

## Cost-Effectiveness Analysis Of Antidiabetic Medications In Patients With Type 2 Diabetes Mellitus at Rajawali Citra Hospital

Qarriy 'Aina Urfiyya\*, Nirma Nur Khasanah

Diploma III Pharmacy, Academy Pharmacy of Indonesia Yogyakarta

\*email: [qarriyainaurfiyya@afi.ac.id](mailto:qarriyainaurfiyya@afi.ac.id)

### Abstract

Indonesia ranks fourth in the world for the number of individuals with diabetes mellitus (DM). To manage this growing health concern, it is crucial to implement treatments that include pharmacological therapies, such as antidiabetic. This study aims to identify the most cost-effective type of antidiabetic drug for patients with type 2 diabetes mellitus, based on the Average Cost-Effectiveness Ratio values. This study was a descriptive observational study that utilized medical records of outpatients with Type 2 Diabetes Mellitus at Rajawali Citra Hospital from 2023 to 2025, involving a total of 52 participants who met the criteria. The sampling technique employed was purposive sampling. Data analysis included demographic and clinical characteristics, therapy cost components, and cost-effectiveness based on Average Cost-Effectiveness Ratio values. The results indicated that the majority of diabetes patients were over the age of 45 (94.2%), with 67.3% being female. For patient covered by BPJS (Indonesia's National Health Insurance), the most cost-effective monotherapy was pioglitazone, whereas the most cost-effective combination therapy was metformin with acarbose. For the non-insured patients with type 2 diabetes, the most cost-effective monotherapy was sulfonylurea, and the most cost-effective combination was sulfonylurea with acarbose.

**Keywords:** antidiabetic, CEA, ACER, COI, HbA1c

### 1. INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disease characterized by high blood sugar levels (hyperglycemia). This condition arises when the body cannot produce enough insulin or when it becomes resistant to insulin. Indonesia ranks fourth globally in the number of diabetes patients (Badan Penelitian dan Pengembangan Republik Indonesia, 2023). More than 90% of individuals with diabetes have type 2 diabetes, which is primarily caused by insulin resistance (World Health Organization, 2023). The prevalence of diabetes in Indonesia reached 11.7% in 2023, up from 10.9% in 2018. It is estimated that the number of diabetes patients will exceed 20 million by 2024 (Kemenkes, 2023).

The management of diabetes mellitus involves the use of antidiabetic medications. When selecting these medications, it is important to consider their effects on the patient's condition, their effectiveness in reducing blood glucose, the potential risk of side effects, and the availability of the drugs (Perkumpulan Endokrinologi Indonesia, 2021). According to the International Diabetes Federation (IDF), the cost of diabetes care was estimated at US\$465 billion in total global healthcare expenditure on diabetes in the year 2011, with projections indicating that this cost could exceed US\$595 billion by 2030 (IDF, 2019). The high expenses associated with diabetes therapy create a significant economic burden on both the healthcare system and the national economy (Direktorat Jenderal Pencegahan dan Pengendalian Penyakit, 2019).

There is a necessity for improved cost control while ensuring effective treatment, which can be achieved through cost-effectiveness analysis. A study by Sulastrı et al.'s (2023) concluded that metformin is more cost-effective than the combination of metformin and glimepiride, as determined by the Average Cost-Effectiveness Ratio (ACER) and Incremental Cost-Effectiveness Ratio (ICER) methods (Sulastrı, et al., 2023). Another study found that the combination of metformin and glimepiride is more cost-effective according to the ACER method (Apriandy, 2022). Based on this background, it is essential to perform a cost-effectiveness analysis of antidiabetic medications for patients with type 2 diabetes.

## **2. METHOD**

### **Research design**

The study utilized a descriptive observational design to analyze direct medical cost data for evaluating the cost-effectiveness of antidiabetic. This research has received ethical approval from Rajawali Citra Hospital with the number 023/Pemb/RSU/RS/III/2025.

### **Population and Research Sample**

The population for this study consists of all medical record data from outpatient Type 2 Diabetes Mellitus patients who had their HbA1c levels checked between February 2023 and February 2025 at Rajawali Citra Hospital. A purposive sampling technique will be employed for this research. The inclusion criteria for participants are as follows: patients who are receiving antidiabetic treatment, those who have undergone HbA1c testing 2-3 months after starting the therapy, and patients with complete medical and financial records. The exclusion criterion was pregnant patients. The sample was 52 patients, including 42 patients covered by BPJS (Indonesia's National Health Insurance) and 10 non-insured patients.

### **Data Collection**

Data collection included patient identity (age, gender, disease history, diagnosis), laboratory data (HbA1c), pharmaceutical data (drugs obtained by the patient) and financial data (registration fees, laboratory, doctor's services, supporting measures, and medicine).

### **Data Analysis**

Data collection included patient demographic and clinical characteristics, cost component and effectiveness of therapy using the ACER (average cost-effectiveness ratio) method. Therapy effectiveness was assessed based on the achievement of HbA1c control, which was categorized into good and poor glycemetic control. Cost adjustments were made by referring to 2025 values. Patient costs incurred in 2023–2024 were converted to their 2025 equivalent using the future value formula, taking into account the annual interest rate and the time period (Urfiyya, et al., 2020). The average interest rate in 2023-2024 is 6% (Badan Pusat Statistik, 2025). The formula for effectiveness and ACER is as follows:

$$Effectiveness (\%) = \frac{Total\ patient\ who\ achieved\ the\ therapy\ target}{total\ patient\ with\ the\ same\ therapy} \times 100$$

$$ACER = \frac{Average\ medical\ cost}{Effectiveness (\%)}$$

Statistical analysis was conducted to identify the factors influencing glycemetic control in patients with type 2 diabetes mellitus (DM) using the chi-square test. In addition, linear regression tests were used to assess the cost of therapy for these patients. All statistical analyses were performed using SPSS version 23.

## **3. RESULTS AND DISCUSSION**

### **1. Demographic and Clinical Characteristics of Diabetes Mellitus Patients**

Patient characteristics, particularly clinical factors, play a crucial role in the effectiveness of antidiabetic therapy. Successful antidiabetic treatment is indicated by good glycemetic control, defined as less than 7% for age under 60 years and between 7.5% and 8.5% for elderly patients aged over 60 years (PERKENI, 2021). Maintaining good glycemetic control in individuals with diabetes mellitus can reduces the risk of both microvascular and macrovascular complications (Boye, et al., 2022).

**Table 1.** Demographic and Clinical Characteristics of Type 2 Diabetes Mellitus Patients

Category	Control Glycemic n (%)			P value*
	Good	Poor	Total n (%)	
<b>Age</b>				
<45	1(33.3)	2(66.7)	3(5.8)	0.590
≥45	27(55.1)	22(44.9)	49(94.2)	
<b>Gender</b>				
Male	12(70.6)	5(29.4)	17(32.7)	0.091
Woman	16(45.7)	19(54.3)	35(67.3)	
<b>Comorbidities</b>				
None	15(71.4)	6(28.6)	21(40.4)	0.036*
Yes	13(41.9)	18(58.1)	31(59.6)	
<b>Antidiabetic</b>				
Sulfonylurea	6(85.7)	1(14.3)	7(13.5)	0.035*
Metformin	6(66.7)	3(33.3)	9(17.3)	
Pioglitazone	1(100)	0(0)	1(1.9)	
Insulin	3(25)	9(75)	12(23.1)	
Sulfonylurea+Insulin	1(100)	0(0)	1(1.9)	
Sulfonylurea+Acarbose	1(100)	0(0)	1(1.9)	
Metformin+Sulfonylurea	5(71.4)	2(28.6)	7(13.5)	
Metformin+Insulin	1(14.3)	6(85.7)	7(13.5)	
Metformin+Acarbose	2(100)	0(0)	2(3.8)	
Pioglitazone+Insulin	0(0)	1(100)	1(1.9)	
Metformin+Acarbose	0(0)	2(100)	2(3.8)	
Metformin+Sulfonylurea+Insulin	1(100)	0(0)	1(1.9)	
Metformin+Sulfonylurea+Acarbose	1(100)	0(0)	1(1.9)	

Noted =\*Significant difference in chi square/fisher test

The results presented in Table 1 indicated that the majority of individuals with type 2 diabetes mellitus (DM) were over 45 years old (94.2%). This finding aligns with several previous studies that demonstrate a significant increase in the risk of developing type 2 diabetes starting at age 45 (Urfiyya & Azizah, 2025). Individuals over 45 years old exhibit better glycemic control, with 55.1% compared to only 33.3% of those under 45 years old. Previous research suggests that older adults tend to have HbA1c levels under 7%, with an odds ratio of 0.95 (Suprapti, et al., 2023). It because the age of over 45 tends to prioritize self-care, dietary

arrangements, medical supervision and family support (Yu, *et al.*, 2020), so that it can achieve a better HbA1c target.

Women experienced type 2 diabetes mellitus more frequently than men, accounting for 67.3% of the cases. Similar studies have shown that more women than men have type 2 diabetes (Urfiyya & Azizah, 2024). However, approximately 54.3% of women experience poor glycemic control. These findings align with meta-analysis research indicating that a greater percentage of men (60.8%) reach the HbA1c target compared to women (54.3%). This difference may be attributed to the hormone testosterone in men, which aids in lipolysis and enhances insulin sensitivity (Arnetz, *et al.*, 2014).

In the study, 59.6% of patients had comorbidities, while 40.4% did not. Additionally, type 2 DM patients with poor glycemic control were more likely to have comorbidities, with this group representing 58.1% of those studied. An Ethiopian study further highlighted that patients with type 2 diabetes and multiple comorbidities face a 2.56 times higher risk of experiencing poor glycemic control (Mamo & Bekele, F, 2019).

The data in Table 1 indicate that single-therapy insulin was used by the majority of patients with type 2 diabetes mellitus (DM), accounting for 23.1%. Several previous studies have reported similar findings, with single insulin therapy being used by 22.6% of patients (Urfiyya & Aisyah, 2023) dan 53,76% (Fahmi & Urfiyya, 2022). According to DM therapy guidelines, insulin should be utilized if a patient does not achieve the target HbA1c after reaching the optimal dose of oral antidiabetic medications, whether used alone or in combination (Perkumpulan Endokrinologi Indonesia, 2021). However, it is noteworthy that therapy involving single insulin is associated with a high rate of poor glycemic control, with 75% of patients not achieving the desired outcomes. Qualitative research has identified several key obstacles to insulin therapy, including challenges with food intake routines, medication schedules, fear of hypoglycemia, and discomfort associated with using syringes (Tong WT, *et al.*, 2015).

The chi-square test results indicated that comorbidities and antidiabetic therapy significantly influenced glycemic control ( $p$  value  $< 0.05$ ). Other studies have also shown that various antidiabetic therapy regimens significantly impact patients' glycemic control (Wulandari, *et al.*, 2021).

## 2. Components of Costs for Patients with Type 2 Diabetes Mellitus

Fee adjustments are made as the value of money changes over time (Urfiyya, *et al.*, 2022), Therefore, cost data from the previous year needs to be equalized for proper comparison.

**Table 2.** Cost Components of Outpatient Visits for Patients with Type 2 Diabetes Mellitus

Cost Component	Average Cost IDR (Mean $\pm$ SD)	Significance	R
<b>Patient covered by BPJS</b>			
Registration	19.457 $\pm$ 5.255	0.173	0.214
Medicine	327.535 $\pm$ 234.487	0.000*	0.983
Doctor's services	49.363 $\pm$ 10.341	0.036*	0.325
Laboratory	88.862 $\pm$ 30.744	0.002*	0.473
Accommodation	37.203 $\pm$ 10.008	0.172	0.239
Supporting checks	1900 $\pm$ 10.165		
Average Cost per patient	485.247 $\pm$ 193.105		
<b>Non-insured Patients</b>			
Registration	16.741 $\pm$ 8.994	0.005*	0.800
Medicine	126.504 $\pm$ 198.391	0.000*	0.983
Doctor's services	37.320 $\pm$ 10.323	0.989	0.005
Laboratory	97.970 $\pm$ 44.311	0.045*	0.643
Accommodation	74.414 $\pm$ 13.589		
Supporting checks	0		
Average Cost per patient	274.589 $\pm$ 244.332		

**Ket :** \* **Multiple linear regression test**, \* $p < 0.05$ . R coefficient correlation

The average cost for outpatient visits of type 2 diabetes mellitus (DM) patients covered by BPJS was IDR 485,247 per visit, while the average cost for non-insured patients was IDR 235,249 per visit. This amount is significantly higher when compared to the average monthly expenditure on health costs, which is IDR 31,445 in 2023. In contrast, the average monthly expenditure for private healthcare in the DI Yogyakarta province is IDR 27,092 in 2023. This total includes costs for health services, medications, and curative treatments (Badan Pusat Statistik, 2023).

The cost of patients covered by BPJS is higher than that of non-insured patients can be caused by various factors, such as more guaranteed procedures and medications, as well as the characteristics of the patient. In patients covered by BPJS and the non-insured patients, the largest cost components are the cost of drugs (antidiabetes, complication drugs and comorbidities), laboratories, and doctors. The doctor's fee is the services of a general practitioner or internal medicine specialist. A systematic review of studies in Indonesia, found that drug costs are the main contributor to direct medical costs of diabetes mellitus patients

(Patty, et al., 2021). The high cost of medication in outpatients because the drug is given for long-term use, before the next control. A statistical analysis using linear regression was conducted to assess the influence of various cost components on the total expenses of type 2 diabetes mellitus patients covered by BPJS compared to those without it.

The results of the linear regression analysis on BPJS patient costs showed that medicine, doctor's service and laboratory costs had significant p-values ( $< 0.05$ ), indicating a significant influence of these cost components on the total cost of type 2 DM patients covered by BPJS. The correlation coefficient (R) indicated the strength of the relationship between variables, where medication costs and total costs had a very strong relationship ( $R = 0.800-1.000$ ), laboratory costs had a moderate relationship with total costs ( $R = 0.400-0.600$ ), and doctor's services costs had a weak relationship with total costs ( $R = 0.200-0.400$ ). Meanwhile, for non-insured patients, the components of medicine costs, laboratory costs, and registration fees ( $p < 0.05$ ) also had a significant influence on the total cost. Medication and registration costs had a very strong relationship with total cost ( $R = 0.800-1.000$ ), while laboratory costs had a strong relationship ( $R = 0.600-0.800$ ). All correlation coefficients (R) were positive, indicating that higher individual cost components were associated with higher total outpatient costs for type 2 DM patients, both in BPJS and non-insured patient groups.

### **3. Cost-effectiveness analysis**

The effectiveness of antidiabetic therapy in this study used the achievement of the HbA1c target according to the PERKENI (2021) guidelines, after 2-3 months of antidiabetic use. The HbA1c target for diabetes mellitus patients is based on PERKENI (2021), which is  $<7\%$  and  $7.5-8.5\%$  for elderly patients (Indonesian Endocrinology Association, 2021) (Minister of Social Affairs of the Republic of Indonesia, 2012). The results of the antidiabetic effectiveness analysis are shown in table 3.

**Table 3.** Average Cost Effectiveness Ratio (ACER) Antidiabetic Patients with Type 2 Diabetes Mellitus Outpatient Covered by BPJS and Non-Insured Guarantee

Therapy	Number of Patients	% Effectiveness	Average Cost (IDR)	ACER (IDR)
<b>Patients Covered by BPJS</b>				
<b>Monotherapy</b>				
Sulfonylurea	2	100%	679.638	679.638
Metformin	6	50%	427.508	855.017
Pioglitazone	1	100%	207.522	207.522
Insulin	10	30%	563.085	1.876.950
<b>Combination Therapy</b>				
Metformin+ sulfonylurea	3	67%	321.274	481.911
Metformin+Acarbose	2	100%	331.968	331.968
Sulfonylurea+Acarbose	1	100%	458.692	458.692
Metformin+Insulin	5	20%	612.873	3.064.367
Sulfonylurea+Insulin	1	100%	1.285.905	1.285.905
Pioglitazone+Insulin	1	0%	569.183	-
Metformin+Acarbose+Insulin	2	0%	586.385	-
Metformin+Sulfonylurea+Insulin	1	100%	585.898	585.898
Metformin+sulfonylurea+Acarbose	1	100%	420.289	420.289
<b>Non-insured patients</b>				
<b>Monotherapy</b>				
Sulfonylurea	1	100%	90.927	90.927
Metformin	2	100%	486.578	486.578
<b>Combination Therapy</b>				
Metformin+Sulfonylurea	2	50%	168.282	336.565
Metformin+Insulin	1	0%	145.509	-
Sulfonylurea+Acarbose	1	100%	128.588	128.588

The Average Cost-Effectiveness Ratio (ACER) indicates the cost associated with achieving effective therapy results; a smaller ACER value signifies a more cost-effective therapy (Jannah, et al., 2021). The results presented in Table 3 reveal that the lowest ACER for monotherapy among patient covered by BPJS was pioglitazone, which was IDR 207,522 per percentage of therapy effectiveness. This suggests that to reach the same HbA1c target, using pioglitazone is more cost-effective. However, it is important to note that pioglitazone was only

used by one patient in the study, which limits its representation of the overall population. Meta-analytic studies have shown that pioglitazone monotherapy was effective and safe for patients with type 2 diabetes. It has proven efficacy in managing hyperglycemia, lipid metabolism, and blood pressure, making it a viable alternative to metformin treatment (Alam, et al., 2019). For combination therapy in BPJS patients, the lowest ACER was metformin with acarbose, amounting to IDR 331,968. Acarbose can be utilized as a first-line alternative when prandial blood glucose levels exceed fasting blood glucose levels (Perkumpulan Endokrinologi Indonesia, 2021).

Based on the results in Table 3, the lowest Average Cost-Effectiveness Ratio (ACER) value for non-insured patients using single monotherapy was found with Sulfonylurea, which amounted to IDR 90,927. Previous studies indicated that the ACER for Sulfonylurea therapy was IDR 1,369 per percentage of effectiveness, suggesting that it has a very low ACER value (Laelasari, et al., 2017). Additional literature has shown that both Metformin and Sulfonylurea effectively lower blood sugar levels at a low cost (Ivana, et al., 2022). In combination therapy, the ACER for Sulfonylurea combined with Acarbose was IDR 128,588. Acarbose is typically used for patients who do not respond adequately to monotherapy or who experience significant postprandial hyperglycemia. When added to Sulfonylurea, its clinical effectiveness can be considerable in certain patient populations, which may influence the ACER value.

#### **4. CONCLUSION**

In patients with Type 2 Diabetes Mellitus covered by BPJS, the most cost-effective monotherapy was pioglitazone, while the most cost effective of combination therapy was metformin with acarbose. In patients with non-insured Type 2 Diabetes Mellitus, the most cost effective monotherapy was sulfonylurea, and the most cost effective combination therapy was sulfonylurea with acarbose.

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