The Contemporary Management and Coronary Angioplasty Outcomes in Young Patients with ST-Elevation Myocardial Infarction (STEMI) age < 40 years old: The Insight from Nation-wide Registry

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Research Article

Keywords: ST elevation myocardial infarction (STEMI), percutaneous coronary intervention (PCI), coronary artery disease, Thai PCI registry, real-world

Posted Date: April 9th, 2024

DOI: https://doi.org/10.21203/rs.3.rs-4172596/v1

Additional Declarations: No competing interests reported.

Abstract

Background

Cardiovascular disease (CVD) remains one of the major causes of death around the world in which ST elevation MI (STEMI) is in the lead. Although the mortality rate from STEMI seems to decline, this result might not be demonstrated in young adults who basically have different baseline characteristics and outcomes compared with older patients.

Methods

Data of the STEMI patients aged 18 years or older who underwent PCI during May 2018 to August 2019 from Thai PCI Registry, a prospective, multi-center, nationwide study, was included and aimed to investigate the predisposing factors and short-term outcomes of patients aged < 40 years compared with age 41–60, and > 61 years.

Results

Data of 5,479 STEMI patients were collected. The patients' mean age was 62.6 (SD = 12.6) years, and 73.6% were males. There were 204, 2,154, and 3,121 patients in the youngest, middle, and oldest groups. The young patients were mainly male gender (89.2% vs 82.4% and 66.6%; p < 0.001), were current smokers (70.6%, 57.7%, 34.1%; p < 0.001), had BMI ≥ 25 kg/m2 more frequently (60.8%, 44.1%, 26.1%; p < 0.001), and had greater family history of premature CAD (6.9%, 7.2%, 2.9%; p < 0.001). The diseased vessel in the young STEMI patients was more often single vessel disease with the highest percentage of proximal LAD stenosis involvement. Interestingly, there were trends of higher events of cardioversion/defibrillation, procedural failure, procedural complications, and prolonged median hospital stay in both youngest and oldest groups compared to the middle-aged group. In-hospital death was found in 3.4% in the youngest group compared to 3.3% in the middle-aged patients and 9.2% in the older patients (p < 0.001).

Conclusions

STEMI in young patients is not uncommon nowadays. Although the mortality rate of PCI in real-world practice was low, young patients had a trend of having higher procedural failure and complications of PCI when compared with middle-aged group. Their major modifiable factors were smoking and obesity.; Therefore, encouraging young people to quit smoking and control weight might be essential to prevent STEMI in the young.

Background

Cardiovascular disease (CVD) is a major cause of death and adverse clinical outcomes worldwide. Significant advances in primary and secondary prevention of CVD have led to a large reduction of cardiovascular events (CV) as well as CV mortality (1). However, the same reduction in CV events has not been observed in young adults (2), and CVD remains a major cause of death among young people around the world (3, 4, 5). Some studies reported a remarkable increase in the annual MI admission rate, especially in young women (6).

Many epidemiological studies have shown the different risk profiles in the younger MI compared to the older. Although plaque rupture is still a main pathology of myocardial infarction (MI) less atherosclerotic change and some specific conditions such as coronary microvascular dysfunction, spontaneous coronary artery dissection and coronary spasm related to drug use have more prevalences among the younger group (7). Race and ethnicity are recognized as one of the major risks among other several factors related to this fatal condition. Although there was MI in the young studies that conducted in eastern and western countries in the past, the data in Asian countries which had diversity in ethnicity, culture and lifestyles were not many. Moreover, recent technologies and medication have been developing continuously. Therefore, the outcome of the treatment had improved and become more beneficial compared to the previous days.

However, the number of patients of interest in each paper was varied but in hundreds and mostly come from single institutions. Moreover, data of MI in the young have not been extensively analyzed in southeastern Asian population especially not comprising the nationwide information. Therefore, this study which believed to be more contemporary, was conducted using data from the multicenter national Thai PCI registry (8) from 39 hospitals across the country. This study aimed to investigate the predisposing factors and short-term outcomes of patients aged < 40 years compared with age 41–60, and > 61 years from multicenter nationwide Thai PCI registry.

Materials and methods

The present study utilized the data from Thai PCI Registry, a prospective, multi-center, nationwide study initiated by the Cardiac Intervention Association of Thailand (CIAT). Briefly, there were 39 government and private hospitals that voluntarily participated. Patients aged 18 years or older who were diagnosed as ST-elevation myocardial infarction (STEMI) and underwent PCI during May 2018 to August 2019 were included in this study. The study was approved by the Central Research Ethics Committee (COA-CREC # 006/2018), and the local Ethics Committee (EC) if required. All participants provided written informed consents.

Data

The details of baseline characteristics, procedural detail and outcomes were acquired from the Thai PCI Registry main study. All STEMI patients were included and categorized as young, middle-aged, and elderly groups (< 40, 40-60, and >60 years, respectively). Their data with the principal consideration including predisposing factors, left ventricular ejection fraction (LVEF), laboratory results (fasting blood sugar,

HbA1C, hemoglobin and hematocrit, cardiac enzymes, creatinine and LDL level), procedural details, coronary anatomy, intra and post-procedural clinical events, procedural success, causes of procedural failure and procedural complications, in-hospital and 1 year morbidity and mortality and a multivariable Cox regression of factors associated with death at 1 year of the youngest STEMI patients compared to other patient groups were retrieved.

Statistical analysis

Baseline characteristics of patients were described and compared between three age groups using a Chi-square test for categorical variables, and quartile regression for quantitative variables. A univariate Cox regression was applied to assess individual risk factors of mortality at 1 year. Risk factors whose p-values <0.1 were simultaneously considered in a multivariate Cox regression, only significant risk factors were then kept in the final model. All analyses were stratified by age groups and performed using STATA 18.0. A P value less than 0.05 was considered statistical significance.

Results

Of all patients in Thai PCI registry, 5,479 STEMI patients were eligible and included in this study. The mean age was 62.6 (SD=12.6) years, 73.6% of patients were males.

There were 204, 2154, and 3121 patients in the youngest, middle, and oldest groups, respectively. Characteristics of the patient were compared by age groups, see Table 1. Compare among all groups, the youngest and middle-aged patients were mainly male gender (89.2% vs 82.4% and 66.6%; $p < 0.001$), were current smoker (70.6%, 57.7%, 34.1%; $p < 0.001$), had BMI≥25 kg/m^2 (60.8%, 44.1%, 26.1%; $p < 0.001$), and had greater family history of premature CAD (6.9%, 7.2%, 2.9%; $p < 0.001$). In terms of health coverage scheme, almost two-thirds of each group had universal coverage, but the youngest group had a social security service scheme in the highest number (26%), whereas the oldest group was covered with government service/state enterprise (20.4%) ($p< 0.001$). The oldest group were more frequently diagnosed with hypertension, dyslipidemia, cerebrovascular disease, chronic lung disease, prior heart failure, prior valve surgery/procedure, chronic kidney disease (CKD), prior coronary bypass graph (CABG), and diabetes mellitus.

After acute MI presentation, the youngest patients significantly presented to the hospital earlier than other groups with significantly lower median time (IQR) of first medical contact (FMC) to device of 3.4 hours (1.9, 7.9), 4.2 hour (2.2, 11.1) and 4.8 hour (2.6, 12.3) ($p < 0.001$), respectively (see Table 2). They also had greater proportion of primary PCI than older patients (69.0%, 61.1%, 59.8%; $p = 0.017$) and got Alteplase thrombolytic in higher number (5.3%, 0.4%, 0.4%; $p < 0.001$). On the other hand, they seemed less likely to receive pharmaco-invasive treatment than other groups (13.8%, 16.3%, 18.8%). Regarding the extent and severity of disease vessel, the oldest group was significantly associated with triple vessel disease (10.3%, 18.8%, 25.5%) and left main disease (4.4%, 5.3%, 9.5%) with $p < 0.001$, whereas the younger groups highly associated with single vessel disease. Among STEMI patients, the significant

stenosis lesions in LAD were found in 83%, 87.9%, 87.9%, and RCA in 81.2%, 83.8%, 86.0% each group, that did not show statistical differences. The median calculated syntax score (IQR) was notably, but not surprisingly, higher in the oldest group (10 (6, 18), 13 (7, 20), 16 (9, 23); p = 0.009). Although the IRA was insignificantly different among groups, when thoroughly explored the stenotic segment involvement, we found that the youngest group had the highest percentage of proximal LAD stenosis (99%, 90%, 80%; p = 0.003) while the oldest group remarkably had the highest percentage of left main segment stenosis.

Concerning PCI procedures, though there was insignificant difference in PCI status and the percentage of PCI for culprit lesions, the oldest patients seemed to have less emergency PCI than the younger ones (81.9%, 73.6%, 74.1%), see Table 2. Moreover, elderly patients significantly associated with cardiogenic shock at start of PCI (14.7%, 17.0%, 24.7%, p<0.001) and use of IABP (6.9%, 5.7%, 9.7%, p < 0.001). On the contrary, the youngest group had thrombus burden (p<0.001) and aspiration catheters were most use (p = 0.002).

Regarding intra and post procedural clinical events, unsurprisingly, the oldest group had significantly higher events of cardiogenic shock, heart failure, RBC/whole blood transfusion, bleeding within 72 hours, arrhythmia requiring treatment, ET-tube intubation, and temporary pacemaker insertion, death in hospital and death in one year than both younger groups, see Table 3. Interestingly, there were trends of higher events of new requirement for dialysis, cardioversion/defibrillation, procedural failure, procedural complications, and prolonged median hospital stay in both youngest and oldest groups compared to the middle-aged group. Adding to this, the youngest patients had more frequently been prescribed with GP IIb/IIIa inhibitor (23.2%, 16.5%, 15.2%; p = 0.009).

Procedural complications and cause of procedural failure were described, see Supplement Table 1. No reflow after primary PCI was more frequently observed in both youngest and oldest groups comparing to the middle-aged group (2.9%, 1.5%, 3.3%; p <0.001).

Of all 5,479 patients, 7 (3.4%) out of 237 patients in the youngest group died during hospital stay compared to 72 (3.3%) out of 2,512 middle-aged patients and 287 (9.2%) out of 3,624 older patients (p < 0.001), see Table 3. The death at 1 year among all patients as well was notably higher in the oldest group (22.3%) compared with the other younger groups (8.8% in patients age ≤ 40 and 7.9% in patients aged 41-60, respectively).

Univariate and multivariate analyses were performed to identify risk factors associated with death within a year for each age group, see Table 4 and Supplement Table 2. Among patients aged ≤ 40 years, factors associated with increased mortality included chronic lung disease, prior heart failure, left main disease, and having procedural failure with HR of 84.67 (14.38, 498.61), 10.27 (2.71, 38.94), 9.09 (2.28, 36.22), and 12.07 (2.83, 51.53), respectively. For age 41-60 years, left main disease and procedural failure remained significantly with additional CKD and diabetes with HR of 2.60 (1.57, 4.29), 2.42 (1.30, 4.50), 3.84 (2.77, 5.31) and 1.46 (1.06, 2.01), respectively, see Table 4.

For age > 60 years, chronic lung disease, CKD, heart failure, left main disease, and procedural failure were still significantly associated with death with additional risk factors of cerebrovascular disease, dialysis, peripheral arterial disease, prior valve surgery, and procedure complications with HR of 1.46 to 2.51; whereas male and high BMI significantly lowering risk of death by approximately 30%; see Table 4.

Discussion

The present study demonstrated that from the Thai PCI registry data, STEMI was the presentation among 204 (3.7%), 2,154 (39.3%) and 3,121 (57.0%) patients, age 40 years or younger, 41-60, and > 60 years. For the population of interest, the youngest STEMI patient group had significant risk factors including male sex, BMI > 25, current smoking, and significant family history of premature CAD. Compared to the patients who were older, they had highly access to primary PCI and even though the thrombolytic of choice which was streptokinase was alike, they had more chance to get Alteplace. Interestingly, their disease vessels quite predominantly associated with single vessel disease and the lesion of proximal LAD was the commonest vessel involved. Their infarct related lesions had a high thrombus burden and the aspiration catheters and GP IIb/IIIa inhibitors were used in highest number. Furthermore, along with the oldest patient group, they all had higher procedural failure rate and more procedural complications of PCI than the middle-aged group which “no reflow” was the most prevalent.

Death was most presented in old age, followed by younger and middle age groups with 22.3%, 8.8%, and 7.9%, respectively. The risk factors for death were common in all age groups, including chronic lung disease, previous heart failure, left main disease, and additional procedural failure with some more risk factors in older age groups including CKD, cerebrovascular disease, dialysis, peripheral arterial disease, prior valve surgery. Furthermore, male sex and BMI$\geq$ 25 were preventive factors of death in the oldest age group.

According to literatures, the definition of young age was varied from <40 to < 55 years and prevalence of MI in young age patients was also varied from 0.1 % to 20% depending on the definition (9-11). Although male had a higher chance of having MI than female in all age groups, it was strongly more prominent in young age patients, which corresponded to other studies (12,13). This may be explainable from the positive effect of female hormones and less smoking among women (14,15). Risk factors for MI in young including smoking, family history of premature CAD, hyperlipidemia, which are becoming more commonplace in the younger population, were mentioned in previous reports (16-18). Some studies emphasized that smoking was the most important risk factor among the young MI population, particularly those who smoked more than 15 cigarettes per day (19,20). In many studies, high BMI and central obesity were also associated with MI at a younger age (21,22) which the finding agreed with this study. However, the elderly patients who had lower BMI had a strong association with greater mortality rate which relevant to the previous clinical data (23).

There were correlations between smoking, obesity, and the extent of fatty streaks in the coronary vessels (24). On the contrary, the present study found that other traditional comorbid diseases such as

hypertension, dyslipidemia, diabetes mellitus, chronic lung disease, and chronic kidney disease had less prevalence in the younger age groups compared to the older age groups, which was consistent with other reports (25,26). Therefore, this finding emphasized smoking and obesity as ones of major modifiable risk factors which were more common in younger people and should be fully aimed to prevent this lethal disease in young patients. Hence, the encouragement to quit smoking and lifestyle modification were important awareness for coping with MI in the young issues.

Concerning the treatment, reperfusion strategy with primary angiography is recommended over thrombolysis according to the guidelines, especially within 120 minutes after first medical contact (27,28). However, in case that the patients still have ongoing symptoms from 12 to 72 hours or with unstable hemodynamics, this invasive procedure can still be considered (29). On the other hand, routine PCI of an occluded IRA in STEMI patients presenting >48 h after onset of symptoms and without persistent symptoms is not indicated (30,31). The present study demonstrated that not only there were significantly more patients at the young age group who underwent primary PCI compared to the older groups, but also their time to device was shorter. Single vessel disease was more common among the younger group, whereas the older groups had more pathologies of left main, double, and triple vessel with higher syntax score. These findings were in line with other studies (32,33) as the mechanism causing STEMI in different age ranges was different. The older of the patients, the more underlying diseases such as hypertension, diabetes, and dyslipidemia were prevalent. For this reason, atherosclerotic disease was the main factor that narrowed and occluding small vessels in several organs, including the heart, brain, kidney, and extremities, in the older group. On the other hand, non-atherosclerotic coronary problems such as coronary anomalies, coronary embolism, coronary spasm, fibrous plaque, vasculitis, trauma, and spontaneous coronary artery dissection should be considered in young patients (34,35). Thrombus formation due to coronary pathologies was presented more frequently in patients less than 40 years of age. The reason for higher thrombogenic cause possibly was from the effect of tobacco smoking which contributes to higher chance of endothelial dysfunction, inflammation process, and thrombogenesis. Furthermore, the effects of inflammation and hypercoagulable state from cigarette would last for more than 20 years (36,37). Therefore, smoking cessation should be strongly reemphasized.

Postoperative courses and clinical outcomes, particularly both in-hospital and one-year mortality, cardiogenic shock, heart failure and bleeding of patients with < 40 years old were better than other age groups which might be related with the lower comorbid diseases in preoperative status amid these young patients. The main concern of the younger people was the higher incidence of no-reflow phenomenon which was a consequence of greater thrombus formation. Despite successful opening of the occluded epicardial artery, the myocardial reperfusion was still decreased. This phenomenon was associated with microembolization of atherothrombotic particles to the distal vessels regarding as a predictor of adverse outcomes (38,39). Thrombus aspiration was acknowledged as an alternative technique to alleviate the distal microembolization. However, the effectiveness of this adjunct procedure was still in doubt and some studies demonstrated more harm and along with higher stroke rate (40). Although one third of the patients less than 40 years old got the aspiration technique, the overall complications were still lower compared to the others.

Conclusions

STEMI in young patients is not uncommon nowadays. Although the mortality rate of PCI in real-world contemporary practice was low, young patients had a trend of having higher procedural failure and complications of PCI when compared with middle-aged group. Their major modifiable factors were smoking and obesity. Therefore, encouraging young people to quit smoking and control weight were essential to prevent STEMI in the young.

Declarations

Funding

The Thai PCI Registry project received a research grant from the Health System Research Institute, The Ministry of Public Health, in Thailand, March 2017.

Author Contribution

P.P., P.P. and N.S. wrote the main manuscript text and A.T. prepared tables and supplementary materials. All authors reviewed the manuscript.

Data Availability

The data that support the findings of this study are available from the Thai PCI registry, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the corresponding author upon reasonable request and with permission of the Thai PCI registry.

References

1. Eisen A, Giugliano RP, Braunwald E. Updates on acute coronary syndrome: a review. JAMA Cardiol. 2016;1:718–30.
2. Gupta A, Wang Y, Spertus JA, Geda M, Lorenze N, Nkonde-Price C, et al. Trends in acute myocardial infarction in young patients and differences by sex and race, 2001 to 2010. J Am Coll Cardiol. 2014;64:337–45.
3. Roth GA, Huffman MD, Moran AE, Feigin V, Mensah GA, Naghavi M, et al. Global and regional patterns in cardiovascular mortality from 1990 to 2013. Circulation. 2015;132:1667–8.
4. Arora S, Stouffer GA, Kucharska-Newton AM, Qamar A, Vaduganathan M, Pandey A, et al. Twenty year trends and sex differences in young adults hospitalized with acute myocardial infarction. Circulation. 2019;139:1047–56.

5. Trzeciak P, Gierlotka M, Polonski L, Gasior M. Treatment and outcomes of patients under 40 years of age with acute myocardial infarction in Poland in 2009–2013: an analysis from the PL-ACS registry. Pol Arch Intern Med. 2017;127(10):666–73.
6. Garcia M, Mulvagh SL, Merz CNB, Buring JE, Manson JE. Cardiovascular disease in women: clinical perspectives. Circ Res. 2016;118(8):1273–93.
7. Gulati R, Behfar A, Narula J, Kanwar A, Lerman A, Cooper L et al. Acute myocardial infarction in young individuals. Mayo Clin Proc. 2020;95(1):136 – 56.
8. Sansanayudh N, Srimahachota S, Chandavimol M, Limpijankit T, Kehasukcharoen W. Multi-center, prospective, nation-wide coronary angioplasty registry in Thailand (Thai PCI registry): registry design and rationale. J Med Assoc Thai. 2021;104:1678–6784. 10.35755/jmedassocthai.2021.10.13066.
9. Navas-Nacher EL, Colangelo L, Beam C, Greenland P. Risk factors for coronary heart disease in men 18 to 39 years of age. Ann Intern Med. 2001;134(6):433–9.
10. Loughnan ME, Nicholls N, Tapper NJ. Demographic, seasonal, and spatial differences in acute myocardial infarction admissions to hospital in Melbourne Australia. Int J Health Geogr. 2008;7:42.
11. Fournier JA, Sanchez A, Quero J, Fernandez-Cortacero JA, Gonzalez-Barrero A. Myocardial infarction in men aged 40 years or less: a prospective clinical-angiographic study. Clin Cardiol. 1996;19(8):631–6.
12. Avezum A, Makdisse M, Spencer F, Gore JM, Fox KAA, Montalescot G, et al. Impact of age on management and outcome of acute coronary syndrome: observations from the Global Registry of Acute Coronary Events (GRACE). Am Heart J. 2005;149(1):67–73.
13. Doughty M, Mehta R, Bruckman D, Das S, Karavite D, Tsai T, et al. Acute myocardial infarction in the young – the University of Michigan experience. Am Heart J. 2002;143:56–62.
14. Bolego C, Poli A, Paoletti R. Smoking and gender. Cardiovasc Res. 2002;53:568–76.
15. Vasiljevic Z, Scarpone M, Bergami M, van der Yoon J, Krljanac G, et al. Smoking and sex differences in first manifestation of cardiovascular disease. Atherosclerosis. 2021;330:43–51.
16. Haider KH, Alshoabi SA, Alharbi IA, Gameraddin M, Abdulaal OM, Gareeballah A, et al. Clinical presentation and angiographic findings of acute myocardial infarction in young adults in Jazan region. BMC Cardiovasc Disord. 2023;23(1):302.
17. Tungsubutra W, Tresukosol D, Buddhari W, Boonsom W, Sanguanwang S, Srichaiveth B. Acute coronary syndrome in young adults: the Thai ACS Registry. J Med Assoc Thai. 2007;90(Suppl 1):81–90.
18. Bhardwaj R, Kandoria A, Sharma R. Myocardial infarction in young adults–risk factors and pattern of coronary artery involvement. Niger Med J. 2014;55(1):44–7.
19. Weinberger I, Rotenberg Z, Fuchs J, Sagy A, Friedmann J, Agmon J. Myocardial Infarction in young adults under 30 years: risk factors and clinical course. Clin Cardiol. 1987;10(1):9–15.
20. Wannamethee SG, Lowe GDO, Shaper AG, Rumley A, Lennon L, Whincup PH. Associations between cigarette smoking, pipe/cigar smoking, and smoking cessation, and haemostatic and inflammatory

markers for cardiovascular disease. Eur Heart J. 2005;26(17):1765–73.
21. Wu WY, Berman AN, Biery D, Blankstein R. Recent trends in acute myocardial infarction among the young. Curr Opin Cardiol. 2020;35(5):524–30.
22. Shah N, Kelly AM, Cox N, Wong C, Soon K. Myocardial infarction in the “young”: risk factors, presentation, management and prognosis. Heart Lung Circ. 2016;25(10):955–60.
23. Su W, Wang M, Zhu J, Li W, Ding X, Chen H, et al. Underweight predicts greater risk of cardiac mortality post acute myocardial infarction. Int Heart J. 2020;61(4):658–64.
24. Berenson GS, Srinivasan SR, Bao W, Newman WP III, Tracy RE, Wattigney WA. Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. The Bogalusa Heart Study. N Engl J Med. 1998;338(23):1650–6.
25. Head T, Daunert S, Goldschmidt-Clermont PJ. The aging risk and atherosclerosis: a fresh look at arterial homeostasis. Front Genet. 2017;8:216.
26. Jackson CF, Wenger NK. Cardiovascular disease in the elderly. Rev Esp De Cardiol. 2011;64(8):697–712.
27. O’Gara PT, Kushner FG, Ascheim DD, CaseyJr DE, Chung MK, de Lemos JA, et al. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. Circulation. 2013;127:e362–425.
28. Levine GN, Bates ER, Blankenship JC, Bailey SR, Bittl JA, Cercek B, et al. 2015 ACC/AHA/SCAI Focused Update on Primary Percutaneous Coronary Intervention for Patients With ST-Elevation Myocardial Infarction: An Update of the 2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention and the 2013 ACCF/AHA Guideline for the Management of ST-Elevation Myocardial Infarction. Circulation. 2016;133:1135–47.
29. Partow-Navid R, Prasitlumkum N, Mukherjee A, Varadarajan P, Pai RG. Management of ST elevation myocardial infarction (STEMI) in different settings. Int J Angiol. 2021;30(1):67–75.
30. Hochman JS, Lamas GA, Buller CE, Dzavik V, Reynolds HR, Abramsky SJ, et al. Coronary intervention for persistent occlusion after myocardial infarction. N Engl J Med. 2006;355(23):2395–407.
31. Menon V, Pearte CA, Buller CE, Steg PG, Forman SA, White HD, et al. Lack of benefit from percutaneous intervention of persistently occluded infarct arteries after the acute phase of myocardial infarction is time independent: insights from Occluded Artery Trial. Eur Heart J. 2009;30(2):183–91.
32. Wolfe MW, Vacek JL. Myocardial infarction in the young. Angiographic features and risk factor analysis of patients with myocardial infarction at or before the age of 35 years. Chest. 1988;94(5):926–30.
33. Qureshi W, Kakouros N, Fahed J, Rade JJ. Comparison of prevalence, presentation, and prognosis of acute coronary syndromes in ≤ 35 years, 36–54 years, and ≥ 55 years patients. Am J Cardiol. 2021;140:1–6.

34. Thomas M, Waterbury G, Tarantini B, Vogel R, Mehran, Bernard J, Gersh. Rajiv Gulati. Non-atherosclerotic causes of acute coronary syndromes. Nat Rev Cardiol. 2020;17(4):229–41.
35. Krittanawong C, Khawaja M, Tamis-Holland JE, Girotra S, Rao SV. Acute myocardial infarction: etiologies and mimickers in young patients. JAHA. 2023;12:e029971.
36. Ambrose JA, Barua RS. The pathophysiology of cigarette smoking and cardiovascular disease: an update. J Am Coll Cardiol. 2004;43:1731–7.
37. Ngozi SC, Ernest NE. Long-term smoking results in haemostatic dysfunction in chronic smokers. Niger Med J. 2014;55(2):121–5.
38. Ndrepepa G, Kastrati A. Coronary no-reflow after primary percutaneous coronary intervention-current knowledge on pathophysiology, diagnosis, clinical impact and therapy. J Clin Med. 2023;12(17):5592.
39. Januszek R, Siudak Z, Malinowski KP, Wojdyla R, Mika P, Wanha W, et al. Aspiration thrombectomy in patients with acute myocardial infarction-5-year analysis based on a large national registry (ORPKI). J Clin Med. 2020;9(11):3610.
40. Perera D, Rathod KS, Guttmann O, Beirne AM, O'Mahony C, Weerackody R, et al. Routine aspiration thrombectomy is associated with increased stroke rates during primary percutaneous coronary intervention for myocardial infarction. Am J Cardiovasc Dis. 2020;10(5):548–56.

Tables

Table 1. Baseline characteristics of all patients

Factors	Age			P value
	≤ 40	41 - 60	> 60	
	n= 204	n= 2,154	n= 3,121	
Male, n (%)	182 (89.2)	1,774 (82.4)	2,079 (66.6)	<0.001
BMI, n (%)				
< 25	80 (39.2)	1,204 (55.9)	2,305 (73.9)	<0.001
Health coverage scheme, n (%)				
Government service/state enterprise	18 (8.8)	327 (15.2)	638 (20.4)	<0.001
Social security service	53 (26.0)	307 (14.3)	37 (1.2)	
Others	1 (0.5)	32 (1.5)	26 (0.8)	
Universal coverage	132 (64.7)	1,488 (69.1)	2,420 (77.5)	
Current Smoking status, n (%)	144 (70.6)	1,242 (57.7)	1,063 (34.1)	<0.001
Hypertension, n (%)	54 (26.5)	897 (41.6)	1,738 (55.7)	<0.001
Dyslipidemia, n (%)	79 (38.7)	1,032 (47.9)	1,496 (47.9)	0.036
Cerebrovascular disease, n (%)	1 (0.5)	66 (3.1)	164 (5.3)	<0.001
Family history of premature CAD, n (%)	14 (6.9)	155 (7.2)	92 (2.9)	<0.001
Peripheral arterial disease, n (%)	1 (0.5)	11 (0.5)	33 (1.1)	0.084
Prior MI, n (%)	17 (8.3)	172 (8.0)	269 (8.6)	0.720
Known CAD, n (%)	5 (2.5)	91 (4.2)	164 (5.3)	0.065
Chronic lung disease, n (%)	2 (1.0)	33 (1.5)	131 (4.2)	<0.001
Prior heart failure, n (%)	8 (3.9)	80 (3.7)	243 (7.8)	<0.001
Prior valve surgery/procedure, n (%)	0 (0.0)	2 (0.1)	15 (0.5)	0.032
CKD, n (%)	17 (8.3)	293 (13.6)	1,214 (38.9)	<0.001
On Dialysis, n (%)	1 (0.5)	17 (0.8)	28 (0.9)	0.780
Prior PCI, n (%)	6 (2.9)	81 (3.8)	140 (4.5)	0.290
Prior CABG, n (%)	0 (0.0)	0 (0.0)	10 (0.3)	0.023
Diabetes mellitus, n (%)	64 (31.4)	931 (43.2)	1,376 (44.1)	0.002

BMI Body mass index, *MI* Myocardial infarction, *CAD* Coronary artery disease, *CKD* Chronic kidney disease, *PCI* Percutaneous coronary intervention, *CABG* Coronary artery bypass graft, *%* Percentage

Table 2. Cath Lab visit and best estimate of coronary anatomy.

Factors	Age			P value
	≤ 40	41 - 60	> 60	
	n= 204	n= 2,154	n= 3,121	
FMC to device, hr., median (IQR)	3.3 (1.9, 8.6)	4.3 (2.2, 12.0)	4.9 (2.6, 13.0)	<0.001
FMC to device, n (%)				
> 90 min	168 (82.4)	1,846 (85.7)	2,834 (90.8)	<0.001
≤ 90 min	36 (17.6)	308 (14.3)	287 (9.2)	
STEMI, n (%)				
Primary PCI	140 (69.0)	1,309 (61.1)	1,856 (59.8)	0.017
Rescue PCI	25 (12.3)	266 (12.4)	353 (11.4)	
Pharmacoinvasive	28 (13.8)	350 (16.3)	583 (18.8)	
PCI after 48	10 (4.9)	219 (10.2)	313 (10.1)	
Thrombolytics, n (%)	57 (28.1)	760 (35.5)	1,104 (35.7)	0.086
Type of Thrombolytic, n (%)				
Streptokinase	54 (94.7)	745 (98.4)	1,087 (98.7)	<0.001
Alteplase	3 (5.3)	3 (0.4)	4 (0.4)	
Tenecteplase	0 (0.0)	9 (1.2)	10 (0.9)	
Dominance, n (%)				
Right	196 (96.1)	2,011 (93.4)	2,963 (94.9)	0.028
Left	8 (3.9)	143 (6.6)	158 (5.1)	
Previous CABG, n (%)				
Yes	0 (0.0)	2 (0.1)	12 (0.4)	0.091
No	204 (100.0)	2,152 (99.9)	3,109 (99.6)	
Disease vessel, n (%)				
SVD	134 (65.7)	1,028 (47.7)	1,102 (35.3)	<0.001

DVD	40 (19.6)	605 (28.1)	927 (29.7)	
TVD	21 (10.3)	406 (18.8)	796 (25.5)	
Left main	9 (4.4)	115 (5.3)	296 (9.5)	
Calculated syntax score, median (IQR)	10 (6, 18)	13 (7, 20)	16 (9, 23)	0.009
LAD, n (%)	117 (83.0)	1,442 (87.9)	2,204 (87.9)	0.219
Percent stenosis in left main segment (segment No.5, median (IQR))	0.0 (0.0, 60.0)	0.0 (0.0, 50.0)	30.0 (0.0, 50.0)	<0.001
Percent stenosis in proximal LAD segment (segment 6)	99.0 (70.0, 100.0)	90.0 (70.0, 100.0)	80.0 (70.0, 99.0)	<0.001
Percent stenosis in mid LAD segment (segment 7)	70.0 (30.0, 95.0)	80.0 (60.0, 99.0)	80.0 (70.0, 95.0)	<0.001
Percent stenosis in distal LAD segment (segment 8)	0.0 (0.0, 80.0)	0.0 (0.0, 80.0)	0.0 (0.0, 80.0)	1.000
RCA, n (%)	95 (81.2)	1,157 (83.8)	1,943 (86.0)	0.094
PCI Status, n (%)				
Elective	7 (3.4)	156 (7.2)	212 (6.8)	0.100
Urgent	30 (14.7)	412 (19.1)	596 (19.1)	
Emergency	167 (81.9)	1,586 (73.6)	2,313 (74.1)	
Cardiogenic Shock at Start of PCI, n (%)	30 (14.7)	366 (17.0)	770 (24.7)	<0.001
IABP, n (%)	14 (6.9)	122 (5.7)	302 (9.7)	<0.001
PCI for Culprit Lesion, n (%)	196 (97.5)	2,055 (97.5)	2,969 (97.8)	0.780
Thrombus Present, n (%)	99 (48.5)	824 (38.3)	1,121 (36.0)	<0.001
POBA, n (%)	28 (13.7)	164 (7.6)	341 (10.9)	<0.001
Stent, n (%)	93 (45.6)	1,023 (47.5)	1,357 (43.5)	0.016
Aspiration catheter, n (%)	69 (33.8)	566 (26.3)	741 (23.7)	0.002

FMC First medical contact, *hr* Hour, *STEMI* ST-elevation myocardial infarction, *PCI* Percutaneous coronary intervention, *CABG* Coronary artery bypass graft, *SVD* Single vessel disease, *DVD* Double vessel disease, *TVD* Triple vessel disease, *LAD* Left anterior descending artery, *RCA* Right coronary artery, *IABP* Intra aortic balloon pump, *POBA* Plain old balloon angioplasty.

Table 3: Intra and post-procedure clinical events

Factors	Age			P value
	≤ 40	41 - 60	> 60	
	n= 237	n= 2,512	n= 3,624	
Myocardial Infarction, n (%)	40 (19.6)	257 (11.9)	378 (12.1)	0.005
Cardiogenic Shock, n (%)	30 (14.7)	330 (15.3)	730 (23.4)	<0.001
Heart Failure, n (%)	36 (17.6)	434 (20.1)	936 (30.0)	<0.001
CVA/Stroke, n (%)	1 (0.5)	15 (0.7)	28 (0.9)	0.64
Tamponade, n (%)	0 (0.0)	2 (0.1)	10 (0.3)	0.180
New Requirement for Dialysis, n (%)	3 (1.5)	19 (0.9)	48 (1.5)	0.110
Vascular Complications required treatment, n (%)	0 (0.0)	6 (0.3)	16 (0.5)	0.270
RBC/Whole Blood Transfusion, n (%)	1 (0.5)	15 (0.7)	70 (2.2)	<0.001
Bleeding Event within 72 Hours, n (%)	7 (3.4)	82 (3.8)	209 (6.7)	<0.001
Arrhythmia that required treatment, n (%)	15 (7.4)	154 (7.1)	292 (9.4)	0.007
ET-tube Intubation, n (%)	12 (5.9)	167 (7.8)	375 (12.0)	<0.001
Temporary Pacemaker, n (%)	3 (1.5)	40 (1.9)	105 (3.4)	0.002
Cardioversion /defibrillation, n (%)	7 (3.4)	65 (3.0)	128 (4.1)	0.120
Procedural failure, n (%)	6 (2.9)	45 (2.1)	104 (3.3)	0.028
Procedure complications, n (%)	18 (8.8)	126 (5.8)	293 (9.4)	<0.001
Length of stay, day, median (IQR)	3.0 (2.0, 5.0)	3.0 (2.0, 4.0)	3.0 (2.0, 5.0)	<0.001
GP IIb/IIIa, n (%)	47 (23.2)	350 (16.5)	470 (15.2)	0.009
Death in hospital, n (%)	7 (3.4)	72 (3.3)	287 (9.2)	<0.001
Death at 1 year, n (%)	18 (8.8)	170 (7.9)	695 (22.3)	<0.001

CVA Cerebrovascular accident, *RBC* Red blood cell, *ET* Endotracheal, *GP* Glycoprotein.

Table 4. Factors associated with Death 1 year by age groups: A multivariable Cox regression analysis

Age groups	≤40		41-60		>60	
Factors	HR (95%CI)	P value	HR (95%CI)	P value	HR (95%CI)	P value
Chronic lung disease	84.67 (14.38, 498.61)	<0.001			1.46 (1.08, 1.96)	0.014
CKD			3.84 (2.77, 5.31)	<0.001	2.41 (2.06, 2.83)	<0.001
Prior heart failure	10.27 (2.71, 38.94)	0.001			1.84 (1.5, 2.27)	<0.001
Dyslipidemia	0.27 (0.07, 0.98)	0.046	0.56 (0.41, 0.77)	<0.001		
Disease vessel						
Left main	9.09 (2.28, 36.22)	0.002	2.60 (1.57, 4.29)	<0.001	1.70 (1.34, 2.15)	<0.001
TVD	1.37 (0.25, 7.43)	0.712	1.03 (0.66, 1.60)	0.906	1.11 (0.91, 1.35)	0.305
DVD	1.72 (0.47, 6.32)	0.413	1.39 (0.97, 2.01)	0.075	0.96 (0.79, 1.17)	0.686
SVD	1					
Procedural failure	12.07 (2.83, 51.53)	0.001	2.42 (1.30, 4.50)	0.005	2.29 (1.72, 3.06)	<0.001
Procedural complication					1.61 (1.30, 1.99)	<0.001
Diabetes			1.46 (1.06, 2.01)	0.021		
Cerebrovascular disease					1.58 (1.21, 2.05)	0.001
Dialysis					2.4 (1.51, 3.81)	<0.001
Peripheral arterial disease					2.07 (1.29, 3.32)	0.003
Prior valve surgery/procedure					2.51 (1.28, 4.90)	0.007
Gender, Male					0.75 (0.64, 0.87)	<0.001
BMI ≥ 25					0.70 (0.58, 0.84)	<0.001

CKD Chronic kidney disease, *SVD* Single vessel disease, *DVD* Double vessel disease, *TVD* Triple vessel disease, *BMI* Body mass index, *HR* Heart rate, *CI* Confidence interval

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