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Impact of the COVID-19 pandemic on direct medical costs of acute coronary syndrome admissions in Yogyakarta, Indonesia

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ABSTRACT

The number of admissions, therapeutic management, and clinical results of acute coronary syndrome (ACS) have been extensively reported. However, the economic impact of ACS therapy has been ignored. This study examined the effect of the COVID-19 pandemic on direct medical costs for ACS hospitalizations in Yogyakarta, Indonesia. A retrospective study of patients with ACS admitted to one of three hospitals during March to August in 2019, 2020, and 2021 was conducted. Direct medical costs from a provider's perspective were estimated using the charges. All costs were reported in Indonesian Rupiah (IDR) at a 2021 value. Multiple linear regression analysis was used to evaluate the impact of the pandemic on total direct medical costs. The total direct medical costs associated with ACS admission per patient during the pandemic period was approximately 40% higher than that during the pre-COVID period (28.41 vs. 20.33 million IDR or 1976.90 vs. 1414.65 USD). A substantial impact of the COVID-19 pandemic on total direct medical costs still remained after adjusting the ACS types, hospital types, length of stay, percutaneous coronary intervention, in-hospital mortality, and delay time of onset to first medical contact. Given the limited health budget, reallocation of health care resources must be prioritized to maintain the provision of essential health care for those who timely treatment is crucial.

Keywords: acute coronary syndrome; COVID-19 pandemic; hospitalization; direct medical costs

1. INTRODUCTION

The COVID-19 pandemic has devastatingly affected public health and health systems worldwide. The balance between restricting health service utilization to limit viral transmission and the providing of optimal health services to satisfy ongoing patient requirements during the additional COVID-19 caseloads posed a significant challenge to health systems. The findings suggest that patients experiencing acute coronary syndrome (ACS) delayed the seeking of medical help during the pandemic, mainly due to fear of contracting COVID-19 (Braiteh et al., 2020; Metzler et al., 2020). Moreover, an appropriate transportation system was lacking during the lockdown period (Braiteh et al., 2020; Nab et al., 2021; Tan et al., 2021).

ACS is a time-sensitive health condition, in which timely access to effective treatment can remarkably affect the health outcomes of the patients (Collet et al., 2020; Ibanez et al., 2017). Furthermore, early invasive management strategy was likely to be less costly than delayed management in most patients with ACS (Bainey et al., 2014). This is possibly due to the fact that the shortened time from symptom onset to reperfusion therapy resulted in fewer complications and severity (Moser et al., 2006; Simpson et al., 2014). On the contrary, a number of studies have consistently revealed that the COVID-19 pandemic significantly reduced the number of ACS admissions, increased the time from onset to ACS treatment, and possibly increased the mortality rate of ACS patients (Helal et al., 2021; Kiss et al., 2021; Pourasghari et al., 2022; Rattka et al., 2020). However, evidence on the cost of ACS treatment during COVID-19 is scarce (Alharbi et al., 2023).

Coronary heart diseases, including ACS, remain the major cause of mortality and morbidity in Indonesia (WHO, 2020). Prior to the COVID-19 pandemic, delayed treatment among ACS patients has been widely observed in the country (Artha et al., 2017; Dharma et al., 2021). Thus far, no study examining the cost of ACS patients nor the impacts of the COVID-19 pandemic on cost of ACS treatment in Indonesia has been identified. The present study aims to examine the impact of the pandemic on direct medical costs related to ACS admissions in Yogyakarta, Indonesia.

2. MATERIALS AND METHODS

2.1 Study design and setting

The study was designed to consider the incidence-based cost of illness in terms of cost per episode of hospitalization. The costs only include direct medical costs from the providers (hospitals) and estimates based on the charges. The costs from different years were adjusted for inflation using the Indonesian inflation rate (Indonesia B JISDOR, 2021) to reflect the value in 2021. The hospitals studied encompass two secondary hospitals (i.e., RSUD Wates Hospital, PKU Muhammadiyah Gamping Hospital) and one tertiary hospital (i.e., RSUP. DR. Sardjito Hospital). For the assessed periods, the COVID-19 pandemic transpired between March to August 2020 and March to August 2021. Conversely, the phase from March to August 2019 was defined as the pre-COVID pandemic period. These stages were determined using the onset of the COVID-19 pandemic and the period of case explosions in Indonesia (Bagikan, 2021).

2.2 Study population and samples

Study population comprises all adult (≥18 years) patients who were admitted with ACS at the participating hospitals during the specified periods. The following diagnosis codes based on ICD-10 were used to identify ACS patients: I200 (unstable angina; UA); I210A, I211A, and I214 (non- ST-elevation myocardial infarction, and NSTEMI); and I210B, I211B, I212, and I213 (ST-elevation myocardial infarction; STEMI). The study samples include all the patients admitted in the studied hospitals during the study periods.

2.3 Data collection

Direct medical costs associated with ACS admission, which included cost of medical treatment, medical procedures, laboratory tests, and other ACS-related treatment costs, were collected through medical records and billing receipt review. The data of the study period were retrospectively collected from March 24 to August 4, 2022. General characteristics of the patients (i.e., age, sex, and ACS type), treatment management (i.e., receiving invasive treatment, delay time from onset to first medical contact (FMC), and length of stay), and in-hospital mortality, all identified as factors affecting the cost of ACS patients (Jan et al., 2018; Moleerergpoom et al., 2007), were also collected. Moreover, the ACS type was classified as ST-elevation myocardial infarction (STEMI) and non-ST-elevation acute coronary syndrome (NSTEACS). Delay time from onset to FMC was classified as the time from onset to FMC of ≥12 h (Ibanez et al., 2017).

Ethical approval for this study was obtained from the Ethical Committee of Universitas Muhammadiyah Yogyakarta, Indonesia with approval number 041/EC-KEPK FKIK UMY/II/2022.

2.4 Data analysis

For each patient, the total direct medical cost was computed as the sum of the cost of medical treatment, medical procedures, laboratory tests, and other ACS treatment-related costs from the day the patients were presented at the hospital to the day they were discharged. The mean and proportion of each component of direct medical costs were also computed. All costs were reported in IDR (1 USD = 14,371 IDR) and adjusted to achieve the 2021 value (Indonesia B JISDOR, 2021). Multiple linear regression analysis with step-wise method was used to examine the impact of the COVID-19 pandemic and other factors on total direct medical costs. The total direct medical costs were transformed to natural logarithm (Ln) to satisfy an assumption of normality. Model diagnostics were conducted to measure the model quality. Statistical significance was determined using a p-value less than 0.05, with the exception of univariate analysis, which utilized a p-value less than 0.25 to identify candidate factors for multivariate analysis.

3. RESULTS

During the specified COVID-19 pandemic periods, 1,213 patients with ACS were admitted to the three hospitals. Among them, 313 were identified during pre-COVID, whereas 900 were identified during the pandemic period. Table 1 illustrates that the mean age of the patients was 61.02±11.54, approximately 72% of which were male. Nearly 63% of the patients were identified from secondary hospitals. Approximately 57% underwent percutaneous coronary intervention (PCI), whereas 42% reported delayed treatment from onset to FMC. In-hospital mortality was reported in 14.1% of the patients.

3.1 Total direct medical costs associated with ACS admissions

The mean of total direct medical costs associated with ACS admissions per patient along with each cost component are reported in Table 2 for each COVID-19 pandemic period. The mean total cost per person during the pandemic period was approximately 23.66 million Indonesian Rupiah. The total

cost during the pandemic was 8.08 million Indonesian Rupiah (USD 566.30) higher than that incurred during the pre-pandemic period. All cost components were relatively high during the pandemic period, except for radiology and ambulance costs. In these COVID-19 pandemic periods, medical procedures and medical treatments accounted for the two largest elements of the total costs. Cost of medical procedures (i.e., echocardiography, ECG, and PCI) contributed the highest share of the total direct medical costs (46.81%–49.94%). Prior to the pandemic, costs of medical treatment accounted for 23.64% of total costs. However, it increased to 26.89% during the pandemic.

Table 1. General characteristics of included patients

	Before (n = 313)	**During (n = 900)**	**Overall (n = 1213)**
Age (N = 1,213), Mean±SD	61.52±1.78	60.88±11.313	61.02±11.54
Gender (N = 1,213), n (%)			
Male	227 (72.52%)	651 (72.33%)	878 (72.38%)
Female	86 (27.48%)	249 (27.67%)	335 (27.62%)
Type of ACS (N = 1,213), n (%)			
STEMI	147 (46.96%)	451 (50.11%)	598 (49.30%)
NSTEACS	166 (53.04%)	449 (49.89%)	615 (50.70%)
Type of hospital (N = 1,213), n (%)			
Secondary hospital	230 (73.48%)	538 (59.78%)	768 (63.31%)
Tertiary hospital	83 (26.52%)	362 (40.22%)	445 (36.69%)
COVID period (N = 1,213)*, n (%)			
Before COVID pandemic	N/A	N/A	313 (25.80%)
During COVID pandemic	N/A	N/A	900 (74.20%)
Underwent PCI (N = 1,213), n (%)	161 (51.44%)	526 (58.44%)	687 (56.64%)
Delayed treatment from onset to FMC (N = 1201), n (%)	120 (39.09%)	389 (43.51%)	509 (42.38%)
In-hospital mortality (N = 1,213), n (%)	44 (14.06%)	122 (13.56%)	166 (13.68%)

Note: NSTEACS = non-ST-elevation acute coronary syndrome; PCI = percutaneous coronary intervention; and STEMI = ST-elevation myocardial infarction
*Before pandemic = March–August 2019, During pandemic = March–August 2020 and March–August 2021

Table 2. Direct medical costs associated with ACS admissions

Service	**Before pandemic**			**During pandemic**			**Difference: before – during pandemic mean costs (Million IDR)**	**P-value***
	Mean (Million IDR)	**SD (Million IDR)**	**Proportion (%)**	**Mean (Million IDR)**	**SD (Million IDR)**	**Proportion (%)**		
Total direct medical costs	20.33	19.69	100.00	28.41	23.66	100.00	8.08	<0.001
Inpatient room	0.51	0.62	2.28	0.66	1.19	2.26	0.15	0.001
ICCU	0.93	0.64	4.19	1.18	0.86	4.03	0.25	<0.001
Emergency room	0.99	1.71	4.43	1.11	1.71	3.78	0.12	<0.001
Radiology	0.59	1.36	2.64	0.53	1.06	1.81	−0.06	0.022
Doctor	0.49	0.55	2.19	0.66	0.83	2.25	0.17	0.016
Pharmacist	0.04	0.05	0.18	0.10	0.07	0.34	0.06	<0.001
Nutritionist	0.04	0.03	0.17	0.07	0.05	0.23	0.03	<0.001
Ambulance	1.57	2.10	7.06	0.33	0.17	1.14	-1.24	0.176
Medical treatment	5.27	8.30	23.64	7.87	11.07	26.89	2.61	0.027
Medical procedure	10.42	11.62	46.81	14.63	12.74	49.94	4.20	<0.001
Laboratory test	1.39	1.39	6.25	2.06	2.17	7.05	0.67	<0.001
Preparation for funeral Service	0.03	0.22	0.14	0.09	0.59	0.29	0.05	0.006

Note: ICCU = intensive cardiac care unit
*Mann Whitney U test comparing between pre and during pandemic periods

3.2 Impact of the COVID-19 pandemic on the total direct medical costs associated with ACS admissions

In the univariate analysis, the ACS type, hospital type, length of stay, PCI, COVID-19 pandemic period, delay time from onset to FMC, and in-hospital mortality were found to be associated with total direct medical costs. According to the multivariate analysis (Table 3), the total direct medical costs were significantly low among NSTEACS patients (β = −0.177, $p < 0.001$) and in patients whose time from onset to FMC was longer than 12 h (β = −0.043, $p < 0.001$). On the contrary, the total direct medical cost was significantly higher among patients who underwent PCI (β = 0.590, $p < 0.001$), hospitalized at tertiary hospitals (β = 0.270, $p < 0.001$), admitted during COVID-19 pandemic (β = 0.167, $p < 0.001$), reported longer length of stay (β = 0.224, $p < 0.001$), and reported in-hospital mortality (β = 0.097, $p < 0.001$).

Table 3. Factors associated with direct medical costs of ACS admission

Variables	β	SE (β)	P-value
Constant	15.502	0.047	<0.001
Underwent PCI (Ref: no PCI)	0.590	0.032	<0.001
Type of hospital (Ref: Secondary hospital)	0.270	0.033	<0.001
Length of stay (days)	0.224	0.005	<0.001
Type of ACS (Ref: STEMI)	−0.177	0.030	<0.001
COVID-19 pandemic period (Ref: Pre-COVID pandemic period)	0.167	0.033	<0.001
In-hospital mortality (Ref: Alive)	0.097	0.042	<0.001
Delay time from onset to FMC (Ref: No delay)	−0.043	0.029	0.005

Note: Y = Ln of total direct medical cost, Adjusted $R^2 = 0.766$
PCI, Percutaneous coronary intervention

4. DISCUSSION

This cost analysis study was performed to estimate the average total direct medical costs associated with ACS admission per patient during and prior to pandemic in Yogyakarta, Indonesia. The total direct medical costs prior to and during the pandemic were 20.33 million IDR and 28.41 million IDR (2021 value), respectively. The cost during the pandemic significantly increased by approximately 40% ($p<0.001$) from the pre-pandemic period. The costs of each component were significantly higher during the pandemic period except for ambulance and radiology. The increase in costs during the pandemic could generally be due to the additional procedures, medical supplies, and medical devices (e.g., personal protective equipment, sets of COVID-19-related test, and isolated catheterization laboratories (Cath-Lab)) required to rule out COVID infection and to control transmission (Guha et al., 2020; Piątek et al., 2021). This finding is consistent with the high healthcare spending observed in many countries in response to the COVID-19 pandemic (WHO, 2022).

Similar to Taylor et al. (2007), who found that the largest cost component of the ACS treatment during the first year was related to the revascularization procedure and pharmaceutical treatment, our study established that the direct medical cost related to medical procedures accounted for the highest proportion of the total costs, followed by the medical treatment costs. Consistent with previous studies, our finding revealed that patients who underwent PCI reported significantly high direct medical cost (Jan et al., 2018; Moleerergpoom et al., 2007; Sheikhgholami et al., 2021). Nevertheless, while PCI increased direct medical costs during admission, the patients who received PCI could experience less complications and mortality. Thus, ultimately, the direct non-medical costs, as well as the total costs after 1 year of timely PCI, might be lower than those of patients who did not receive PCI.

In line with other studies, length of stay, hospital type (Jan et al., 2018; Moleerergpoom et al., 2007), as well as in-hospital mortality (Moleerergpoom et al., 2007) were positively associated with the total direct medical costs. While longer time from onset to FMC is expected to result in worse clinical outcomes and higher treatment costs, this study found that delay time from onset to FMC was associated with lower direct medical costs. This finding could be explained by the fact that those who reported delay time from onset to FMC might not always receive late invasive treatment. Some patients, who presented late at the hospitals might have received prompt invasive treatment, resulting in an optimal outcome. Therefore, total ischemic time and the duration from the symptom onset to the administration of reperfusion therapy might be a better predictor of cost than the total time from onset to FMC.

After adjusting the ACS types, hospital types, PCI, in-hospital mortality, and delay time from onset to FMC, we found that COVID-19 pandemic exhibited significant and positive impact on total direct medical cost of ACS patients. The total direct medical costs related to ACS admissions was significantly higher during the pandemic than during the pre-pandemic period. These outcomes could possibly be due to additional procedures and equipment required during the COVID-19 pandemic. Consistent with these findings regarding the ACS type as a contributing factor to the total direct medical costs, a previous study comparing the total medical costs between STEMI and NSTEMI patients revealed that the costs were significantly greater in the STEMI group than in the NSTEMI group (Murakami et al., 2022). This difference was primarily due to the procedures performed during hospitalization (Bainey et al., 2014; Jan et al., 2018). In addition, during the COVID-19 pandemic, the delay in receiving effective treatment could increase the total cost of direct medical cost. Nevertheless, further studies that examine the association between total ischemic time and cost of ACS treatment are warranted. According to the findings, the government should have allocated additional budget and resources to the hospitals during the pandemic period to provide effective treatment to patients while limiting disease transmission.

While our study is the first in Indonesia to examine the direct medical costs of ACS admission, it presents some

limitations. First, our results were generated from one province in Indonesia. Therefore, generalizability of these findings to the country level should be made with caution. Nevertheless, our study was conducted in Yogyakarta, one of Indonesia's provinces with a relatively high population density and a national referral hospital for ACS services. Second, our study only estimated the direct medical costs associated with ACS admission. While direct medical costs were important cost drivers of ACS hospitalization (Roggeri et al., 2014), the productivity loss and out-of-pocket costs after hospitalization were also substantial (Anukoolsawat et al., 2006). Further studies that examine the direct non-medical costs as well as indirect costs associated with ACS during and after hospitalization are warranted to provide comprehensive economic burden of ACS patients. Lastly, the costs reported in our study were cost-at-charge. Further studies examining the costs are required to understand the actual burden that ACS imposed on the health system.

5. CONCLUSION

Direct medical costs associated with ACS admission are substantial and significantly increased during the COVID-19 pandemic. Given the limited budget, health systems must effectively reallocate and prioritize resources across health services to maintain the provision of treatment for essential and time-sensitive conditions, such as ACS.

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