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Original Article

# Determinants of cost discrepancies in inpatients with acute decompensated heart failure

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ABSTRACT

*Background*: Acute decompensated heart failure (ADHF) is a prevalent and complex condition that significantly burdens healthcare systems, requiring intensive care and leading to high treatment costs.
*Objective*: This study aims to identify factors influencing cost discrepancies in hospitalized ADHF patients.
*Methods*: This retrospective study was conducted at Universitas Brawijaya Hospital from July to August 2024. Data were collected from 86 ADHF patients who were hospitalized between January 2021 and December 2023. Information regarding the patients' clinical conditions, comorbidities, and medical procedures was extracted from their case histories. Statistical analyses included t-tests and Mann-Whitney tests.
*Result*: In this study of 86 individuals with ADHF, 58.1% were over 65 years old, 31.4% were between 45 and 64 years old, and 10.5% were between 18 and 44 years old. By classification of care, 58.1% were admitted for Class 1 care, 30.2% for Class 2, and 11.6% for Class 3. Our findings indicated that the costs of treatment for patients with moderate and severe diseases were higher as compared to those of mild severity. Patients who had a length of stay over 7 days had higher costs than the ones whose length of stay was 1 to 3 days. Furthermore, Class 2 care was associated with higher costs than Class 3 care. The analysis also revealed that an increase in the number of comorbidities and medical procedures corresponded with higher treatment costs.
*Conclusion*: This study identified factors that increase the cost of treatment for patients with ADHF.

## 1. Introduction

Acute decompensated heart failure (ADHF) is a critical public health problem and the leading cause of hospitalization.[1] Two factors believed to be causing an increased incidence of ADHF include an aging population and the rising prevalence of heart diseases.[2] The reported frequency varies from 1.5% to 40%, with an estimated death rate between 4% and 7%.[3] One of the most important clinically and financially related issues is the divergence between budgets of hospitals or health care facilities and actual expenditures for the care of the patients.[4] This issue of divergence, especially in developing nations where resources may be few, is very important.[5] Generally, three major determinants of the cost of care for ADHF patients include length of stay, presence of coexisting conditions, and severity of illness.[2]

The severity of ADHF, the type of care received, and the patient's additional comorbidities are all important factors that can affect the cost of therapy for ADHF.[2] Economic costs can vary from patient to patient. In the meantime, information regarding the various elements influencing the cost of treatment for ADHF patients in Indonesia has not been extensively accessible. Therefore, this study aims to close this information gap by determining and quantifying the variables that affect hospital cost differences for patients with ADHF, with a particular emphasis on three important predictive factors: duration of stay, concomitant illnesses, and disease severity.[6] It's critical to comprehend these elements in order to improve hospital resource use and patient care efficiency.[7] The study's conclusions can therefore guide the development and application of initiatives and policies that should lower the expenses associated with treating ADHF. As a result of this research investigation, individuals with ADHF would generally receive higher-quality healthcare through improved management.

## 2. Methods

*Design & ethical approval*

This study employed a retrospective design in determining the factors that were associated with disparities in the cost of care for inpatients diagnosed with ADHF. This study was conducted at Universitas Brawijaya Hospital from July to August 2024. The data in this study was taken from the medical record of the patients. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist.[8] The protocols of our study were approved by the local ethics committee of Universitas Surabaya under registration number 414/KE/VIII/2024. This study also followed the Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects.[9] Informed consent from the patients was not applicable, since this study retrospectively analyzed patients' medical data.[10],

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*Participants & eligibility criteria*

The study population consists of all inpatient patients at Universitas Brawijaya Hospital diagnosed with ADHF. The sample for the study was selected using a consecutive sampling technique based on inclusion and exclusion criteria. The minimum sample size required for this study is 86 patients. This minimum sample size was calculated using a sample size formula with a 5% margin of error and a 95% confidence level, based on the estimated prevalence of ADHF derived from historical data of the hospital. The inclusion criteria for this study include patients aged 18 years and older who were diagnosed with ADHF, hospitalized during the study period, and had complete medical records and insurance claims data. Exclusion criteria for this study include patients with severe comorbidities unrelated to ADHF or patients who died before a final diagnosis was made.

Data collection & covariates

The study data were collected from patient medical records, medication claim details, and actual treatment costs at Universitas Brawijaya Hospital. Collected information included medical record numbers, gender, age, primary diagnosis, comorbidities, number of medical procedures, length of stay, patient condition upon discharge, and total treatment costs. Data collection was carried out by the research team, consisting of the principal investigator (JA) and two researchers (AL, AR). Discrepancies in the data were resolved through discussions. The outcome variable in this study was the alignment of actual patient costs during hospitalization at our facility. The predictor variables included age, gender, disease severity, ward class, length of stay, presence of comorbidities, and the number of medical procedures performed.

Statistical analysis

Data in this study were presented as mean ± standard deviation (SD) for normally distributed data or median (IQR) for non-normally distributed data. Normality was assessed using the Kolmogorov-Smirnov test, where a p-value < 0.05 indicated non-normal distribution, and a p-value ≥ 0.05 indicated normal distribution. To identify differences in patient care costs at our hospital, we performed a t-test for normally distributed data or a Mann-Whitney test for non-normally distributed data. Effect sizes were reported as mean differences or median differences with 95% confidence intervals (95% CI), depending on the data distribution. Statistical analyses were conducted using GraphPad Prism software (GraphPad Prism; GraphPad Software, Inc.; California, US).

## 3. Results

*Baseline characteristics of patients included in our study*

This study involved 86 patients with ADHF treated at Brawijaya University Hospital between January 1, 2021, and December 31, 2023. Among the total 86 samples, the majority of patients were aged > 65 years (58.1%), followed by those aged 45-64 years (31.4%) and 18-44 years (10.5%). Male patients had an average actual treatment cost of IDR 5,565,834 (IDR 2,924,138), while female patients had a cost of IDR 5,254,087 (IDR 3,444,922). Based on age groups, patients aged 18-44 years had an average cost of IDR 6,566,766 ± IDR 1,888,489; those aged 45-64 years, IDR 5,354,994 ± IDR 3,213,537; and those aged ≥ 65 years, IDR 5,565,834 (IDR 3,132,732). Patients with mild, moderate, and severe disease severity incurred costs of IDR 4,894,548 ± IDR 1,440,847; IDR 6,010,367 (IQR: IDR 4,554,640); and IDR 8,927,856 ± IDR 5,490,763, respectively. Costs also varied by treatment class: IDR 5,564,617 ± IDR 3,848,556 (Class 1); IDR 7,741,553 ± IDR 4,239,923 (Class 2); and IDR 5,254,087 ± IDR 2,893,061 (Class 3). For the length of stay (LOS), patients hospitalized for 1-3 days incurred costs of IDR 4,195,061 ± IDR 1,487,968; those for 4-6 days, IDR 5,661,280 (IQR: IDR 3,216,648); and those for ≥ 7 days, IDR 14,718,724 (IQR: IDR 2,287,035). Regarding comorbidities, patients without comorbidities had costs of IDR 4,372,056 ± IDR 886,600; with one comorbidity, IDR 4,613,894 ± IDR 1,682,175; with two comorbidities, IDR 5,565,834 ± IDR 2,659,093; with three comorbidities, IDR 6,777,230 (IQR: IDR 4,051,714); and with ≥ four comorbidities, IDR 11,241,558 ± IDR 5,356,313. Patients undergoing 0-4 medical procedures incurred costs of IDR 5,264,610 ± IDR 2,614,197, while those undergoing ≥ 5 procedures incurred costs of IDR 5,611,019 ± IDR 2,988,756.

*Factors associated with cost discrepancies in inpatients with acute decompensated heart failure*

Our findings revealed no significant cost differences between male and female patients (MD: 311,747; 95% CI: -780,673 to 1,279,042; p: 0.5130). Regarding age groups, costs for patients aged 18–44 years did not differ significantly from those aged 45–64 years (MD: 357,497; 95% CI: -1,773,821 to 2,912,081; p: 0.3448) or >65 years (MD: 146,657; 95% CI: -1,868,701 to 2,472,811; p: 0.4694). Similarly, costs for the 45–64 age group were not significantly different from those for patients >65 years (MD: -210,840; 95% CI: -1,413,237 to 756,280; p: 0.5818). In terms of disease severity, costs for patients with mild severity were lower than those with moderate (MD: -1,167,016; 95% CI: -2,602,380 to -421,056; p: 0.0039) and severe conditions (MD: -4,033,309; 95% CI: -6,121,357 to -1,945,260; p: 0.0003). However, costs for moderate and severe cases were not significantly different (MD: 1,395,133; 95% CI: -1,628,100 to 4,657,706; p: 0.4466). For care classes, no significant cost differences were found between Class 1 and Class 2 (MD: -954,649; 95% CI: -2,602,411 to 1,366,477; p: 0.5742) or Class 3 (MD: 310,531; 95% CI: -208,779 to 2,022,597; p: 0.1265). However, costs for Class 2 were higher than Class 3 (MD: 1,265,179; 95% CI: 967 to 3,556,009; p: 0.049) (Figure 1).

Regarding LOS, we found that costs for LOS 1–3 days were lower than for LOS 4–6 days (MD: -1,699,226; 95% CI: -3,123,056 to -1,266,317; p: <0.0001) and LOS >7 days (MD: -10,756,670; 95% CI: -12,403,263 to -7,235,809; p: 0.0007). Costs for LOS 4–6 days were also lower than for LOS >7 days (MD: -9,057,444; 95% CI: -10,527,044 to -3,207,594; p: 0.0108). For the number of comorbidities, costs for patients without comorbidities were not significantly different from those with 1 comorbidity (MD: -232,680; 95% CI: -1,188,473 to 1,418,256; p: 0.8656) or 2 comorbidities (MD: -1,193,778; 95% CI: -2,669,775 to 235,825; p: 0.0989). However, costs for patients without comorbidities were lower than for those with 3 comorbidities (MD: -2,405,174; 95% CI: -5,408,706 to -190,801; p: 0.0245) and >4 comorbidities (MD: -6,187,686; 95% CI: -13,400,285 to -1,456,363; p: 0.0023). Costs for patients with 1 comorbidity were lower than for those with 3 comorbidities (MD: -2,172,494; 95% CI: -4,247,279 to -809,976; p: 0.0040) and >4 comorbidities (MD: -5,955,006; 95% CI: -11,661,218 to -2,093,220; p: 0.0006). Patients with 2 comorbidities had lower costs than those with >4 comorbidities (MD: -4,993,908; 95% CI: -7,861,825 to -690,906; p: 0.0174) but no significant difference compared to patients with 3 comorbidities (MD: -1,211,396; 95% CI: -2,953,785 to 407,019; p: 0.1811). Costs for patients with 3 comorbidities were not significantly different from those with >4 comorbidities (MD: -3,782,512; 95% CI: -7,326,049 to 1,346,479; p: 0.1101). For the number of medical procedures, costs for patients with 0–4 procedures were lower than for those with >5 procedures (MD: -766,317; 95% CI: -2,367,433 to -32,681; p: 0.0449). Finally, regarding profitability, costs for patients in the loss group were lower than for those in the profit group (MD: 2,367,157; 95% CI: 1,773,076 to 4,171,807; p: <0.0001) (Figure 2).

## 4. Discussion

This study reported the factors associated with the healthcare costs of ADHF patients. Our results showed that the actual cost of care for ADHF patients varies, with an average cost of IDR 6,629,766. The range of healthcare costs for ADHF patients in our hospital was between IDR 4,195,061 and IDR 14,718,724, and may still increase depending on factors such as LOS, comorbidities, and the severity of the disease. Our results were consistent with findings from a study by Lilis Suryani et al. (2017), which reported higher heart disease treatment costs, around IDR 19,776,669, as well as research by Nisa (2020), which reported a cost range between IDR 5,365,745 and IDR 23,387,781. However, the costs found in our study tend to be lower compared to these studies. This may be due to factors such as disease severity, gender, and age of the patients, which also influence the cost of care.[11] This aligns with findings from other studies that highlight the significant impact of comorbidities and disease severity on the hospitalization costs of heart failure patients.[12]

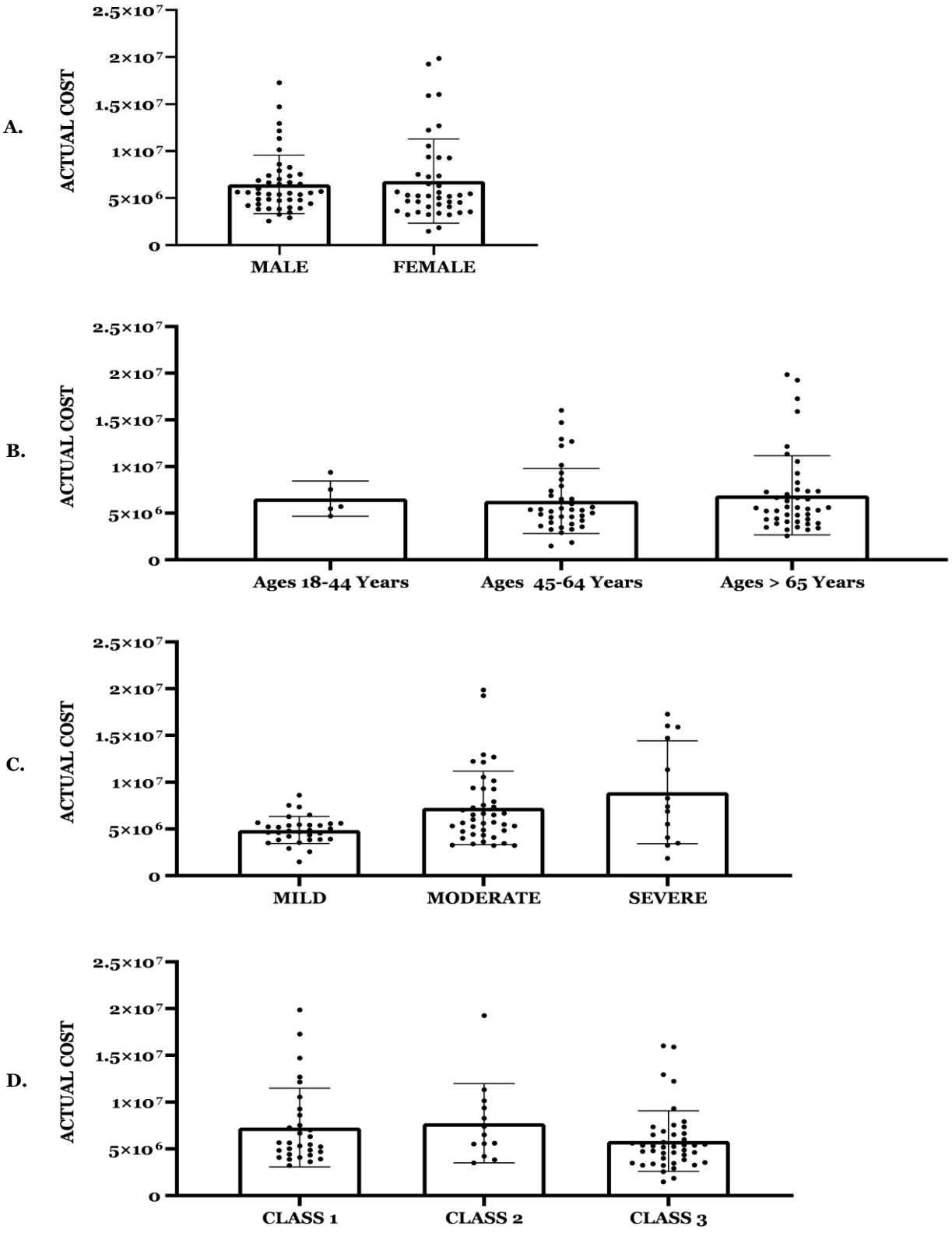


**Figure 1.** A). Differences in costs by gender, showing no significant difference between males and females (MD: 311,747; 95% CI: -780,673 to 1,279,042; p = 0.5130). B). Differences in costs by age, indicating no significant difference between the 18–44 age group and the 45–64 age group (MD: 357,497; 95% CI: -1,773,821 to 2,912,081; p = 0.3448) or the >65 age group (MD: 146,657; 95% CI: -1,868,701 to 2,472,811; p = 0.4694). Costs for the 45–64 age group were also not significantly different from those of the >65 age group (MD: -210,840; 95% CI: -1,413,237 to 756,280; p = 0.5818). C). Differences in costs by severity level, showing that costs for patients with mild severity were significantly lower than those with moderate severity (MD: -1,167,016; 95% CI: -2,602,380 to -421,056; p = 0.0039) and severe severity (MD: -4,033,309; 95% CI: -6,121,357 to -1,945,260; p = 0.0003). Costs for patients with moderate severity were not significantly different from those with severe severity (MD: 1,395,133; 95% CI: -1,628,100 to 4,657,706; p = 0.4466). D). Differences in costs by BPJS class, showing no significant difference between Class 1 and Class 2 (MD: -954,649; 95% CI: -2,602,411 to 1,366,477; p = 0.5742) or Class 3 (MD: 310,531; 95% CI: -208,779 to 2,022,597; p = 0.1265). Costs for Class 2 were significantly higher than those for Class 3 (MD: 1,265,179; 95% CI: 967.0 to 3,556,009; p = 0.049). Note, data were presented in IDR

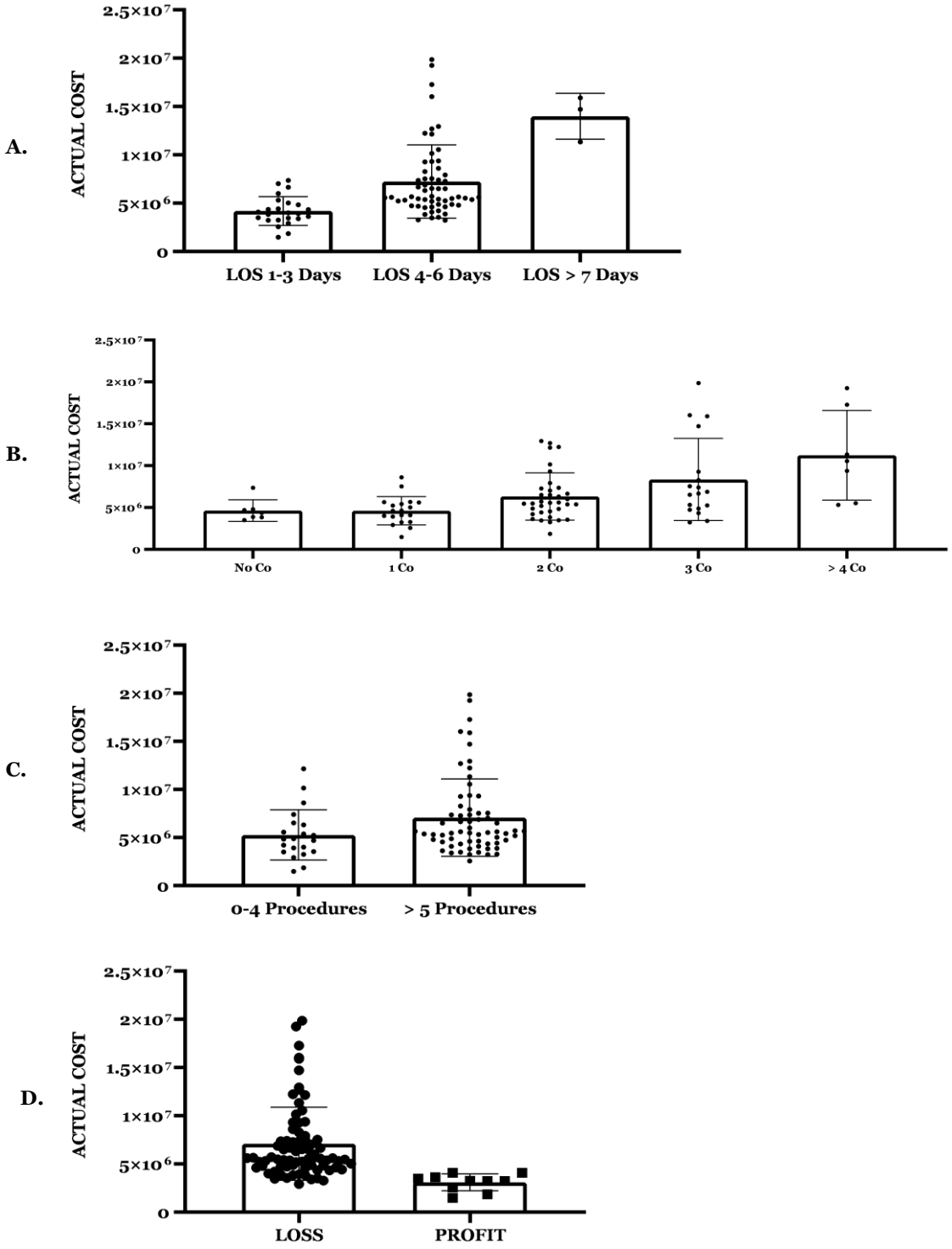


Figure 2. A). Differences in costs based on length of stay (LOS): Costs for patients with LOS 1–3 days were significantly lower than those with LOS 4–6 days (MD: -1,699,226; 95% CI: -3,123,056 to -1,266,317; p < 0.0001) and LOS >7 days (MD: -10,756,670; 95% CI: -12,403,263 to -7,235,809; p = 0.0007). Costs for patients with LOS 4–6 days were also significantly lower than those with LOS >7 days (MD: -9,057,444; 95% CI: -10,527,044 to -3,207,594; p = 0.0108). B). Differences in costs based on the number of comorbidities: Costs for patients without comorbidities were not significantly different from those with 1 comorbidity (MD: -232,680; 95% CI: -1,188,473 to 1,418,256; p = 0.8656) or 2 comorbidities (MD: -1,193,778; 95% CI: -2,669,775 to 235,825; p = 0.0989). However, costs for patients without comorbidities were significantly lower than those with 3 comorbidities (MD: -2,405,174; 95% CI: -5,408,706 to -190,801; p = 0.0245) and >4 comorbidities (MD: -6,187,686; 95% CI: -13,400,285 to -1,456,363; p = 0.0023). Costs for patients with 1 comorbidity were lower than those with 3 comorbidities (MD: -2,172,494; 95% CI: -4,247,279 to -809,976; p = 0.0040) and >4 comorbidities (MD: -5,955,006; 95% CI: -11,661,218 to -2,093,220; p = 0.0006). Costs for patients with 2 comorbidities were lower than those with >4 comorbidities (MD: -4,993,908; 95% CI: -7,861,825 to -690,906; p = 0.0174) but not significantly different from those with 3 comorbidities (MD: -1,211,396; 95% CI: -2,953,785 to 407,019; p = 0.1811). Costs for patients with 3 comorbidities were not significantly different from those with >4 comorbidities (MD: -3,782,512; 95% CI: -7,326,049 to 1,346,479; p = 0.1101). C). Differences in costs based on the number of medical procedures: Costs for patients with 0–4 procedures were significantly lower than those with >5 procedures (MD: -766,317; 95% CI: -2,367,433 to -32,681; p = 0.0449). D). Differences in costs based on profitability: Costs for patients in the loss group were significantly lower than those in the profit group (MD: 2,367,157; 95% CI: 1,773,076 to 4,171,807; p < 0.0001). Note, data were presented in IDR

The theoretical basis of our findings is factors influencing healthcare costs for ADHF patients, though causality cannot be precisely established. One such theory is the health cost model, which includes comorbidities, length of stay, and disease severity. These factors together influence the utilization of medical resources and the overall cost of care.[13] As proof, research by Munawaroh et al. (2019)[14] and Mardiah et al. (2015)[15] finds evidence that the more serious diseases a patient suffers from, the more he requires treatment, which correspondingly raises the cost of caring.[16] Besides disease complexity, the number of detemines the overall cost, whereby there is an increase in length of stay due to diagnosis, hence increasing cost.[17] Larger studies are needed to understand more of the mechanisms behind such findings and, inportantly, whether age, sex, and comorbidities can provide a better prediction of health costs.

This study has several benefits and clinical implications. First, it provides important information for hospital budgeting regarding the healthcare costs of ADHF patients, which can help manage hospital resources more efficiently. Second, the findings can assist doctors in determining more effective treatment options to reduce unnecessary healthcare costs. Third, knowledge of the impact of comorbidities on healthcare costs can encourage medical practice to focus more on the effective management of comorbid conditions. Fourth, this study can be used by hospital managers to design training for medical staff to enhance service efficiency without compromising service quality. Fifth, the results provide a basis for health insurance policies to improve the INA-CBGs-based payment system, making it more aligned with the actual costs incurred by hospitals, and to enhance both efficiency and the quality of patient care.

However, this study also has several limitations. First, the retrospective design limits our ability to identify causal relationships between the factors influencing healthcare costs. Second, this research was conducted at a single hospital, namely the Universitas Brawijaya Hospital, so the findings may not be generalizable to other hospitals. Third, the data used was derived from existing medical records, which may contain errors or missing information regarding variables that affect costs. Fourth, although we considered many factors, it is possible that other unmeasured variables, such as hospital policies, service quality, or differences in medical protocols, may also play a role in increasing costs. Fifth, we did not account for variations in care policies or differences in hospital financing systems, which could contribute to variations in healthcare costs. Further research using a prospective design and a larger sample from other hospitals in Indonesia is needed to obtain more comprehensive and generalizable results.

## 5. Conclusion

In conclusion, we have shown that the actual healthcare costs for ADHF patients vary based on severity, length of stay, number of procedures, and comorbidities. In the future, it is hoped that the findings of this study can assist hospitals and policymakers in designing more efficient healthcare cost management strategies without compromising service quality, while also encouraging further research to optimize clinical pathways and integrate technological approaches in patient care management

## 6. Declaration

### *6.1 Ethics Approval and Consent to participate*

This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist.[8] The protocols of our study were approved by the local ethics committee of Universitas Surabaya under registration number 414/KE/VIII/2024. This study also followed the Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects.[9] Informed consent from the patients was not applicable, since this study retrospectively analyzed patients' medical data.[10]

### *6.2. Consent for publication*

Not applicable.

### *6.3 Availibility of data and materials*

Data used in our study were presented in the main text.

### *6.4 Competing interests*

All the authors declare that there are no conflicts of interest.

### *6.5 Funding Source*

This study received no external funding.

### *6.6 Authors contributions*

Data Curation: JA; Formal Analysis: JA; Investigation: JA; Project Administration: JA; Resources: JA; Methodology: JA; Software: JA; Visualization: JA; Supervision: AL, AR; Validation: AL, AR; Writing – Original Draft Preparation: JA; Writing – Review & Editing: JA. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

### *6.7 Acknowledgements*

None.

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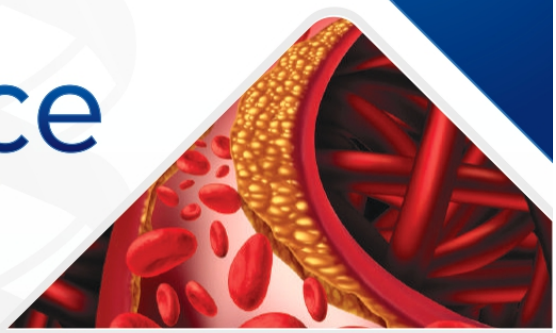

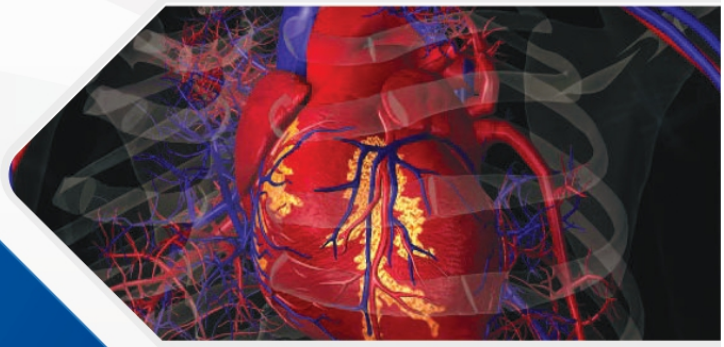

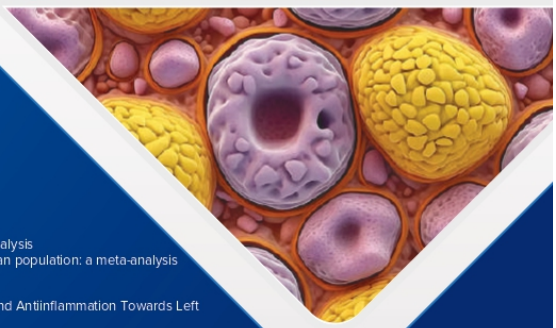

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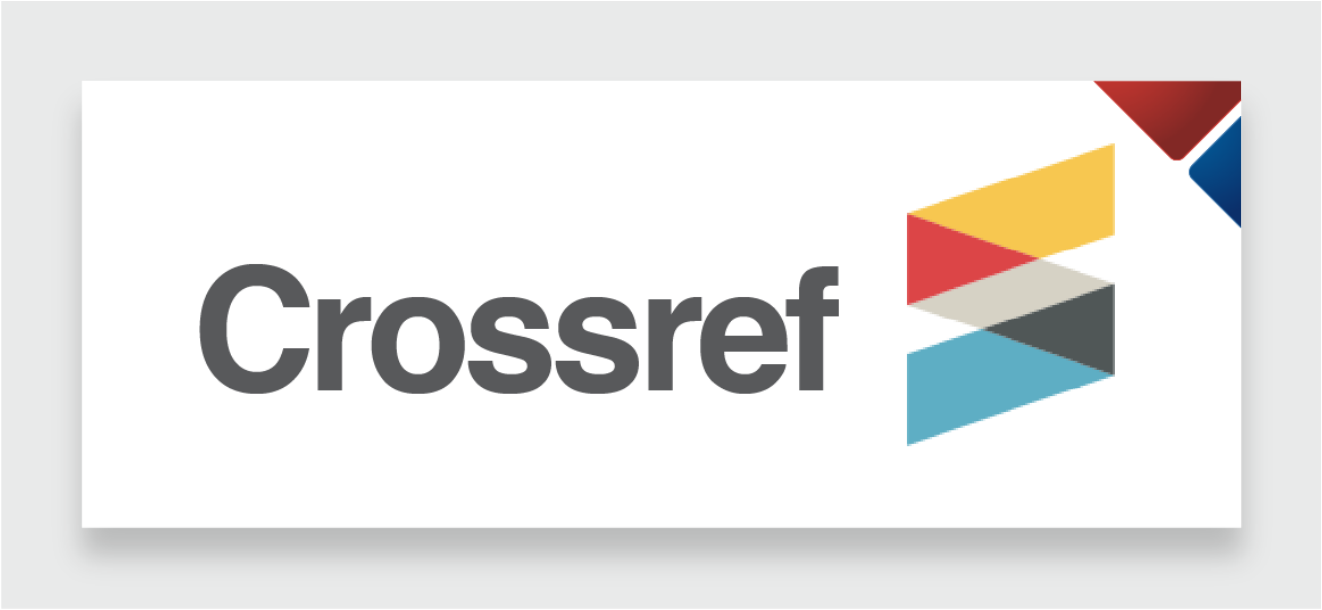
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# Vol. 6 No. 2 (2025): The Complexity in the Management of Heart Rhythm Disorder


Heart Science Journal Volume 6-2, April 2025

Focus Issue on: The Complexity in the Management of Heart Rhythm Disorder

**DOI:** https://doi.org/10.21776/ub.hsj.2025.006.02

**Published:** 2025-04-30

## Full Issue

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## Editorial

### AF-CARE: The current approach in atrial fibrillation management

**DOI:** https://doi.org/10.21776/ub.hsj.2025.006.02.1

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## Review Article

### Atrial myopathy: a pathogenic mechanism linking atrial fibrillation and ischemic stroke

**DOI:** https://doi.org/10.21776/ub.hsj.2025.006.02.2

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### Time components contributing to door-to-balloon time of patients with ST-elevation myocardial infarction

**DOI:** https://doi.org/10.21776/ub.hsj.2025.006.02.3

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### The role of GALNT and EGFR in vascular calcification: Study on pathophysiology and its implications in vascular therapy

**DOI:** https://doi.org/10.21776/ub.hsj.2025.006.02.4

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### Technical procedure of endovenous laser ablation for chronic venous insufficiency

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### Transcatheter atrial septal defect closure: Focus on tips and tricks for interventional procedure in challenging cases

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### Benefits of exercise training on pulmonary arterial pressure as measured by

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### Cardioprotective effects of colchicine: Targeting pyroptosis and inflammation in myocardial infarction

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## Original Article

### The relationship between atrial myopathy with and without atrial fibrillation to cryptogenic stroke

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### Long term radial artery occlusion following distal or proximal transradial artery access in invasive cardiovascular procedures

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### Analysis of activated clotting time in patients receiving unfractionated heparin with and without continuous infusion during elective percutaneous coronary intervention

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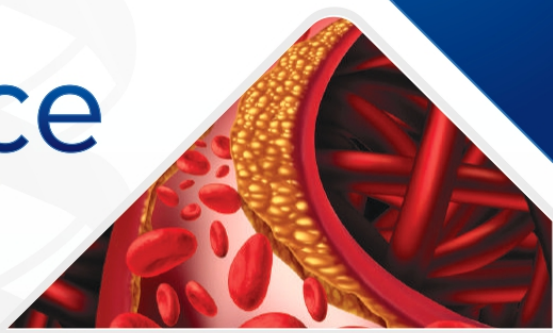

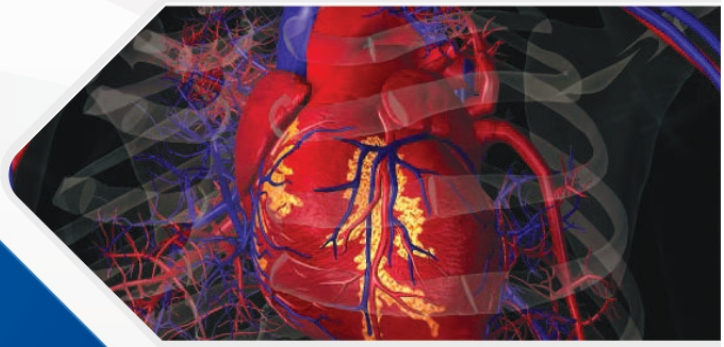

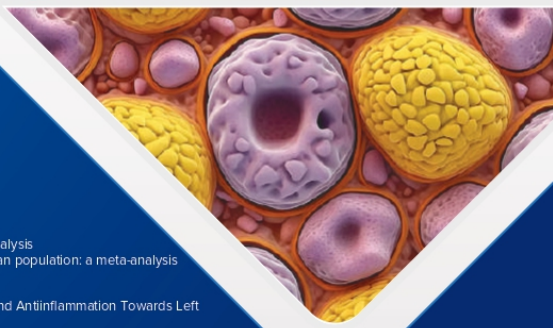

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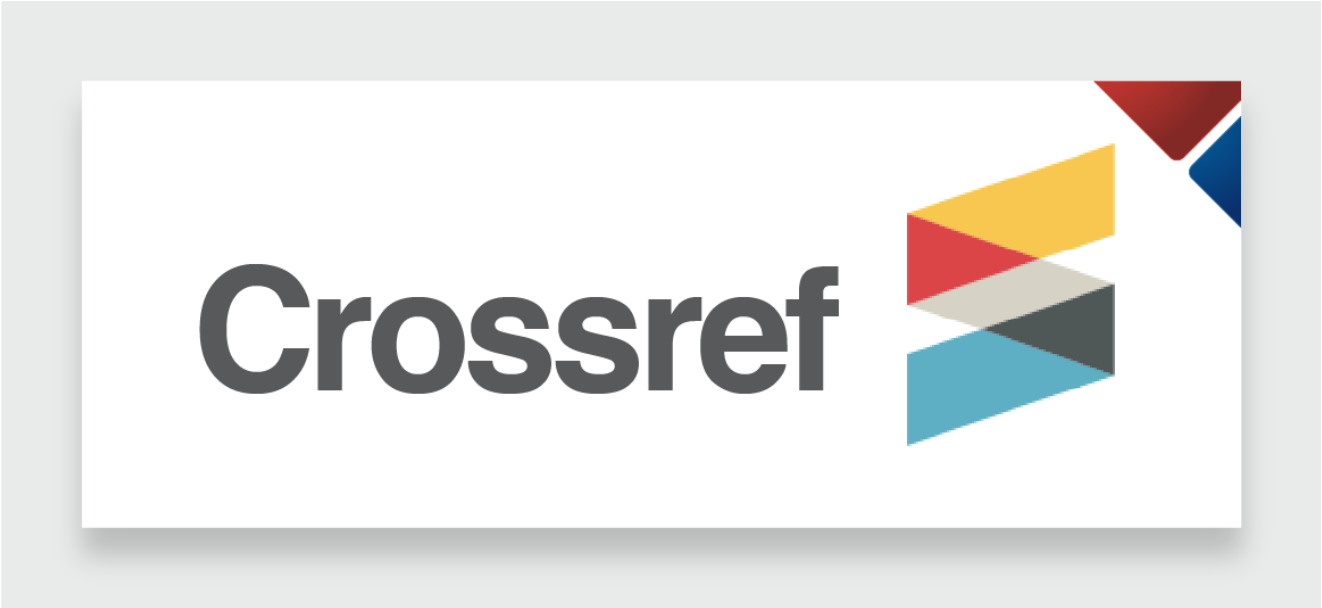
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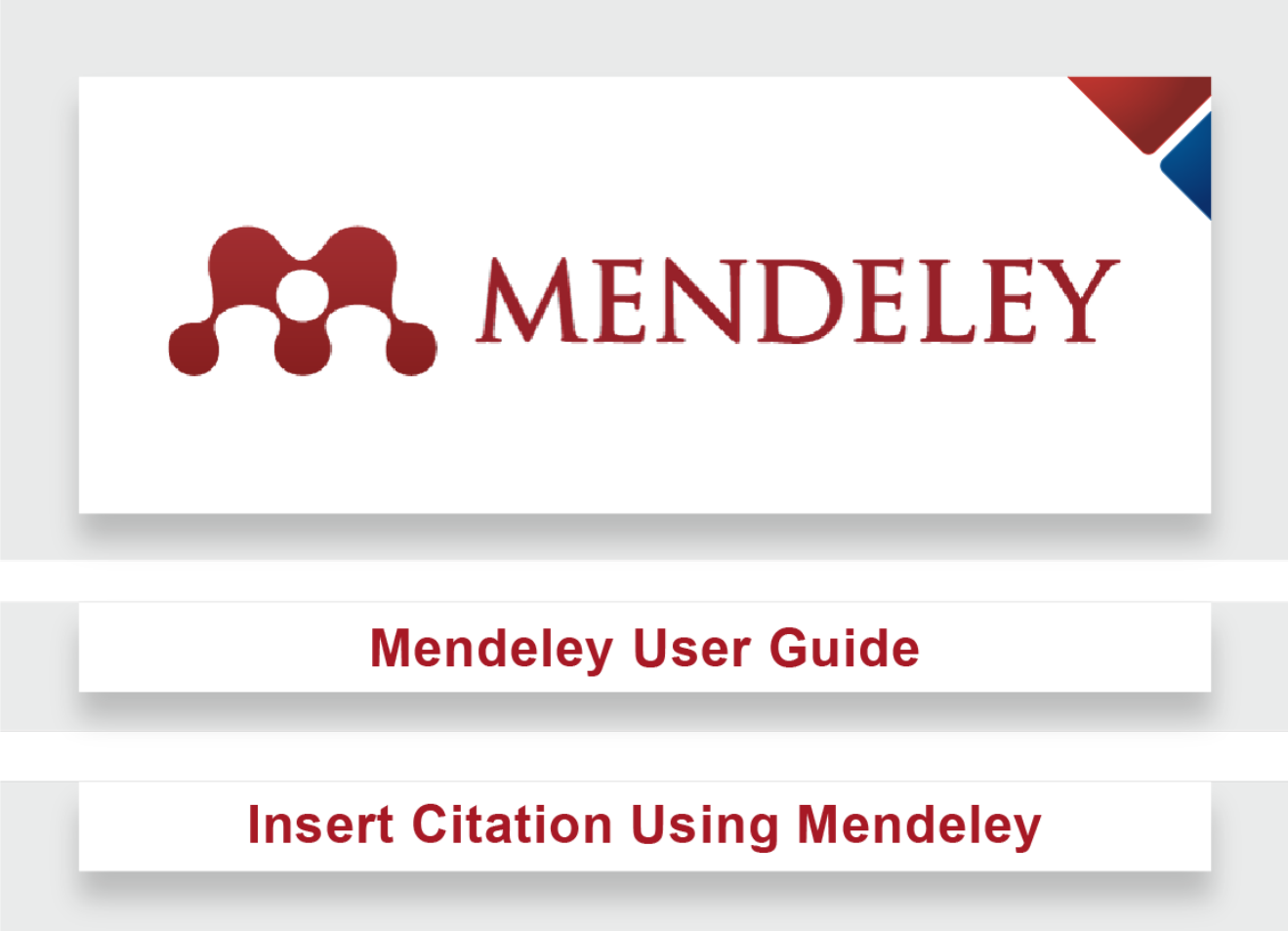


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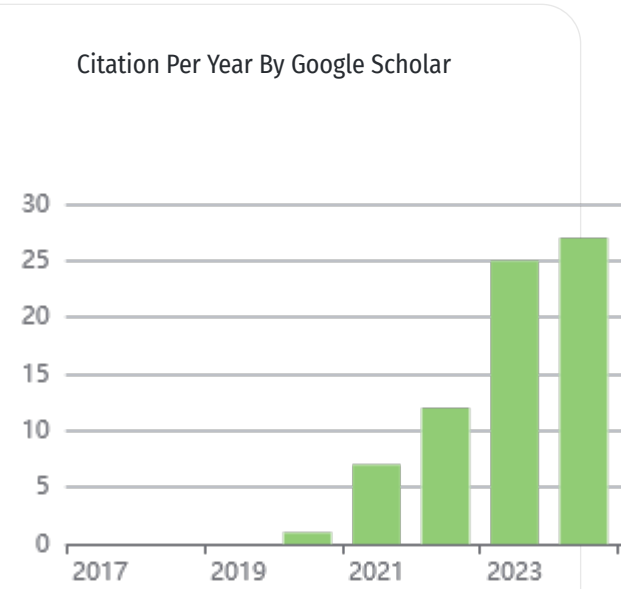


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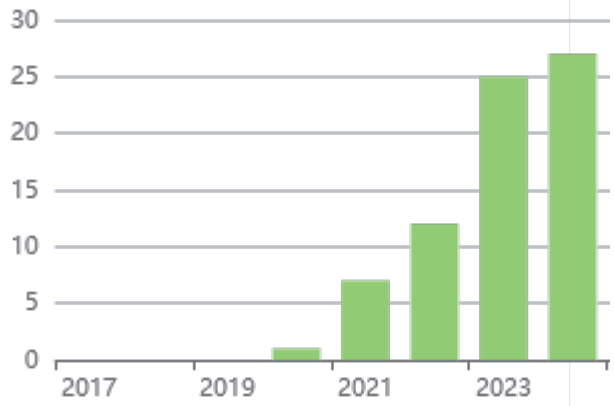


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