Insights and challenges of Indonesia's acute coronary syndrome telecardiology network: three year experience from a single center and in West Jakarta, Indonesia

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Abstract. Acute Coronary Syndrome (ACS) is the leading cause of morbidity and mortality globally and in Indonesia. Reduce time to reperfusion is crucial in reducing cardiac myocardium necrosis and improving prognosis in ACS patients. The use of telecardiology shows great potential to bridge current inefficiencies and the Indonesian STEMI network (iSTEMI) was hence introduced in 2014. This study aims to provide insights and describe the challenges faced by Indonesia's Acute Coronary Syndrome telecardiology network over the past 3 years based on a single center experience and in West Jakarta. Data was derived from the iSTEMI Network West Jakarta database obtained from the Department of Cardiology, Cengkareng General Hospital for the period of 30\textsuperscript{th} June 2014 to 30\textsuperscript{th} June 2017. The availability of the iSTEMI network in West Jakarta has made it more accessible for primary care facilities to receive direct consult and advice from cardiologists. Overall, over the three years patient ischemic time had reduced from a median of 330 minutes to 275 minutes. This study has shown great potential of pre-hospital telecardiology network in improving care in acute coronary syndrome patients by reducing ischemic time and hence improve patient's chance of survival and recovery. A nationwide implementation of this system is therefore recommended to make better ACS care not only available to residents in Jakarta but to other parts of Indonesia as well.

1. Introduction
According to the World Health Organization, cardiovascular disease is the leading cause of death globally, with an estimated 17.9 million deaths in 2016 representing 31\% of all global deaths, over three quarters of which take place in low and middle income countries. This number is expected to increase to 23.3 million deaths per year by 2030 [1,2]. In Indonesia, ischemic heart disease also remains the number one cause of mortality and morbidity with the total number of disability adjusted life years (DALYs) rising by 10.5\% from 5.9 million in 2006 to 6.52 million in 2016 with an estimated incidence of 200 events per 100,000 population annually. Lifestyle changes and the rise of other comorbidities such as diabetes and hypertension in Indonesia has also contributed to this increase in prevalence [3-5]. Eighty percent of all cardiovascular deaths are caused by acute coronary syndrome (ACS) and stroke [6]. Acute coronary syndrome (ACS) refers to a state of reduced blood flow to the heart due to coronary artery obstruction. Obstructions can be caused by rupture of atherosclerotic plaque and partial or total thrombosis of the arteries. ACS can be
further classified into several different conditions namely unstable angina (UA), ST-elevation myocardial infarction (STEMI) and non ST- elevation myocardial infarction (NSTEMI) with differing management for each condition [7].

When handling ACS patients, the quote time is muscle is more important than ever. Reduced time to reperfusion is crucial in slowing cardiac myocardium necrosis and improving prognosis in ACS patients. Marked decrease in salvageable myocardium has been reported when reperfusion occurred greater than 90 minutes [8] as well as increase in mortality when done greater than 180 minutes post occlusion [9]. Previous registry studies in Jakarta [10] and Bali [5] have shown that transfer time from first medical contact (FMC) at a non-percutaneous coronary intervention (PCI) capable center remains inefficient. The mean door in to door out (DI-DO), defined as the duration of time from arrival to discharge from the non-PCI capable health center to a PCI capable centre from Jakarta ACS registry was 3.1 hours [10] which was far beyond the recommended 30 minutes set by the American Heart Association (AHA) Guidelines [11].

Hence, novel strategies are required to improve efficiency in diagnosis and management with the aim of increasing rates of ACS often classified as telecardiology therefore shows great potential to bridge this inefficiency. Digital health or telehealth is defined by the World Health Organization as the use of telecommunication technologies to provide information and health services in order to improve the health of communities [12]. The rise of the internet generation in Indonesia and improving connectivity has made Indonesia more ready than ever to make telecardiology a routine part in the management of ACS patients especially in urban areas [13,14].

Furthermore, the use of telecardiology especially prehospital electrocardiography (ECG) and direct referral to PCI able center has been previously reported to reduce treatment delay and in-hospital mortality [15]. In Indonesia, starting from 2014, the Indonesian ACS telecardiology network called Indonesian STEMI (iSTEMI) network was formed and implemented in Jakarta to reduce referral time, improve efficiency and outcomes of ACS patients [16]. This study therefore aims to provide insights and describe the challenges faced by Indonesia’s Acute Coronary Syndrome telecardiology network over the past 3 years based on a single center experience and in West Jakarta.

2. Materials and Methods

2.1. Data Source

Data was obtained from the West Jakarta iSTEMI Network database acquired from the Department of Cardiology, Cengkareng General Hospital from the period of 30th June 2014 to 30th June 2017. ACS was diagnosed based on the presence of typical chest pain and ST-segment elevation (≥ 0.1 mV) in two or more contiguous leads on the initial ECG.

2.2. The iSTEMI Network

The iSTEMI network was introduced as a government project in Jakarta in the year 2014 and was built to improve STEMI patients care in Jakarta. In a previous telecardiology study by Dharma et al. based on data from the Jakarta Cardiovascular Care Unit Network System had showed that after the introduction of this network, there was an increase in interhospital referrals for STEMI patients and an increase in primary PCI procedures in the Harapan Kita National Cardiovascular Center in Jakarta [17].

2.3. Outcomes of Interest

Outcomes of interest were number of patients referred for reperfusion, distribution of referring centers, transfer time, door to device, door to needle and total ischemic time of patients referred in the network. Furthermore, rates of in-hospital mortality based on reperfusion strategy was also assessed.
3. Results

Study population
Between the 30th June 2014 to 30th June 2017, a total of 2,017 ACS patients were admitted into the emergency department of the participating health centers. Nine hundred and eighty six patients (48.9%) was subsequently diagnosed as STEMI of which 437 (44.3%) of them were referred for reperfusion. There was a steady decline in the number of ACS cases and percentage of STEMI patients referred in the network through the periods, from 844 cases (356 STEMI) in 2014-2015 to 607 cases (332 STEMI) in 2015-2016 with a further decline to 566 cases (298 STEMI) in 2016-2017. The lower prevalence of STEMI in this study was similar to that of previous studies in America which have showed a reduction in the prevalence of STEMI patients and increase in NSTEMI patients due to better preventive measures among patients and the availability of more sensitive diagnostic tools for NSTEMI [18].

Clinical characteristics
Except for the first year, the majority of ACS patients were diagnosed with STEMI. Among those with STEMI, reperfusion was not done in most patients. Even so, the three periods have shown a decline in the percentage of patients arriving 12 hours after the onset of symptoms from 58.7% in 2014-2015 to 27% in 2016-2017 as shown in Table 1.

| Table 1. Patient Diagnosis and Management Strategy over the 3 years |
|-----------------|------------------|------------------|------------------|------------------|
| Variable        | 2015-2015        | 2015-2016        | 2016-2017        | Total            |
|                 | Proportion (%)   | Proportion (%)   | Proportion (%)   | Proportion (%)   |
| Number of ACS Cases | 844 (46.9)      | 607 (47.3)      | 566 (37.9)      | 437 (44.3)       |
| STEMI            | 356 (42.2)      | 332 (54.7)      | 298 (52.7)      | 986 (48.9)       |
| UAP/NSTEMI       | 488 (57.8)      | 275 (45.3)      | 268 (47.3)      | 1031 (51.1)      |
| Management Strategy |                  |                  |                  |                  |
| Reperfusion      | 167 (46.9)      | 157 (47.3)      | 113 (37.9)      | 437 (44.3)       |
| Fibrinolysis     | 88 (52.7)       | 87 (55.4)       | 60 (53)         | 235 (53.8)       |
| Primary PCI      | 75 (44.9)       | 67 (42.7)       | 50 (44.3)       | 192 (43.9)       |
| Autolysis        | 4 (2.4)         | 3 (1.9)         | 3 (2.7)         | 10 (2.3)         |
| Without Reperfusion | 189 (53.1)    | 175 (52.7)      | 185 (62.1)      | 549 (55.7)       |
| Onset < 12 hours | 111 (58.7)      | 87 (49.7)       | 50 (27)         | 248 (45.2)       |
| Onset > 12 hours | 78 (41.3)       | 88 (50.3)       | 135 (73)        | 301 (54.8)       |

Patient distribution
Seven hospitals with reperfusion capabilities were part of the West Jakarta network. Cengkareng General Hospital remains the leading referral center with regards to the cases managed over the 3 periods, handling almost 50% of all cases in the region. With regards to referral from primary health centers, the Kebon Jeruk Community Health Center (CHC) leads with 25 ACS referrals from 2016-2017 followed by Taman Sari and Kembangan CHC with 4 referrals each. Other cases referred are from hospitals without reperfusion capabilities.

Management Strategy
On most STEMI patients referred for reperfusion, over half of them were given fibrinolysis. Primary PCI was performed in around 40% of patients, the remaining minority of patients had autolysis. Reperfusion was not performed to all patients eligible for reperfusion. From the 421 STEMI patients referred to Cengkareng General Hospital, 69.4% was eligible for reperfusion, however reperfusion was done in only 53.2% of patients. In patients where fibrinolysis was performed, success rate was above 50% for all three years. It was 95.5% in the first year followed by 82.8% and 61.7% in the second and third year respectively. (Figure 1)
In-hospital mortality
A total of 45 deaths were documented over the 3 years. Based on reperfusion strategy, 39 mortalities were found in the fibrinolysis group whereas only 6 mortalities were found in the primary PCI group. Mortality percentages fluctuate over the years. In the fibrinolysis group, mortality percentage was at 17.2%, 12.5% and 21.7% for the first, second and third year respectively. On the other hand, in the primary PCI group mortality percentage was at 2.7%, 4.9% and 2.0% for the first, second and third year respectively.

Time to Reperfusion
The availability of the iSTEMI network in West Jakarta has made it more accessible for primary care facilities to receive direct consult and advice from cardiologists, over 85% of STEMI diagnosis in the network was confirmed by a cardiologist. This was similar to the percentage of confirmation by cardiologists in the National Cardiovascular Center which was reported to be at 97%.

![Figure 1. Reperfusion Rate in Referral Centers in West Jakarta](image)

Over the 3 years, there have been an increase in median time between ACS onset to first medical contact from 120 minutes in the 1st year to 150 minutes in the 2nd year and 3rd year. However, median transfer time had reduced from 155 minutes in the 1st year to 120 minutes in the 2nd year and finally to 105 minutes in the 3rd year. (Table 2)

While door to device time has also slightly increase over the years from 104 minutes in year one to 115 minutes in the third year, door to needle time has also reduced to an almost equal extent from 80 minutes in year one to 75 minutes in the third year. Overall, over the three years patient ischemic time had reduced from a median of 330 minutes to 275 minutes. (Table 2)

| Variable      | 1st Year (N=147) | 3rd Year (N=95) |
|---------------|------------------|-----------------|
|               | Median           | Min - Max       | Median           | Min - Max       | Median           | Min - Max       |
| Onset – FMC   | 120              | 25-640          | 150              | 21-710          | 150              | 15-700          |
| Transfer Time | 155              | 40-480          | 120              | 21-450          | 105              | 60-615          |
| Door to Device| 104              | 45-474          | 101.5            | 25-344          | 115              | 30-562          |
| Door to Needle| 80               | 27-325          | 85               | 16-360          | 75               | 10-330          |
| Ischemic Time | 330              | 75-705          | 330              | 65-710          | 275              | 90-780          |
4. Discussion

Similar studies on the application of telecardiology in Indonesia have been conducted with the earliest study performed during the period of 2008-2011. After its implementation, increased hospital referral cases, PCI procedures and improved door-to-needle time were observed. However, no significant decrease in the number of late presenting patients and door-to-balloon time was found [16]. Another study comparing the management of ACS patients before and after the implementation of an Indonesian telecardiology network at the year 2007 and 2013 respectively, found a significant decrease in the proportion of non reperfused patients (67.7% vs 62.8%, p <0.001), in-hospital mortality (11.7% vs 7.5%, p <0.001) and increase in patients receiving primary PCI (35% vs 24%, p <0.001) [17]. The most recent study conducted by Dharma et al, during the period of October 2014-July 2015 obtained similar results showing a steady improvement in reperfusion time and patients outcome [10].

The generational shift from the X generation to Z generation has made Indonesia dominated by a technology savvy generation. The most recent survey in October 2016 by the Indonesian Internet Service Provider Association (APJII) reported that 132.7 million or 51.8% of Indonesians are connected to the internet. Currently, Indonesia also houses the third largest smartphone user in the Asia Pacific with 100% internet penetration among private sector employees and in the health sector [13,14].

Technological development has brought numerous opportunities for digital health and has great potential to be a gatekeeper for health in Indonesia. Improvements in telecommunication technology through satellites, the Palapa Fiber Optic Ring project, 3G, 4G and 5G networks has also made connectivity available throughout the archipelago [19]. In addition to its use in the pre-hospital management of ACS patients, another possible application of telecardiology in ACS patients is for monitoring post-surgery and home monitoring post discharge. In a previous study by Chiantera et al. in Italy comparing the use of telecardiology and usual care, 63% of patients discharged after ACS were found to exhibit cardiac symptoms 1 month post discharge. Telecardiology was found to be able to slightly reduce hospital readmissions (telecardiology 44% versus usual care 56%) while at the same time better identifying true from false angina among the patients (telecardiology 85% true positive for cardiac cause versus usual care 55%) [20]. Another study by Brunetti et al. involving 27,481 elderly patients (>70 years old) found telecardiology significantly decreased diagnosis time, in patients presenting with both typical and atypical symptoms. Telecardiology was instead found to improve the quality of diagnosis in patients with atypical presentation with increased rates of diagnosis from 9.2% in patients 60-69 years old, 25.6% in patients 70-79 years old, 35.2% in patients 80-89 years and 46.1% in patients >89 years (p <0.001 in all cases) [21].

Studies have also shown other possible applications of telecardiology for non-ACS patients. This include echocardiographic teletransmission & teleconsultation, remote control & monitoring of implantable devices and monitoring of patients with chronic heart failure as well as arrhythmia [22]. Further development of telehealth networks in Indonesia is therefore recommended to improve quality of health care to the masses.

5. Conclusion

In the field of cardiology, this study has shown great potential of pre-hospital telecardiology network in improving care in acute coronary syndrome patients by reducing ischemic time and hence improving patient’s chance of survival and recovery. A nationwide implementation of this system is therefore recommended to make better ACS care not only available to residents in Jakarta but to other parts of Indonesia as well.

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7. References

[1] World Health Organization (WHO). World Health Organization (WHO). [Online].; 2016 [cited 2018 September 20. Available from: http://www.who.int/mediacentre/factsheets/fs317/en/.

[2] World Health Organization (WHO). Global Status Report on Noncommunicable Diseases 2014.

[3] Sunjaya AP, Sunjaya AF. Glycated hemoglobin targets and glycemic control: Link with lipid, uric acid and kidney profile. Diab Metab Syndr. 2018 September; 12(2018).

[4] Mboi N, Murty Surbakti I, Trihandini I, Elyazar I, Houston Smith K, Bahjuri AP, et al. On the road to universal health care in Indonesia 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet. 2018 August; 392(10147).

[5] Artha IMJR, Dwipayana IMP, Saputra BMI, Juzar DA, Soerianata S. Clinical Characteristics, Medical Management and Outcomes of Patients with ST-Elevation Myocardial Infarction in Sanglah General Hospital, Denpasar, Bali, Indonesia. Biomedical & Pharmacology Journal. 2017; 10(3).

[6] Centers for Disease Control and Prevention (CDC). Centers for Disease Control and Prevention (CDC). [Online].; 2013 [cited 2018 September 20. Available from: http://www.cdc.gov/globalhealth/countries/indonesia/pdf/indonesia.pdf.

[7] American Heart Association (AHA). American Heart Association (AHA). [Online].; 2016 [cited 2018 September 20. Available from: http://www.heart.org/HEARTORG/Conditions/Heart Attack/AboutHeartAttacks/Acute-Coronary- syndrome_UCM_428752_Article.jsp#.V6iOPl95D8.

[8] Francone M, Bucciarelli-Ducci C, Carbone I, Canali E, Scardala R, Calabrese FA, et al. Impact of Primary Coronary Angioplasty Delay on Myocardial Salvage, Infarct Size, and Microvascular Damage in Patients With ST-Segment Elevation Myocardial Infarction: Insight From Cardiovascular Magnetic Resonance. Journal of the American College of Cardiology. 2009 December; 54(23).

[9] Rollando D, Puggioni E, Robotti S, De Lisi A, Bravo MF, Vardanega A, et al. Shorter symptom onset-to-balloon time predicts lower mortality up to 7 years in STEMI patients treated with primary percutaneous coronary intervention. Heart. 2012 September; 98(23).

[10] Dharma S, Andriantoro H, Purnawan I, Dakota I, Basalamah F, Hartono B, et al. Characteristics, treatment and in-hospital outcomes of patients with STEMI in a metropolitan area of a developing country: an initial report of the extended Jakarta Acute Coronary Syndrome registry. BMJ Open. 2016; 6.

[11] Jneid H, Addison D, Bhatt DL, Fonarow GC, Gokak S, Grady KL, et al. 2017 AHA/ACC Clinical Performance and Quality Measures for Adults With ST-Elevation and Non–ST-Elevation Myocardial Infarction. Journal of the American College of Cardiology. 2017 October; 70(16).

[12] World Health Organization & International Telecommunication Union. National eHealth strategy toolkit; 2012.

[13] Jakarta Globe. More than Half of Indonesians are Internet Users. [Online].; 2016 [cited 2018 September 20. Available from: http://jakartaglobe.id/news/half-indonesians-internet-users/.

[14] Indonesia Investments, eMarketer, APJII. Indonesia Has 100 Million Internet Users, Internet Penetration at 40%. [Online].; 2016 [cited 2018 September 20. Available from: http://www.indonesia-investments.com/news/todays-headlines/indonesia-has-100-millioninternet-users-internet-penetration-at-40/item6827?

[15] Zanini R, Aroldi M, Bonatti S, Buffoli F, Izzo A, Lettieri C, et al. Impact of prehospital diagnosis in the management of ST elevation myocardial infarction in the era of primary percutaneous coronary intervention: reduction of treatment delay and mortality. J Cardiovasc Med (Hagerstown). 2008 June; 9(6).

[16] Dharma S, Siswanto BB, Firdaus I, Dakota I, Andriantoro H, Wardeh AJ, et al. Temporal Trends of System of Care for STEMI: Insights from the Jakarta Cardiovascular Care Unit Network System. PLOS One. 2014 February; 9(2).
[17] Dharma S, Andriantoro H, Dakota I, Purnawan I, Pratama V, Isnanijah H, et al. Organisation of reperfusion therapy for STEMI in a developing country. Open Heart. 2015 April; 2.

[18] McManus DD, Gore J, Yarzebski J, Spencer F, Lessard D, Goldberg RJ. Recent Trends in the Incidence, Treatment, and Outcomes of Patients with ST and Non-ST-Segment Acute Myocardial Infarction. Recent Trends in the Incidence, Treatment, and Outcomes of Patients with ST and Non-ST-Segment Acute Myocardial Infarction. Am J Med. 2012; 124(1).

[19] Okezone. Mengintip Teknologi Mobil Unit Bencana Kominfo. [Online]; 2012 [cited 2018 September 20. Available from: http://techno.okezone.com/read/2012/06/05/56/641627/mengintip-teknologi-mobil-tanggap-bencana-besutan-kominfo/large.

[20] Chiantera A, Scalvini S, Pulignano G, Pugliese M, De Lio L, Mazza A, et al. Role of telecardiology in the assessment of angina in patients with recent acute coronary syndrome. J Telemed Telecare. 2005; 11(Suppl 1).

[21] Brunetti N, De Gennaro L, Amodio G, Dellegrottaglie G, Pellegrino P. Telecardiology improves quality of diagnosis and reduces delay to treatment in elderly patients with acute myocardial infarction and atypical presentation. Eur J Cardiovasc Prev Rehabil. 2010 December; 17(6).

[22] Molinari G, Molinari M, Di Biase M, Brunetti ND. Telecardiology and its settings of application: An update. Journal of Telemedicine and Telecare. 2018 June; 24(5).