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Direct Medical Costs of Diabetes Mellitus Treatment for Patients with Cardiovascular and Renal Complications

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Abstract

Type 2 Diabetes Mellitus (T2DM) represents a growing global health challenge with significant clinical and economic implications, notably in Indonesia. The burden is intensified by renal and cardiovascular complications, especially among National Health Insurance beneficiaries. This retrospective study evaluated the direct medical costs of hospitalized T2DM patients with such complications at a type B hospital from 2019 to 2022. Costs were analyzed from both healthcare provider and payer perspectives, covering medical services, medical support services, pharmaceuticals, and other support services. Of the 192 patients reviewed, most were male (57.8%), aged 45–64 years (72.4%), with hospital stays of 1–5 days (90,1%) and severity level E-4-10-I (100%). Renal complications incur higher treatment costs than cardiovascular complications, with medical support services dominating renal costs and medical services such as doctor and nursing procedures, examinations, and visits contributing most to cardiovascular costs. These results highlight the urgent need for preventive measures, early diagnosis, and innovative treatments to optimize T2DM management and reduce associated economic burdens.

Keywords: cardiovascular complications, diabetes mellitus, direct medical costs, renal complications, type 2

Introduction

Indonesia has one of the highest rates of mortality from diabetes mellitus (DM). The escalating incidence rate among individuals diagnosed with diabetes constitutes a critical public health challenge and a primary area of concern. According to the International Diabetes Federation (IDF), the number of people living with diabetes in Indonesia will rise from 10.7 million in 2019 to a total of 16.6 million by 2045.[1] This projection is corroborated by findings from the 2018 Indonesian Basic Health Research, which indicated a rise in the prevalence of DM from 6.9% to 8.5%.[2] The DM requires relatively high costs if not properly managed.[3] Long-term management is essential to prevent complications from diseases such as heart disease, stroke, and retinopathy.[4] Additionally, DM can induce macrovascular complications, including coronary heart disease, stroke, and peripheral artery disease, alongside microvascular complications, such as diabetic nephropathy and retinopathy.[5] Heart failure frequently emerges as an initial indicator of cardiovascular disease among patients with Type 2 Diabetes Mellitus (T2DM), thereby heightening mortality risk.[6] Furthermore, diabetic foot ulcers are likely to occur in about 15% to 25% of individuals with diabetes during their lifetime. DM patients may also suffer from depression, anxiety, and other psychosocial disorders, which can lower their quality of life.[7]

The financial implications associated with DM management in Indonesia are projected to escalate to approximately USD 1.27 billion by 2020.[5] Furthermore, this financial strain is anticipated to rise significantly in the forthcoming decade, as the global prevalence of DM is expected to surge from 171 million individuals in 2000 to an estimated 366 million by 2030.[4] Complications lead to an increase in the cost burden associated with DM. The T2DM patients with heart complications incur the highest direct medical costs, followed by nephropathy, neuropathy, cerebrovascular disease, retinopathy, and peripheral vascular disease.[3] Treating T2DM with complications takes longer, increasing treatment costs, including direct medical expenses.[8] To surmise, complications of DM significantly impact the cost of managing the disease in Indonesia, create a significant financial burden, and affect the healthcare system as well as the individual and society as a whole, necessitating comprehensive strategies to reduce healthcare spending on DM management.[9]

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The costs associated with DM have continued to rise, driven by the increasing prevalence of diabetes and the escalating expenses related to managing its complications. The cost of diabetes management, particularly in patients with severe complications such as renal and cardiovascular diseases, is approximately twice as high compared to patients without complications or comorbidities.[10] These complications not only deteriorate patients' quality of life but also significantly increase the financial burden on the healthcare system.[11]

The Indonesian Government, through its program called National Health Insurance (NHI), exhibits a substantial commitment to providing comprehensive healthcare coverage for its citizens. This program is specifically designed to address the healthcare needs of all Indonesians, including the ongoing management of patients with DM. However, there remain concerns regarding whether the financial resources allocated by the Social Security Administrative Body/*Badan Penyelenggara Jaminan Sosial* (BPJS) are sufficient to fully fund the medical needs of DM patients, particularly those with cardiovascular and renal complications. In light of the high burden of cardiovascular and renal complications among DM patients in Indonesia, a critical assessment of the adequacy of BPJS funding in ensuring the delivery of these healthcare services is imperative.

Healthcare providers received payment from BPJS through the prospective payment method known as the Indonesian Case-Based Groups (INA-CBGs) tariff, which provides a set price for a specific disease classification episode of care. The INA-CBGs tariff amount is predetermined based on agreed-upon package rates, regardless of the actual costs incurred while providing patient services. The tariff differs by the class of facilities, hospital ownership, class of care, and region. Implementing the prospective payment system in hospitals often leads to discrepancies between the hospital's actual tariff and the INA-CBGs' tariff.[12] The objective of this study was to estimate the direct medical cost of DM treatment for patients with cardiovascular and renal complications and analyze the differences between hospital rates and INA-CBGs rates based on the type of DM complications so it can offer a deeper understanding of cost disparities and assist in the development of policies within Indonesia's healthcare system.

Method

This study was observational research conducted from August until September 2023. This study collected data retrospectively from patient medical records and hospitalization costs for inpatients with DM at a type B hospital in Malang City, Indonesia. According to the Indonesian Minister of Health Regulation Number 03 of 2023, type B hospitals had a minimum of 200 beds.[13] The population only included patients from 2019 to 2022 who met the inclusion criteria: (i) diabetic patients treated without complications, with kidney complications, and with heart complications; (ii) participants of BPJS Healthcare Security; (iii) patients aged 18 years or older; and (iv) those with comprehensive medical record documentation. The three years of data gathered were to observe conditions both before and after COVID-19. Patients with T2DM were identified based on the diagnostic criteria outlined in the International Classification of Diseases Tenth Revision (ICD-10) code E-4-10.

The cost data in this study were sourced from patient billing records obtained through the Hospital Management Information System and the INA-CBGs tariff data collected from databases on computers that incorporated ICD-10. The INA-CBGs tariff was the total claim payments by BPJS Healthcare Security to Advanced Referral Health Facilities for service packages based on the grouping of disease diagnoses and procedures, covering all hospital resources used in both medical and non-medical services.[13] Inpatient data recorded in the medical records, including patient identity profiles, the quantifiable reduction of blood glucose levels during hospitalization, and length of stay (LoS), were also used. Patient data who met inclusion criteria were then analyzed: 1) patient characteristics (age, sex, LoS, disease severity level, type of hospital room); 2) direct medical cost; 3) difference of actual cost and INA-CBGs tariff.

The direct medical cost analysis was conducted by summing up the costs of administration, nutritional services, medical services, medical procedures, medical support, radiology, rehabilitation, and medications based on the perspective of healthcare providers. The costs were categorized into medical services, medical support services, pharmaceuticals, and other support services. After calculating the direct medical costs for DM patients with cardiovascular and renal complications based on the billing records that reflected the total charges, the values were then converted into the actual cost charged by the hospital to the patients.

The distribution of patient severity in DM with cardiovascular and renal complications was classified according to the INA-CBGs system, specifically into three codes: E-4-10-I, E-4-10-II, and E-4-10-III, representing Diabetes Mellitus & Nutritional or Metabolic Disorders. The Roman numerals in the codes indicate the severity level of the disease.[14] The direct medical cost data were then analyzed and compared to the INA-CBG rates based on the diagnosis of cardiovascular

and renal complications. If the direct medical cost was lower than the INA-CBGs tariff, the INA-CBGs rate was considered sufficient; conversely, if the direct medical cost exceeded the INA-CBGs rate, it was deemed insufficient. All costs were standardized to September 19, 2024 (USD 1 = approximately IDR 15,349.70). Further analysis will be conducted to examine cost analysis from healthcare provider and payer (BPJS Healthcare Security) perspectives. The Mann-Whitney test compared two groups with a 95% confidence level (α = 5%).

Results

The characteristics of T2DM patients are illustrated in Table 1. In this study's population, 31.8% had cardiovascular complications, and 68.2% had renal complications. Most were males (57.8%) aged between 45 and 64 years (72.4%). Most patients had a hospital LoS of 1 to 5 days (90.1%). All T2DM with cardiovascular and renal complications were performed at severity level I (100%). Most patients were admitted in 3rd class type of hospital room (46.9%). In this study, the cost components of T2DM cardiovascular and renal complications patients were divided into the actual cost components: medical costs, medical support costs, pharmaceutical costs, and support costs (nutrition and supplement). Table 2 shows the highest cost component during treatment for T2DM cardiovascular and renal complications, respectively.

Table 1. Characteristics of Patients with Type 2 Diabetes Mellitus Cardiovascular and Renal Complication (n=192)

Variable	All (n=192)	Cardiovascular Complication (n=61)		Renal Complication (n=131)	
		n	%	n	%
Sex					
Male	111	42	37.8	69	62.2
Female	81	19	23.5	62	76.5
Age					
18-44 years	20	7	35.0	13	65.0
45-64 years	139	42	30.2	97	69.8
≥65 years	33	12	36.4	21	63.6
Length of Stay					
1-5 days	173	53	30.6	120	69.4
6-10 days	18	7	38.9	11	61.1
>10 days	1	1	100.0	0	0.0
Disease severity level based on INA-CBG category					
E-4-10-I	192	61	31.8	131	68.2
E-4-10-II	0	0	0.0	0	0.0
E-4-10-III	0	0	0.0	0	0.0
Type of hospital room					
1st class	47	12	25.5	35	74.5
2nd class	55	16	29.1	39	70.9
3rd class	90	33	36.7	57	63.3

The total direct medical for treating T2DM with renal complications patients was higher than for treating T2DM with cardiovascular complications. The highest cost component for T2DM patients with cardiovascular complications in I, II, and III classes was medical costs, consisting of doctor and nursing procedures, examinations, visits, and medical service costs. Meanwhile, medical support cost was the highest cost component for T2DM patients with cardiovascular complications in 2nd class. The highest cost component for T2DM patients with renal complications in I, II, and III was medical support costs since the treatment for patients with renal complications contained medical procedures such as surgery and transfusion.

The different amounts of total T2DM with cardiovascular and renal complications based on the actual cost calculation and the INA-CBGs' tariff are shown in Table 3. The amounts were all negative, indicating that the actual costs were higher compared to the INA-CBGs' tariff rates or there was a deficit budget from the perspective of the hospital. For the period of 2019-2022, there was a total deficit of USD 3,293.92 and USD 12,412.61 for the treatment of T2DM with cardiovascular and renal complications, respectively.

Table 2. Average Actual Cost Per Treatment Grade for Type 2 Diabetes Mellitus with Cardiovascular and Renal Complication Patients

Type of Hospital Room	Complication	Average Actual Cost*				
		Medical Cost	Medical Support Cost	Pharmaceutical Cost	Support Cost	Total
1st Class	Cardiovascular	131.06	109.45	79.35	61.94	381.80
	Renal	89.90	184.07	92.12	57.68	423.77
2nd Class	Cardiovascular	96.23	116.90	71.48	28.34	312.94
	Renal	97.30	150.20	108.50	33.99	389.99
3rd Class	Cardiovascular	100.26	66.79	86.20	32.34	285.59
	Renal	97.17	157.20	99.04	35.89	389.30

*) The costs are in USD. USD 1 = approximately IDR 15,349.70.

Table 3. Difference of Total Cost for Type 2 Diabetes Mellitus with Cardiovascular and Renal Complications Patients Between the Actual Cost and the INA-CBG Tariff

Type of Hospital Room	Cardiovascular Complication		Renal Complication	
	Number of Cases	Difference of Costs*	Number of Cases	Difference of Costs*
1st Class	12	760.48	35	2,228.01
2nd Class	16	628.96	39	2,942.96
3rd Class	33	1,904.48	57	7,241.64
Total	61	3,293.92	131	12,412.61

*) The costs are in USD. USD 1 = approximately IDR 15,349.70.

Table 4 presents the results of statistical analyses comparing the actual healthcare costs with the INA-CBGs' tariffs on T2DM with cardiovascular and renal complications. No statistically significant differences were observed among T2DM patients with cardiovascular complications receiving treatment under the disease severity level of E-4-10-I in the 2nd class hospital room (p-value = 0.151) and 3rd class hospital room (p-value = 0.650), as both p-values exceeded the 0.05 significance threshold. Similarly, no significant difference was found among T2DM patients with renal complications treated under the disease severity level of E-4-10-I in the 3rd class hospital room (p-value = 0.145).

Table 4. Comparison of the Actual Cost and INA-CBGs' Tariff Rates for Type 2 Diabetes Mellitus with Cardiovascular and Renal Complication Patients

Type of Hospital Room	Method of Cost Measurement	Cardiovascular Complication		Renal Complication	
		Average Cost	Sig.	Average Cost	Sig.
1st Class	Actual Cost	381.80	<0.001*	423.77	<0.001*
	Ina CBG's Tariff	319.47		360.67	
2nd Class	Actual Cost	312.94	0.151	389.99	<0.001*
	Ina CBG's Tariff	273.84		314.78	
3rd Class	Actual Cost	285.59	0.650	389.30	0.145
	Ina CBG's Tariff	228.19		262.88	

**) significant value.* The costs are in USD. USD 1 = approximately IDR 15,349.70.

Discussion

This study focused on T2DM with complications, particularly cardiovascular and renal complications, in the NHI scheme. T2DM and its complications have reached epidemic proportions, especially in developing countries. The global diabetes epidemic is primarily driven by rapid socioeconomic changes, including urbanization and industrialization.[15] Most patients in this study were in the 3rd class of hospital room type since the proportion of patients covered by BPJS Healthcare Security in the 3rd class was the highest. All T2DM cases were in the severity level of E-4-10-I. In all groups of severity level and hospital room type of the T2DM with complication cases in the study, the different amounts of the actual cost expenditure and the INA-CBGs' tariff rates were negative, or in other words, the actual costs were higher as compared to the INA-CBGs' tariff rates.

For four years, the hospital experienced a substantial financial deficit resulting from the discrepancy between actual healthcare costs and the INA-CBGs' tariff rates, particularly for cases of T2DM with renal complications, which outnumbered cardiovascular complications. The average expenditures for T2DM with complications, based on the actual cost calculations and INA-CBGs' tariffs, showed significant differences, with actual costs consistently lower than the corresponding INA-CBGs' tariff rates across both types of complications. In terms of hospital room classification, both the actual costs and INA-CBGs' tariffs were highest in 1st class hospital rooms and progressively decreased in the 2nd and

3rd class hospital rooms. Additionally, treatment costs for patients categorized under severity level E-4-10-I were the lowest. Increased costs associated with severity levels E-4-10-II and E-4-10-III were attributed to comorbidities and disease complications, necessitating more intensive procedures, additional services, and longer LoS in the hospital.[16] These findings are consistent with a previous study, which reported that the average hospital inpatient costs exceeded the INA-CBGs' tariff rates.[17] This suggests that the unit costs calculated using activity-based costing methods were higher than both the actual costs and the INA-CBGs' tariffs.[18]

The main issue of this study was that the Indonesian Government's claim for T2DM with complications through the INA-CBGs was significantly lower than the total costs incurred by the hospital. The lower the type of hospital room, the higher the disparity since the hospital financing package decreased. No studies have been conducted to compare the costs of T2DM with cardiovascular and renal complications in Indonesia. However, this study showed low claims of funding from the Indonesian Government for T2DM with complications. Additionally, this study revealed that 68.22% of T2DM patients experienced renal complications. This result was consistent with a previous study, which reported a 32% prevalence of microalbuminuria among T2DM patients in Japan.[19] Similarly, studies in the United States have shown that approximately 36% of T2DM patients experience albuminuria, while 28% suffer from kidney-related complications.[20]

T2DM is a major risk factor for the development of chronic kidney disease, which can progress to end-stage renal disease and require costly treatments such as dialysis or kidney transplantation.[21] The significant increase in the prevalence of T2DM has led to an increased financial burden due to diabetic complications. Aggressive efforts to raise awareness, improve treatment adherence, ensure early diagnosis, and optimize monitoring are essential to achieve treatment goals and slow the progression of cardiovascular and renal complications associated with T2DM.[22] Furthermore, the treatment costs for T2DM with complications are often associated with pharmacological treatments, diagnostics, and therapeutic procedures.[23] These results aligned with a previous study on the impact of complications on direct treatment costs for T2DM in Indonesia, which showed that 84.35% of T2DM patients had at least one complication, with an average treatment cost of USD 774.37 per patient.[8]

Meanwhile, studies from the United States have estimated that the annual direct medical costs attributable to diabetes are approximately USD 12,022 per patient.[24] This means that the lowest price in the US area has a T2DM payment rate of up to 30 times the INA-CBGs claim for T2DM in Indonesia. The low price of T2DM claims needs to be a concerning issue. It is crucial to define a grouping algorithm as a Diagnosis-Related Group (DRG), which we refer to as INA-CBGs, to have a fair performance comparison and hospital reimbursement.[25] The optimal design of the DRG system for T2DM cases is critical to ensure adequate performance comparisons and appropriate reimbursement for these causes of frequent hospitalizations. The impact of low financing can certainly disrupt service quality and hospital cash flow, which needs further investigation. However, the World Health Organization has never recommended a specific rate for a country or hospital because each region has a different situation.

Moreover, hospitals must implement Clinical Pathways (CP) to assist the Responsible Medical Officer/*Dokter Penanggung Jawab Pelayanan* (DPJP) in making decisions regarding patient care. The CP in cost control serves as a guideline for medical staff to refer to when administering treatments and medications to patients. This is necessary to ensure that treatment is provided according to the medications and procedures that are truly required based on the patient's diagnosis and condition. In treating patients with DM and complications, CP can provide more detailed guidance on daily management and standardization of other medical disciplines, such as surgeons managing blood sugar levels during procedures with service standards deemed appropriate.[26] The CP also impacts hospital management in making decisions about patient care. Timely and optimal management of T2DM can offer potential cost-saving capacities in preventing complications, which can be achieved through ongoing monitoring and treatment at each level of care.[27]

This study had a limitation. The investigation was conducted in a single hospital, limiting the ability to compare hospital cost rates across multiple facilities. A broader analysis involving multiple hospitals is necessary for a more comprehensive understanding of cost variations. Generally, the INA-CBG claims from the Indonesian Government are significantly lower than those in other countries and addressing the rising costs of T2DM treatments is crucial to align with actuarial standards. Strengthening the financing scheme within the NHI system is essential to support providing high-quality T2DM care and improving the quality of life for patients in Indonesia.

Conclusion

This study provides valuable insights into the clinical and economic challenges of managing T2DM with complications in Indonesia. The total direct medical for treating T2DM with renal complications patients is higher than for treating T2DM with cardiovascular complications. The highest cost component for T2DM with cardiovascular consists of doctor and nursing procedures, examinations, visits, and medical service costs. Meanwhile, the highest cost component for T2DM with renal complications is medical support costs. This study highlights differences between T2DM with complication expenditures based on the actual cost and INA-CBGs' tariff rates, in which the INA-CBGs' tariff was lower than the actual cost. The study supports evaluating the INA-CBGs' tariff rates to accommodate actual healthcare expenditure. On the other hand, the hospital needs to evaluate the service quality of patient treatment by optimizing the budget allocated by the health insurance.

Abbreviations

DM: Diabetes Mellitus; T2DM: Type 2 Diabetes Mellitus; BPJS: *Badan Penyelenggara Jaminan Sosial*/Social Security Administrative Body; INA-CBGs: Indonesian Case-Based Groups; LoS: length of stay; NHI: National Health Insurance; DRG: Diagnosis-Related Group; CP: Clinal Pathways.

Ethics Approval and Consent to Participate

Ethical approval for this study was obtained from the Health Research Ethics Commission of Poltekkes Kemenkes Malang No.516/VI/KEPK POLKESMA/2023. Informed consent was obtained prior to data collection, and confidentiality was guaranteed.

Competing Interest

The authors declared no conflict of interest to be disclosed.

Availability of Data and Materials

Data and materials are available upon request.

Authors' Contribution

RF designed the study. RF, ATP, and AAICD conducted data collection. RF and ATP interpreted the data and wrote the manuscript.

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