DETAK Application: An Artificial Intelligence used to Improve Outcome in Coronary Artery Disease Patients

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ABSTRACT

Coronary artery disease is the foremost single cause of mortality and loss of disability adjusted life years (DALYs). This burden falls on low- and middle-income countries accounting to approximately 7 million deaths and 129 million DALYs annually. Hence many efforts tried to prevent events and improve outcome, including in limited resources and supporting system counties such as Indonesia. The outcomes of patients suffering from acute myocardial infarction setting of coronary artery disease (CAD) are contingent on the time taken to deliver definitive treatment. The biggest delays and challenges in reducing the time to reperfusion, however, are in fact mostly seen in the prehospital setting, especially related to patient delay. Our previous research suggested that patient awareness is lacking knowledge of CAD natural history. Therefore, we provide an artificial intelligent based DETAK C application fitted to smartphones to let patients easily access on demand at any time and anywhere they need. By using the DETAK C application patients will be guided to the health facilities according to their symptoms or they don't have to worry about it. Our database also suggested that patient delay significantly reduced and definitive treatment could be facilitated, resulting in a better outcome in patients using the DETAK C application. In conclusion, DETAK C has been proven beneficial to improve outcomes in CAD patients' event in a limited emergency supporting system, further collaborative effort warranted to support development of digital health in Indonesia.

Keywords: Cardiovascular disease, artificial intelligence, DETAK C application

1. INTRODUCTION

Coronary Artery Disease (CAD) is one of the leading causes of death and disability worldwide, accounting for about 9.4 million deaths and 182 million disability-adjusted life years (DALYs) in 2019. According to Roth et al [1] CAD is also a major contributor to the global burden of cardiovascular diseases (CVDs), which are responsible for 32% of all deaths and 10% of all DALYs globally. According to Amini et al [2] The most significant types of CAD are ischemic heart disease, primary and secondary cardiomyopathies, heart failure, cardiac arrhythmias, and stroke.

The burden of CAD varies across regions and countries, depending on the prevalence and distribution of risk factors, such as smoking, high blood pressure, high cholesterol, diabetes, obesity, and faMIly history[1]. Some of the regions with the lowest CAD mortality rates were Western Europe, Australasia, North America, and high-income Asia Pacific. According to the Heat Association [3] & Maharani et al [4] Globally, the prevalence of MI in individuals under 60 years old is found to be 3.8%. In individuals over 60 years old, this value increases to 9.5%2. According to Nilsson et al [5] These statistics highlight the significant impact of CAD and MI on global health.

Indonesia is a low-middle income country in Southeast Asia with a population of about 270 million people. Indonesia faces a double burden of communicable and non-communicable diseases, including CVDs. According to the SMARThealth extended study conducted in 2016–2017 in Malang District, East Java Province, Indonesia, 29.2% of

Prehospital delay wax one of the factors predicting poor outcome in MI Patients. This delay refered to the time from the onset of symptoms to the initiation of treatment, and it has been associated with increased mortality and decreased possibility of revascularisation.[7], [8] Furthermore, Multiple multicentre studies during COVID19 outbreak have found

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that the median time from symptom onset to reperfusion was extended from 180 minutes in 2018 to 290 minutes in 2020, one of which due to reluctance to seek medical attention during the pandemic.[9]

The “DETAK C” smartphone application specifically designed to expedite the detection and treatment of Myocardial Infarction (MI). The DETAK C application aims to reduce the delay in diagnosing MI by providing a focused chest pain assessment. This is crucial as early detection and treatment of MI can significantly improve patient outcomes. The application uses a comprehensive and systematic approach to assess chest pain, one of the key symptoms of MI.

This article aimed to elaborate the role of DETAK C in management of patients with MI in Malang, Indonesia.

2. METHOD

2.1 Study Design

We conducted a multicenter cross-sectional study involving patients with chest pain who presented to the emergency department (ED) of four hospitals in Indonesia from January to December 2022. The study protocol was approved by the ethics committee of each hospital and written informed consent was obtained from all participants.

The inclusion criteria were patients aged 18 years or older who had chest pain or discomfort suggestive of acute myocardial infarction (MI) within the past 24 hours. The exclusion criteria were patients who had a history of MI, coronary artery bypass grafting, percutaneous coronary intervention, or cardiac arrest; patients who were hemodynMIcally unstable, pregnant, or unable to communicate; and patients who refused to participate in the study.

Table 1. Baseline Characteristic

Characteristic	Diagnosis				Total
	Non ACS		ACS		
	n	%	n	%	
Age					
<65	138	27	364	73	502
>65	13	35	24	65	37
Sex					
Male	121	29	303	71	424
Female	30	26	85	74	115
Diabetes					
No	120	29	295	71	415
Yes	31	25	93	75	124
Hypertension					
No	99	27	263	73	362
Yes	52	29	125	71	177
Chronic Kidney Disease					
No	151	28	381	72	532
Yes	0	0	7	100	7

2.2 Study Procedure

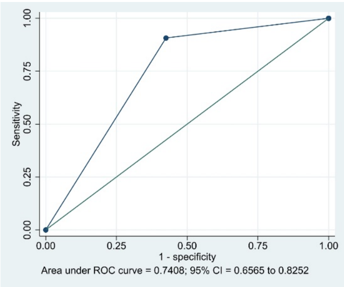
Upon arrival at the ED, the patients were asked to complete a smartphone-based questionnaire that contained the MI diagnostic algorithm called DETAK. DETAK is a novel tool that uses 5 questions to assess the likelihood of MI based on the characteristics of chest pain and risk factors.

DETAK C was developed using Android Studio and Firebase. The application also provided feedback on the DETAK C score and suggested further actions based on the level of risk. After completing the questionnaire, the patients underwent standard diagnostic procedures for MI, including serial blood tests for cardiac biomarkers (troponin I and CKMB), repeated ECGs, and coronary angiography if indicated. The final diagnosis of MI was established by an independent cardiologist who was blinded to the DETAK C score and used the universal definition of myocardial infarction.

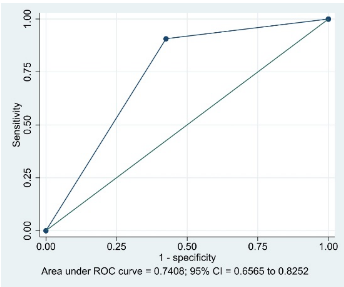
The primary outcome of the study was to evaluate the diagnostic performance of DETAK C in detecting MI in the overall population, as well as in subgroups of elderly (age ≥ 65 years), female, and diabetic patients.

The diagnostic performance of DETAK was assessed using the receiver operating characteristic (ROC) curve analysis. The area under the curve (AUC), sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated for different cut-off points of DETAK score. The optimal cut-off point was determined by maximizing the Youden index (sensitivity + specificity - 1). The ROC curves of DETAK and other tools were compared using the DeLong test. A p-value < 0.05 was considered statistically significant.

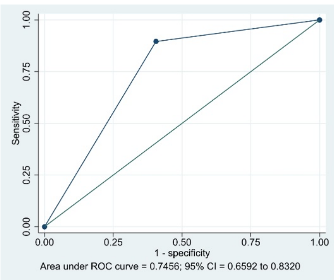
2.2 Statistical Analysis



ROC Curve for Overall Population



ROC Curve for Female Population



ROC Curve for Diabetes Population

Figure 1 ROC Curve on DETAK C MI Risk Predictionation

The data were analyzed using SPSS version 25.0. The diagnostic performance of DETAK C was evaluated by calculating the area under the receiver operating characteristic curve (AUC), sensitivity, and specificity for each subgroup using the confirmed diagnosis as the reference standard. The AUC represents the ability of DETAK C to discriminate between AMI and non-AMI cases. Sensitivity represents the proportion of AMI cases correctly identified by DETAK C. Specificity represents the proportion of non-AMI cases correctly excluded by DETAK C. The 95%

confidence intervals (CI) for the AUC, sensitivity, and specificity were calculated using the DeLong method. The statistical analysis was performed using R software version 4.0.5.

3. RESULT

3.1 Study Sample

The baseline characteristics of the study population are shown in Table 1. A total of 539 participants were enrolled from several hospitals in Malang, Tulung Agung, Banjarmasin, and Kandangan, Indonesia. Of these, 248 (46.0%) were diagnosed with MI and 291 (54.0%) were diagnosed with non-MI chest pain. The mean age of the participants was 58.7 ± 12.4 years and 328 (60.9%) were male. The most common risk factors were hypertension (64.6%), diabetes mellitus (37.1%), and dyslipidemia (35.4%).

The diagnostic performance of DETAK in the overall population and in subgroups of elderly, female, and diabetic patients are shown in Table 3 and Figure 1. In the general population, DETAK revealed excellent diagnostic performance for MI, with an area under the curve (AUC) of 0.8109 (95% confidence interval [CI] 0.7738 to 0.8481), a sensitivity of 87.1%, a specificity of 79.5%, a positive predictive value (PPV) of 76.6%, a negative predictive value (NPV) of 88.7%, and an accuracy of 83.3%. However, for elderly patients (age ⩾ 65 years), DETAK showed good but lower diagnostic performance than in the overall population, with an AUC of 0.7189 (95% CI 0.6337 to 0.8041), a sensitivity of 84.1%, a specificity of 62.9%, a PPV of 63.2%, a NPV of 83.6%, and an accuracy of 72.9%. which yielded a sensitivity of 84.1% and a specificity of 62.9%.

Similarly, for female patients, DETAK showed good but lower diagnostic performance than in the overall population, with an AUC of 0.7408 (95% CI 0.6565 to 0.8252), a sensitivity of 80.0%, a specificity of 76.7%, a PPV of 68.8%, a NPV of 85.7%, and an accuracy of 78.2% which yielded a sensitivity of 80.0% and a specificity of 76.7%. For diabetic patients, DETAK showed good and comparable diagnostic performance to the overall population, with an AUC of 0.7458 (95% CI 0.6592 to 0.8320), a sensitivity of 83.9%, a specificity of 79.9%, a PPV of 77.4%, a NPV of 85.7%, and an accuracy of 81.8% which yielded a sensitivity of 83.9% and a specificity of 79.9%.

4. DISCUSSION

The results showed that DETAK had excellent diagnostic performance for MI in the overall population, with an area under the curve (AUC) of 0.8109, which indicates a high accuracy and discriminative ability. The algorithm also had high sensitivity and specificity, which means that it could correctly identify most of the MI and non-MI cases. The accuracy of the algorithm was 83.3%, which means that it correctly classified more than four out of five cases.

Table 2. Multivariate analysis on Risk Prediction of MI incorporated in DETAK C Algorithm.[9]

VARIABLES	P VALUE	EXP (β)	95% CI	
			LOWER	UPPER
Gender (Male)	0.061	2.986	0.952	9.369
Diabetes Mellitus (yes)	0.005	6.393	1.777	23.004
Was the chest pain located at the left/middle chest? (yes)	0.000	4.381	1.047	18.333
Did the chest pain radiate to the back? (yes)	0.052	12.384	3.378	45.405
Was the chest pain provoked by activity and relieved by rest? (no)	0.000	34.543	10.761	110.853
Was the chest pain provoked by food ingestion, positional changes, or breathing? (no)	0.043	4.679	0.988	22.158

However, the diagnostic performance of DETAK varied across different subgroups of patients, such as elderly, female, and diabetic patients. For elderly patients (age ≥ 65 years), DETAK showed good but lower diagnostic performance than in the overall population, This means that the algorithm had more difficulty in distinguishing MI from non-MI cases in this subgroup, especially in terms of specificity and PPV, which indicate the probability of having MI given a positive test result. Similarly, for female patients, DETAK showed good but lower diagnostic performance than in the overall population, with an AUC of 0.7408, a sensitivity of 80.0%, a specificity of 76.7%, a PPV of 68.8%, a

NPV of 85.7%, and an accuracy of 78.2%. This means that the algorithm also had more difficulty in distinguishing MI from non-MI cases in this subgroup, especially in terms of sensitivity and PPV, which indicate the ability to detect MI cases and the probability of having MI given a positive test result. For diabetic patients, DETAK showed good and comparable diagnostic performance to the overall population,

DETAK C has a significant role in early diagnosis of MI thus lowering Ischemic time. Longer Ischemic time was

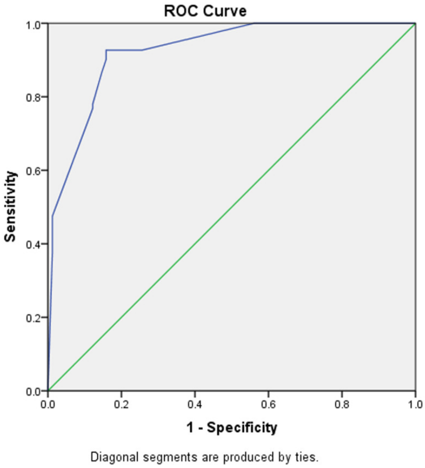


Figure 2 receiver operating characteristic (ROC) curve analysis of DETAK C algorithm in predicting MI in previous study.[10]

associated with increased in hospital and late cardiovascular mortality and especially higher in high – risk population.[6] Despite the critical importance of timely treatment, delay times exceeding 2 hours are still commonly reported.[8] A multicentre study by Sohlpour *et al.,* (2015) suggested that longer IT correlated with larger infarct size and higher 30 day-mortality in Myocardial infarction patients.[11] Furthermore, IT was a better predictor of prognosis dan Door to Needle and Door to Balloon time.[12] Longer delay also contribute to the choice of revascularization and its efficacy. STREAM (Strategic Reperfusion Early After Myocardial Infarction) trial observed Thrombolysis and early PCI within 3 hours of onset has similar efficacy as PPCI.[10] Understanding and addressing these delays is crucial for improving patient outcomes and optimizing healthcare delivery for MI patients.

The findings in this study augments the result of our previous study by Hendrawati et al., (2020) which showed that early revascularization through primary PCI was associated with better outcomes (rehospitalizatoin, and mortality than late, and even no revascularization in STEMI patients.[13] Further highlighting the importance of timely diagnosis and treatment of AMI to prevent adverse consequences such as mortality, hospital readmission, recurrent MI, and worsening heart failure.

4.1 Artificial Intelligence for Early Diagnosis of MI and Improve Quality of Care

DETAK C is a smartphone application using AI algorithm for risk prediction of MI. Risk prediction algorithm for DETAK C has been elucidated in a multicentre study by [12]. The study was conducted in Malang, Indonesia enrolling 199 patients admitted to emergency room with chest pain.[14] Among the patients were 106 patients diagnosed with MI. The result was the risk prediction using following algorithm: 1) left/middle chest pain, 2) retrosternal chest pain, 3) exertional chest pain that is relieved by rest, and 4) chest pain from food ingestion, positional changes, or breathing triggering. This model has 92.7% sensitivity, 84.1% specificity, 85% positive predictive value (PPV), 86% negative predictive value (NPV), and 86% accuracy.[15] Figure (2) and Table (2) further summarize this finding.

Artificial intelligence (AI) has begun to be studied to improve quality of care for MI patients. There have been several studies that have used artificial intelligence to aid in the treatment of patients with Myocardial Infarction (MI). One such study was the “Me & My Heart” (eMocial) Study, which evaluated whether patient support, administered via

Figure 4 DETAK C Interface in Reporting Chest Pain Real Time and Referral to Appropriate Healthcare Facility.[12]

an electronic device-based app, increased adherence to treatment and lifestyle changes in patients with MI treated with ticagrelor in routine clinical practice.[13] Another study, the MoTER-MI study, used a user-centered design approach to develop a smartphone app for patients with MI.[14] Additionally, a study published in the Journal of Telemedicine and Telecare found that smartphone-based tele-electrocardiography support for primary care physicians reduced the pain-to-treatment time in MI.[15] These studies demonstrate the potential for AI to improve the treatment and management of MI.

DETAK C algorithm determines whether patient should be referred to nearest PCI capable hospital for revascularization or primary healthcare centre for further diagnosis (Figure 3).[12] This functionality was could further reduce ischemic time and improve cost effectiveness as it more accurately allocate patient with high risk of MI immediately to appropriate facility. As of the present, DETAK C has already been installed by more than 2,170 users.

The results suggested that DETAK is a promising tool for detecting MI, but it may need further refinement and validation for different subgroups of patients who may have atypical presentations of MI. The algorithm may also benefit from incorporating other clinical variables, such as symptoms, risk factors, and biomarkers, to improve its diagnostic performance and reduce its variability across subgroups. Future studies should also evaluate the impact of DETAK on clinical outcomes, such as mortality, morbidity, and resource utilization, compared to conventional methods for diagnosing MI.

3. CONCLUSION

The DETAK C smartphone application has good performance in diagnosing of MI in patients with symptom of chest pain. The risk prediction algorithm however, need to be improved and validated in larger population. Further collaborative effort warranted to support development DETAK C in Indonesia.

AUTHORS' CONTRIBUTIONS

All authors contributed equally to the production of this article.

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