spent on diabetes care and diabetes complications amounted to USD 760 million, increasing by 4.5% from 2017 (USD 727 million) (International Diabetes Federation, 2019). The result of a systematic review of the cost of type 1 and type 2 diabetes mellitus with complications in Indonesia showed expenses of USD 654.65-1,268.05/patient/year for outpatients and USD

4,063.32-8,126.64/patient/year for inpatients (Patty *et al.*, 2021). Based on the explanation above, the main objective of this study was to explore the cost of illness in diabetic inpatients with complications, calculated from the time the patient was hospitalised until they were discharged and carried out outpatient control. Factors influencing the cost of diabetes mellitus with complications were also investigated.

Method

Study design and data source

This study was a pharmaco-economic study using a prevalence-based epidemiological data approach with the perspective of the health service provider, the hospital perspective. It also used a cross-sectional design with retrospective data collection of patient medical and medical cost records during inpatient to outpatient control. Ethical clearance was obtained from Dr Ramelan Navy Central Hospital No. 54/EC/KERS/2020.

Study subjects

The study population was all type 2 diabetes mellitus (T2DM) patients who met the following inclusion criteria: (a) hospitalised from July to December 2019, (b) had complications based on ICD 10 criteria (E11.0-E11.8), (c) discharge status of "healthy" or "getting better", (d) did not have TB or HIV/AIDS, and (e) had complete medical and medical costs records (where all the information needed in the study was available there).

Determining direct medical costs and data analysis

The calculation of the Cost of Illness (COI) was bottom-up and done by adding up the direct medical cost components from hospitalisation to outpatient control. This study also looked at the difference between the actual total hospital costs and the total tariff of Indonesian Case Base Groups (INA-CBG's). Analysis of differences of total diabetes costs on diabetes factors applied the Mann Whitney test and the Kruskal-Wallis test. A further test was conducted using multiple linear regression analysis to identify factors that significantly influenced the COI of diabetes mellitus with complications. One-way sensitivity using Microsoft Excel was carried out based on the many sources and assumptions used. It caused uncertainty in the estimation of the COI of T2DM with complications.

Results

The population of inpatients with the primary diagnosis of T2DM in a type A/referral hospital in Surabaya for the period of July-December 2019 was 262 patients. A total of 91 patients were excluded (death, discharge at their own request, and diagnosis of T2DM without complications upon admission). The final sample consisted of 171 subjects (Table I).

Cost of illness of diabetes mellitus with complications

All patients in this study underwent one episode of hospitalisation during July-December 2019. No patient was readmitted to the hospital within six months after discharge. A total of 118 patients attended the first post-hospitalisation outpatient visits. So, with a total of 289 episodes from hospital admission to outpatient control, the cost of illness was IDR 2,654,047,597, with an average of IDR 15,688,528±20,363,629/patient.

Table I: Population characteristics

Variables	n (%)
Sex	
Male	82 (48.0)
Female	89 (52.0)
Types of Complications (ICD 10)	
T2DM with Hyperosmolar (E11.0)	5 (2.9)
T2DM with Ketoacidosis (E11.1)	25 (14.6)
T2DM with Nephropathy (E11.2)	8 (4.7)
T2DM with Neuropathy (E11.4)	17 (9.9)
T2DM with Peripheral Circulation (E11.5)	31 (18.1)
T2DM with other Specified Complications (E11.6)	71 (41.5)
T2DM with Multiple Complications (E11.7)	10 (5.8)
T2DM with Unspecified Complications (E11.8)	4 (2.3)
Age (years)	
<40	7 (4.1)
40 - 59	78 (45.9)
≥ 60	86 (50.0)
Mean ± SD	59.73 ± 11.51
Length of hospitalisation (days)	
<7	92 (53.8)
7	79 (46.2)
Mean ± SD	7.35 ± 4.12
Inpatient class	
I	48 (28.1)
II	74 (43.3)
III	39 (22.8)
VIP - VVIP	10 (5.8)
Outpatient visit	
Control	118 (69.0)
Non-Control	53 (31.0)
Financing system	
Insurance	161 (94.2)
Non-Insurance	10 (5.8)

Direct medical costs of diabetes mellitus with complications

Medical service fees, room fees, and medication costs were the components of direct medical costs with the most significant expenses (Table II) due to diabetes complications. Medical services included general services in addition to specialist and sub-specialist services.

Factors affecting the cost of diabetes mellitus with complications

The results of multiple linear regression analysis showed that the types of complications were based on Charlson comorbidity index ($p=0.0001$), class of hospitalisation ($p=0.005$), and length of stay ($p=0.0001$) and had a significant effect on the cost of illness of diabetes mellitus (Table III). One-way sensitivity analysis was carried out on the type of complication factor (Charlson comorbidity index) with a variety of ± 25% following the

prevalence of complications of diabetes mellitus in previous studies. The total average cost changed by \pm IDR 3,880,187/patient. The length of stay varied by \pm 28% following the ultimate day of treatment. The class of treatment differed by \pm 50% following the difference in

cost per class of hospitalisation. The length of stay and class of hospitalisation also changed the total cost by an average of \pm IDR 4,241,214/patient and \pm IDR 1,881,184/patient, respectively.

Table II: Distribution of costs by component of direct medical costs

Cost component	Average cost in IDR (Inpatient - Outpatient) ¹	Total cost in IDR (Inpatient - Outpatient)
Drug	2,888,666 \pm 4,534,609/Patient	
Diabetes mellitus	57,413 \pm 92,298/Patient	493,962,038
Non-diabetes mellitus	2,831,253 \pm 4,514,890/Patient	
Medical services	5,666,901 \pm 9,088,584/Patient	
Doctor	3,602,414 \pm 7,494,577/Patient	969,040,200
Nursing	2,064,487 \pm 2,325,894/Patient	
Medical support	1,686,8732 \pm 2,508,619/Patient	
Clinical and anatomy laboratory	1,523,246 \pm 2,325,894/Patient	288,455,200
Radiology	163,625 \pm 361,013/Patient	
Medical consumables	424,467 \pm 706,086/Patient	72,583,909
Medical treatment	1,091,469 \pm 3,254,012/Patient	186,641,250
Room	3,762,368 \pm 3,417,987/Patient	643,365,000

¹ Average cost of diabetes per patient from inpatient - outpatient (1 episode of inpatient to 1 episode of outpatient post-KRS)

Table III: Cost distribution based on complication and patient characteristics

Patient factors	Average cost per DM patient with complications in IDR (Inpatient - Outpatient) ¹	p-value
Type of complication		
E11.0 (n = 5) T2DM with hyperosmolarity	15,575,085 \pm 11,463,725/Patient	
E11.1 (n = 8) T2DM with ketoacidosis	11,780,324 \pm 5,925,734/Patient	
E11.2 (n = 25) T2DM with kidney complications	12,118,241 \pm 8,215,311/Patient	
E11.4 (n = 17) T2DM with ophthalmic complications	10,158,392 \pm 12,050,723/Patient	0.0001 [†]
E11.5 (n = 31) T2DM with neurological complications	34,135,284 \pm 34,310,383/Patient	
E11.6 (n = 71) T2DM with circulatory complications	10,773,437 \pm 12,700,681/Patient	
E11.7 (n = 10) T2DM with other specified complications	13,861,071 \pm 13,022,194/Patient	
E11.8 (n = 4) T2DM with unspecified complications	11,140,595 \pm 6,150,616/Patient	
Sex		
Male (n = 82)	18,063,573 \pm 24,614,647/Patient	
Female (n = 89)	13,177,917 \pm 13,569,318/Patient	0.466
Age (years)		
<40 (n = 7)	12,943,577 \pm 10,274,854/Patient	
40 - 59 (n = 78)	16,312,370 \pm 22,289,423/Patient	0.828
\geq 60 (n = 86)	15,012,531 \pm 17,918,822/Patient	
Inpatient class		
I (n = 48)	12,345,813 \pm 13,493,218/Patient	
II (n = 74)	12,898,095 \pm 13,515,248/Patient	
III (n = 39)	19,622,899 \pm 27,057,709/Patient	(0.005)
VIP-VVIP (n = 10)	34,169,649 \pm 19,748,148/Patient	
Length of hospitalisation (days)		
<7 (n = 92)	7,118,148 \pm 5,257,949/Patient	
\geq 7 (n = 79)	25,306,050 \pm 25,248,114/Patient	0.0001 [†]
Outpatient		
Control (n = 118)	15,386,022 \pm 19,899,579/Patient	
Non-Control (n = 53)	15,820,697 \pm 19,592,026/Patient	0.623
Financing		
Insurance (n = 161)	15,323,340 \pm 18,570,754/Patient	
Non-Insurance (n = 10)	18,698,993 \pm 34,978,156/Patient	0.213

¹ Average cost of diabetes per patient from inpatient - outpatient (1 episode of inpatient to 1 episode of outpatient post-hospital discharge); [†]Significant with the Mann-Whitney and Kruskal Wallis tests

The difference in total real cost and total tariff of INA-CBG's package

Of 158 patients, the 108 patients who had the National Health Insurance (JKN) showed a negative difference in

classes I, II, and III, with the highest difference in cost occurring in class III. Most JKN patients were hospitalised using class III. They had a higher average cost of medications, medical support, treatment, and room than class I and class II.

Table IV: Difference in real cost and INA – CBG's per class of hospitalisation

Inpatient class	n	Total cost of INA-CBG's in IDR	Total real hospital costs in IDR	Total cost difference in IDR
Class I	33	226,512,600	415,896,338	189,383,738
Class II	47	397,179,000	621,007,048	223,828,048
Class III	24	224,232,100	403,307,679	179,075,579
Class VIP - VVIP	4	33,015,200	106,336,841	73,321,641
Total cost		880,938,900	1,546,547,906	665,609,006

Inpatient class	n	Average cost of INA-CBG's ¹ in IDR	Average real hospital costs ¹ in IDR	Average difference in cost ¹ in IDR
Class I	33	6,864,018/Patient	12,602,919/Patient	5,738,901/Patient
Class II	47	8,450,617/Patient	13,212,916/Patient	4,762,299/Patient
Class III	24	9,343,004/patient	16,804,487/Patient	7,461,482/Patient
Class VIP - VVIP	4	8,253,800/patient	26,584,210/Patient	8,330,410/patient
Total average cost		8,156,842/Patient	14,319,888/Patient	6,163,046/Patient

INA-CBG's data for 108 patients from a total of 158 patients using JKN

¹ Average cost of diabetes per patient is based on the class of hospitalisation for one episode of hospitalisation

Discussion

T2DM with circulatory complications (E11.5) had the highest direct medical costs, while T2DM with neuropathy complications (E11.4) had the lowest direct medical costs. The components of medical costs that required the highest expenses were medical services, room, and medications. The length of stay and complication types significantly and positively affected direct medical costs, while inpatient care significantly and negatively impacted direct medical costs. The number and severity of complications contributed to increased costs due to the increased need for medical care (Andersson *et al.*, 2020). Several studies reported that the length of stay is influenced by the type of diabetes complication. Complications that require specific medical actions cause patients to have a longer time to be treated, which increases the cost of care (Adiga & Adiga, 2018; Ganasegeran *et al.*, 2020). The difference in accommodation and service in each treatment class also affects costs. The higher the class of care, the greater the cost of hospital accommodation (Puspandari *et al.*, 2015; Aulia *et al.*, 2017).

The strength of this study is that costs reflect total expenditure from the patient's first hospitalisation until six months later upon outpatient control visit, while previous studies only calculated costs of either inpatient or outpatient treatment. This result needs serious attention for the hospital to review whether there are differences in health services provided to

patients in various classes of care or other factors that cause high costs for class III user patients.

Conclusion

The cost of diabetes mellitus with complications in patients hospitalised in one hospital in Surabaya from July to December 2019 was IDR 2,654,047,597, with an average cost of IDR 15,688,528/patient based on the hospital perspective. Average direct medical costs for each type of complication (ICD 10) based on an intermediate hospital perspective were IDR 10,158,392-34,135,384/patient. The lowest mean direct medical costs were for neuropathic complications (E11.4), while the highest mean direct medical costs were peripheral circulation complications (E11.5). Medical service fees, room fees, and medication costs were the components of direct medical costs with the highest average cost. The type of complications, class of hospitalisation, and length of stay significantly affected direct medical costs.

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