

## **Cost-Effectiveness Analysis of Simvastatin and Atorvastatin in Hypertensive patients with type 2 Diabetes Mellitus Comorbidities at KHZ Musthafa Regional Hospital: from the provider's perspective**

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### **Abstract**

Hypertension with comorbid type 2 diabetes mellitus is a chronic condition strongly associated with an increased risk of cardiovascular complications, such as coronary heart disease, stroke, and vascular damage. This condition requires pharmacological therapy that is not only clinically effective but also cost-effective in terms of healthcare services. In clinical practice, statins such as simvastatin and atorvastatin are frequently used as lipid-lowering therapy to help reduce the risk of cardiovascular complications in patients with metabolic diseases. However, differences in treatment costs and clinical outcomes between these two medications make pharmacoeconomic evaluation crucial in determining the most cost-effective therapeutic option. This study aims to analyze the cost-effectiveness of simvastatin and atorvastatin use in hypertensive patients with type 2 diabetes mellitus comorbidity from the perspective of healthcare providers at KHZ Musthafa Regional General Hospital, Tasikmalaya. This study employed a retrospective cross-sectional design based on medical records and patient billing data from January 2024 to December 2025. Using purposive sampling, 57 patients who met the inclusion criteria were included in the study. Cost-effectiveness analysis was performed by calculating direct medical costs, therapeutic effectiveness based on the average length of hospital stay (LOS), the Average Cost-Effectiveness Ratio (ACER), and the Incremental Cost-Effectiveness Ratio (ICER). The results showed that the group of patients receiving simvastatin had lower direct medical costs, namely Rp4,269,569, compared to the atorvastatin group at Rp5,902,031. In addition, the simvastatin group also showed a shorter average length of stay, namely 3.8 days, while the atorvastatin group reached 4.7 days. The ICER for simvastatin was recorded at Rp1,123,570 per day, which is lower than that of atorvastatin at Rp1,255,751 per day. Based on these results, simvastatin is considered more cost-effective than atorvastatin in hypertensive patients with type 2 diabetes mellitus, making it a potentially more efficient therapeutic option for hospitals.

**Keywords:** atorvastatin, cost-effectiveness analysis, hypertension, simvastatin, type 2 diabetes mellitus

### **Introduction**

Hypertension is one of the major risk factors for cardiovascular disease (CVD) and contributes significantly to rising rates of morbidity and mortality worldwide. The

significant increase in the risk of complications can lead to chronic high blood pressure, which triggers systemic changes in the body, including alterations in the structure and function of blood vessels and ultimately accelerates the development of atherosclerosis, such as coronary heart disease, and even stroke.<sup>1</sup> This risk can increase significantly in individuals with comorbid conditions such as type 2 diabetes mellitus (T2DM), where the interplay of these comorbidities accelerates atherosclerosis, increases vascular inflammation, and hastens cardiometabolic progression.<sup>2</sup>

According to the Survey Kesehatan Indonesia (SKI), the prevalence of hypertension among the population aged  $\geq 18$  years reached 30.8%, while the prevalence of diabetes based on laboratory tests reached 11.7%; these figures indicate that a high burden of metabolic diseases is associated with an increasing incidence of chronic diseases.<sup>3</sup> In Tasikmalaya City, the number of people with diabetes was recorded at 11,782 in 2023, this figure illustrates the high need for metabolic disease management in the region. Although specific data on the prevalence of hypertension as a comorbidity with type 2 diabetes in Indonesia are limited, various studies indicate that these two conditions often occur at the same time, thereby increasing the risk of complications. A 2024 meta-analysis reported a prevalence of hypertension comorbidity in patients with type 2 diabetes of 45%, with global prevalence ranging from 45–70%. This condition has a significant impact on the healthcare system, patients' quality of life, and the increased complexity of disease management due to the high risk of chronic complications and the strain on healthcare resources.<sup>4</sup>

In the management of CVD complications in this group, statins are an integral part of therapy, as recommended by the European Society of Cardiology.<sup>5</sup> In addition to being an integral part of therapy, statins work pharmacologically to lower LDL cholesterol levels and reduce the risk of major cardiovascular events.<sup>6</sup> The two most commonly used statins, based on the national formulary, are simvastatin and atorvastatin, due to their widespread availability and relatively affordable cost.

As a high-intensity statin, atorvastatin can lower LDL by approximately 45-60%, whereas simvastatin, a moderate-intensity statin, reduces cholesterol by about 25-40%. Although atorvastatin is more effective in lowering cholesterol, it tends to be more expensive than simvastatin.<sup>7</sup> Given the disparities between these two types of statins in terms of efficacy, potential side effects, and cost differences, there is a need to evaluate whether the increased efficacy of atorvastatin justifies the additional costs borne by healthcare providers.<sup>8</sup>

In this case, statin therapy has a more significant impact on clinical outcomes because the combination of these two conditions can increase the risk of CVD events by up to three times compared to individuals without diabetes. Since high LDL levels can accelerate atherosclerosis, thereby affecting other clinical outcomes including length of hospital stay, statin therapy should be considered in terms of clinical outcomes, long-term safety, and cost-effectiveness.<sup>9</sup>

In pharmacoeconomic studies, the CEA method, particularly when comparing two interventions that differ in terms of their potential and other factors, serves as a tool for assessing the relationship between costs and the clinical outcomes produced by a given therapy. This analysis is particularly important in managing chronic diseases requiring long-term therapy, such as hypertension and type 2 diabetes. Without systematic analysis, drug selection decisions carry potential risks if healthcare

providers rely solely on clinical preferences or short-term pricing considerations, without evaluating the optimal benefits for patients.<sup>10</sup>

## Method

### Research Design

This study is a non-experimental study employing a quantitative, observational, and analytical approach using a retrospective cross-sectional design from the healthcare provider's perspective. The study was conducted at KHZ Musthafa General Hospital in Tasikmalaya, with data collected from inpatients between January 2024 and December 2025. This study has obtained ethical approval from the Ethics Committee of BTH University Tasikmalaya with approval number No. 076-01/E.01/KEPK-BTH/III/2026.

### Research Instruments

The instruments used in this study involved the collection of data obtained from the hospital management information system (HMIS). Data analysis was conducted using secondary data obtained from:

1. Medical Records: include demographic characteristics (covering medical record number, age, gender, discharge status, and length of stay), medical history diagnoses, and clinical data during treatment.
2. Hospital Billing: includes direct medical costs, such as pharmacy costs (including medication prices, medical supplies, etc), consultation fees, laboratory costs, medical procedure costs, and care class costs, as viewed from the provider's perspective.

### Population and Sample

The study population consisted of all inpatients with a primary diagnosis of hypertension and type 2 diabetes mellitus who were hospitalized at KHZ Musthafa General Hospital in Tasikmalaya and received simvastatin and atorvastatin therapy between January 2024 and December 2025. The sample was collected using purposive sampling based on established inclusion and exclusion criteria, resulting in a sample size of 57 patients. Sampling was conducted using a purposive sampling technique based on predetermined inclusion and exclusion criteria. Of the total 57 inpatients who met the study period criteria, 153 patients were excluded due to incomplete medical records, not receiving simvastatin or atorvastatin as primary therapy, or death during treatment, resulting in 57 patients who met the criteria and were analyzed in this study.

Inclusion criteria included patients diagnosed with hypertension accompanied by type 2 diabetes who received simvastatin or atorvastatin therapy, with complete medical records and billing data, and patients whose treatment status was marked as completed (not referred or deceased). Exclusion criteria include patients with incomplete data, changes that occurred during the treatment period, and patients who were reported to have died or been referred.

### Research Variables

The research variables include the type of statin therapy, clinical effectiveness, and direct medical costs. Clinical effectiveness is assessed based on the length of hospital stay during inpatient care. Direct medical costs include pharmaceutical costs (medications, medical devices, and others), inpatient costs, laboratory costs, medical procedure costs, and healthcare administrative costs.

### Data Analysis Phase

Data analysis was conducted using descriptive methods with Microsoft Excel and Microsoft Word to ensure data validity. After the data were processed descriptively and presented in tabular form, the total data were compiled, and direct medical costs were calculated. This cost and effectiveness information was then used to calculate the average value and determine the ACER using the following equation:

$$ACER = \frac{\text{Average Cost (C)}}{\%effectiveness (E)}$$

Notes:

Cost = Average direct medical costs / average treatment costs

Effectiveness = Treatment outcomes, in the form of changes in clinical parameters serving as intermediate outcomes.

The lower the cost and the higher the effectiveness achieved, the more cost-effective the therapy is considered. To determine the additional cost required to achieve a one-unit increase in effectiveness, the Incremental ICER is calculated as follows:

$$ICER = \frac{\Delta Cost}{\Delta Effectiveness} = \frac{Cost A - cost B}{Effectiveness A - Effectiveness B}$$

A negative or smaller ICER value indicates that an intervention is both cheaper and more effective than its alternative, and can therefore be considered a superior therapeutic option from an economic standpoint.

## Result

### Patient Demographic

**Table 1.** Patient Demographic Data

No.	Parameter	Notes	v	%
1.	Gender	Woman	42	26,32
		Man	15	73,68
	<b>Total</b>		57	100
2.	Age (years)	45-59	5	8,77
		60-74	38	66,67
		≥ 90	14	24,56
	<b>Total</b>		57	100
3.	Length of Stay (day)	1-3	22	38,59
		4-7	29	50,87
		>8	6	10,52
	<b>Total</b>		57	100
4.	Type of statin	Simvastatin	16	28,07
		Atorvastatin	41	71,92
	<b>Total</b>		57	100
5.	Group of disease	Hypertensive + Type 2 DM	57	100
	<b>Total</b>		57	100

The majority of patients in this study were women, totaling 42 patients (73.68%), while the largest age group consisted of those aged 60–74 years (according to WHO

2023), comprising 38 patients (66.67%). The predominance of female patients may be related to the increased prevalence of hypertension and type 2 diabetes mellitus among postmenopausal women, as decreased estrogen levels contribute to endothelial dysfunction, increased arterial stiffness, insulin resistance, and dyslipidemia, thereby increasing cardiovascular risk and the need for statin therapy. The most common length of stay (LOS) was 4–7 days, involving 29 patients (50.87%). Statin use was dominated by atorvastatin in 41 patients (71.92%), while simvastatin was used in 16 patients (28.07%). The majority of patients were in the hypertension group with type 2 diabetes mellitus as a comorbidity, totaling 57 patients (98.24%).

## Analyse

**Table 2.** Analysis of Direct Medical Costs, Treatment Effectiveness, and ACER Value

No.	Type of Statin	Direct Medical Cost (Rp)	LOS	ACER (Rp)
1.	Simvastatin	4.269.569	3,8	1,123,570/day
2.	Atorvastatin	5.902.031	4,7	1,255,751/day

**Table 3.** Incremental Cost-Effectiveness Ratio Value

$\Delta C$ (Rp)	$\Delta E$	ICER
-1.632.462	+0.9	Dominant

According to Table 2, the simvastatin group had lower average direct medical costs (Rp4,269,569) than the atorvastatin group (Rp5,902,031). The higher total costs in the atorvastatin group were primarily due to medication costs, as atorvastatin therapy accounted for a larger share of direct medical expenditures than simvastatin.

Therapeutic effectiveness, as assessed based on the LOS parameter, showed that the simvastatin group had a shorter average length of stay of 3.8 days compared to the atorvastatin group's 4.7 days. These results indicate that patients receiving simvastatin therapy tend to have a shorter duration of care compared to those receiving atorvastatin.

Calculations of the ACER showed that the simvastatin group had a lower ACER value of Rp1,123,570/day compared to the atorvastatin group's Rp1,255,751/day. A lower ACER value indicates that simvastatin offers better cost-effectiveness in achieving clinical outcomes compared to atorvastatin.

Overall, the results of the cost-effectiveness analysis (CEA) indicate that simvastatin is more cost-effective than atorvastatin, as it is associated with lower direct medical costs and a shorter average length of stay (LOS), which were used as measures of effectiveness in this study.

## Discussion

### Demographic and Clinical Characteristics of Patients

This study employed a CEA approach from the hospital's perspective (provider perspective) to evaluate the cost-effectiveness of simvastatin and atorvastatin in hypertensive patients with type 2 diabetes mellitus at KHZ Musthafa Hospital in Tasikmalaya. A retrospective approach was used to identify the relationship between

direct medical costs and patient clinical outcomes based on medical records and the hospital billing system during the study period. In this study, treatment effectiveness was measured using the LOS as an indicator of clinical outcomes during the patient's hospitalization.

Patient characteristics indicate that the majority of patients were female, accounting for 73.68%, while male patients accounted for 26.32%. The high number of female patients in this study suggests that women are more likely to develop cardiometabolic disorders, particularly in older age. Hormonal changes following menopause are known to affect lipid metabolism, insulin sensitivity, and blood pressure regulation, thereby increasing the risk of concurrent hypertension and type 2 diabetes.<sup>11</sup>

The age distribution of patients is dominated by the 60-74 age group, accounting for 66.67%, followed by those over 90 years of age at 24.56%. Advancing age is associated with a decline in metabolic function, increased insulin resistance, and reduced vascular elasticity, all of which can increase the risk of cardiovascular and metabolic diseases.<sup>12</sup> These conditions make older patients more susceptible to hypertension with type 2 diabetes as a comorbidity.<sup>13</sup>

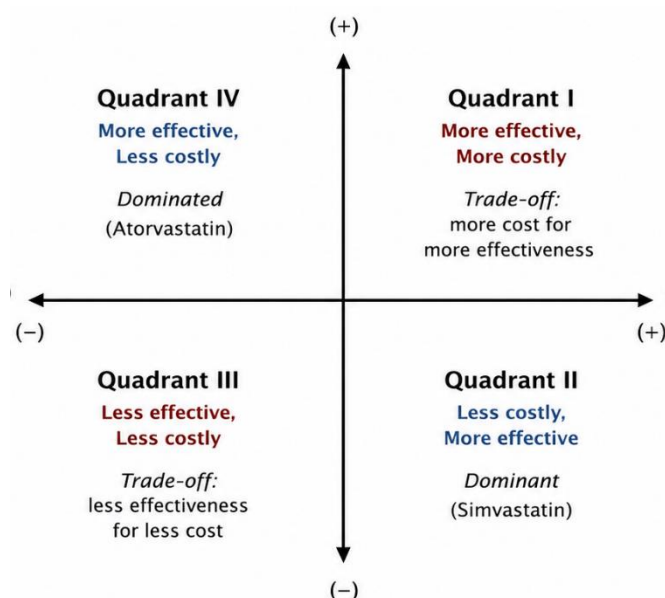
Data on LOS indicate that the majority of patients were hospitalized for 4-7 days (50.87%), while 10.52% of patients had a length of stay exceeding 8 days. Differences in length of stay can be influenced by disease severity, the presence of comorbidities, the patient's clinical condition upon admission, and therapeutic response during treatment.<sup>14</sup> In pharmacoeconomic studies, LOS is one of the indicators frequently used to describe the effectiveness of care and the efficiency of hospital resource utilization.<sup>15</sup>

Most commonly used statin therapy in this study was atorvastatin, accounting for 71.92%, while simvastatin use was 28.07%. The dominance of atorvastatin use is likely influenced by its greater intensity of LDL cholesterol reduction compared to simvastatin.<sup>16</sup> In patients with high cardiovascular risk, such as those with hypertension accompanied by type 2 diabetes mellitus, the use of high-intensity statins is often prioritized to reduce the risk of atherosclerosis and major cardiovascular events.<sup>10</sup>

The patient group in this study was dominated by patients with hypertension and type 2 diabetes mellitus as a comorbidity, accounting for 98.24%. This finding indicates that the two conditions are closely linked in increasing the risk of cardiovascular disease.<sup>17</sup> The combination of hypertension and type 2 diabetes is known to accelerate vascular endothelial damage, increase systemic inflammation, and worsen the progression of cardiometabolic diseases if not optimally managed.<sup>4</sup>

### **Cost-Effectiveness Analysis**

The pharmacoeconomic analysis in this study was conducted using the ACER and ICER approaches to assess the relationship between treatment costs and the resulting clinical effectiveness. ACER was used to describe the average cost required to achieve one unit of treatment effectiveness. In contrast, ICER was used to compare differences in costs and effectiveness between the treatments being compared. The study results showed that the simvastatin group had a direct medical cost of Rp4,269,569, while the atorvastatin group had a cost of Rp5,902,031. This difference indicates that the use of atorvastatin requires higher direct medical costs compared to simvastatin during the inpatient care period.<sup>18</sup>



**Figure 1.** Cost-effectiveness diagram

Therapeutic effectiveness, as measured by the LOS parameter, showed that the simvastatin group had a shorter average length of stay of 3.8 days compared to the atorvastatin group's 4.7 days. A shorter length of stay indicates better clinical outcomes and reflects more optimal healthcare efficiency during the patient's hospitalization.<sup>19</sup>

ACER calculations show that the simvastatin group has a value of Rp1,123,570/day, while the atorvastatin group has a value of Rp1,255,751/day. The lower ACER value indicates that simvastatin is more cost-effective than atorvastatin in achieving clinical outcomes based on the length of patient hospitalization.<sup>20</sup>

Based on the interpretation of the pharmacoeconomic diagram (cost-effectiveness plane), simvastatin therapy is in quadrant II (dominant quadrant) because it has lower treatment costs with better effectiveness compared to atorvastatin. Conversely, atorvastatin is in quadrant IV (dominated quadrant) because it shows higher costs with lower effectiveness based on the LOS parameter. This position indicates that simvastatin is a more cost-effective therapy than atorvastatin from the hospital's perspective.<sup>21</sup>

In pharmacoeconomic evaluations, the interpretation of cost-effectiveness can also be linked to the concept of Willingness to Pay (WTP), which refers to the maximum additional cost that is still acceptable to achieve an improvement in therapeutic effectiveness.<sup>2</sup> In this study, simvastatin did not require further WTP consideration because it was already in a dominant position with lower costs and better clinical outcomes compared to the comparator therapy.<sup>22</sup> These findings indicate that simvastatin provides both clinical benefits and economic efficiency in the management of hypertensive patients with type 2 diabetes mellitus.<sup>23</sup>

The study results show that simvastatin has a better cost-effectiveness profile than atorvastatin. This finding is supported by the ICER analysis, which shows that simvastatin is a dominant strategy because it results in lower direct medical costs ( $\Delta C = -Rp1,632,462$ ) while achieving greater effectiveness, as indicated by a shorter length of hospital stay ( $\Delta E = +0.9$  days). Therefore, simvastatin occupies the dominant quadrant in the cost-effectiveness matrix, indicating that this drug is both less expensive and more effective than atorvastatin. These findings suggest that the

selection of statin therapy should consider not only therapeutic effectiveness but also economic efficiency in the management of patients with hypertension and type 2 diabetes mellitus.<sup>14</sup>

## Conclusion

Based on the study results, simvastatin is more cost-effective than atorvastatin in hypertensive patients with type 2 diabetes mellitus at KHZ Musthafa General Hospital in Tasikmalaya. Simvastatin is associated with lower direct medical costs and a shorter average length of hospital stay. The ACER values and pharmacoeconomic diagram show that simvastatin is the dominant treatment strategy, indicating that this drug is a more efficient therapeutic alternative from the hospital's perspective.

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